

Opportunity Structure and Sex Differences in the Contribution of Genes and Environments
to Political Trust among Young Adults

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Abstract

Students of behavioral genetics tend to attribute sex differences in the expression of genetic influence to differences in the evolution of male and female humans for distinctive roles for reproduction and social life. Others resist this explanation, arguing differences are a product of contemporary gender inequality. We investigate the heritability of political trust among young U.S. adults, and find genetic and environmental contributions to political trust vary as a function of sex. Relying on expectations about how social structure could moderate the expression of genetic influence differently for men and women, we test a gene by environment interaction. Variation in economic and political opportunities enjoyed by women in different states moderates the expression of heritability for political trust. Our findings suggest sex differences are not exclusively the product of evolutionary processes, but that contemporary environments can shape the expression of gene-influenced predispositions.

Introduction

Some distinctions between males and females are empirically manifest among the vast majority of the population, such as physiology and size dimorphism. Other differences in behavior or psychological constructs such as attitudes and personality, as well as explanations for them, remain sources of profound disagreement. Students of the genetic basis for politics are often influenced by evolutionary psychologists in theorizing sex differences in the relative influence of genes and environments on political and social attitudes. In their path-breaking paper, Hatemi, Medland, and Eaves (2009) anticipate sex differences in political orientations as a function of differential evolutionary pressures related to childbirth and care that map to genetic, hormonal, and neurochemical differences between males and females. Similar theoretical and empirical research in sociobiology and psychology is subject to censure from feminist scholars and other critics who assert “these are simplistic explanations based on social ideas hidden falsely in scientific garb” (Kaplan and Rogers 2003:4). They claim that the evolutionary explanation for sex differences is endogenous to contemporary gender-based inequality.

Using data from the National Longitudinal Study of Adolescent Health (Add Health), we identify sex differences in the genetic expression of trust in government among young people in the U.S. Identifying the partial heritability of political trust is a contribution in its own right, given how social scientists currently understand its sources. However, we also question the extent to which these sex differences reflect essential characteristics of young male and female political actors and the extent to which they are a function of contemporary social-structural factors. For example, Eckel (2008) suggests that differences between male and female economic behavior may be rooted in fundamental differences in their preferences, but also anticipates that women are perceived differently from men and are afforded different opportunities as a result of these perceptions. This culturally-induced heterogeneity also influences differences in their behavior.

We hypothesize that the sex differences we find in the relative contribution of genes and environments to political trust are related to variation in the economic and political prospects of males and females. The resources and opportunities enjoyed by women and views about their appropriate role in politics vary across the American states (Arceneaux 2001). Specifically, the residents of some states tend to view women as less qualified for public service and better suited to work in the home. In these states, women also enjoy lower median incomes and less descriptive political representation. We expect variation in these resources, opportunities, and stereotypes about sex roles will moderate the expression of heritability in political trust among females. We do not rule out biological differences between males and females as a source of variation in political trust. However, we find preliminary evidence that suggests political behavior genetics researchers take seriously the role of environments to shape the expression of politically relevant genes. Given the nascence of the political behavior genetics research program and the potential for artifactual Gene x Environmental interactions (Eaves 2005), these findings – though suggestive - will require additional study and replication.

The Heritability of Trust in Government

Trust in government is an important concept in politics and political science. Just as many social scientists associate social trust with a wide variety of positive social and political outcomes, political scientists generally recognize political trust as beneficial to the smooth functioning of a government that has earned it. One of the primary motivations for studying the role of trust in government is a pervasive fear among scholars in the U.S. that people are less trusting of government today than they were years ago (Hetherington 1998, Alford 2001) and a general expectation that governments and societies function far better on a variety of dimensions when their members can and do trust each other and their government (Putnam 1993, Uslaner 2002).

For all of our collective interest in political trust, there is surprisingly little consensus about its causes and effects. Perhaps the most famous debate of this literature focuses on whether political trust flows from broad attributes of the political system (Miller 1974) – or from judgments about specific incumbents and regimes (Citrin 1974). Certainly other debates abound: Does political trust flow from good government (Hetherington 1998) or trust produce good government (Putnam 1993)? Is political trust learned from government performance (Jackman and Miller 1996) or a culturally embedded, moral characteristic (Almond and Verba 1989, Uslaner 2002) of a polity? Amid this discussion, study, and debate, “all of this research, whatever its specific conclusions, agrees on one point. Whether citizens express trust or distrust is primarily a reflection of their political lives, not their personalities nor even their social characteristics” (Levi and Stoker 2000:481). More directly to our purposes here: “Trust is not a natural or innate characteristic,” but rather, it is a form of learned behavior (Newton 2007: 348).

We investigate genetic influences on political trust, with a focus on evaluating this shared proposition that political trust is entirely learned. A variety of social psychological correlates of trust have already been shown to have a genetic component: cooperative behavior (Cesarini et al. 2007, Loh and Elliott 1998), altruism and antisocial behavior (Koenig, McGue, Krueger, and Bouchard 2007), and other elements of social capital like volunteerism (Son and Wilson 2010). In a recent article, Sturgis and colleagues (2010) find that two-thirds of the variance of social trust is attributable to the influence of heritability. Given the apparent relationship between social and political trust (Chanley, Rudolph, and Rahn 2000), among these other associated constructs, we hypothesized that trust in government is also partially heritable – we should find a non-zero, non-negligible genetic influence on political trust. Such a result would be consistent with the idea that most social and political attitudes are partially heritable (Alford, Funk and Hibbing 2005; Freese 2008).

We also investigate sex differences in heritable and environmental sources of variance for

trust in government. Because genetic expression is constrained in important ways by both psychical and social aspects of one's immediate environment, we expect to find stronger genetic expression of trust among men. On average, men have a wider range of economic and political opportunities than women enjoy (Hooghe and Stolle 2004, Mayer and Schmidt 2004). By having more opportunities in politics, men who want to build stronger relations with government and accumulate more experiences upon which to evaluate government may do so, those who do not wish to will not. Constrained political opportunities for women mean that some women who wish to have these kinds of experiences will not be able to do so. This expectation is consistent both with the general notion that genetic expression is moderated by environmental factors and more specifically with socio-structural theories of gender-based inequality (Wood and Eagly 2002).

Gender Roles, Essentialism, and Behavioral Genetics

Efforts to unpack the bio-social origins of gender difference must distinguish between “sex” (biological differences between men and women, commonly tied to reproductive physiology) and “gender” (differences with social and cultural sources). For political scientists, the central questions concerning men, women, and politics have historically involved “gender” rather than “sex.” In practice, empirical work in this area classifies respondents on the basis of their reported sex – whether they self-identify as male or female – while referring to differences between respondents in these categories as a “gender gap.” Thus, sex and gender differences are often confounded. As Hatemi, Medland, and Eaves (2009) underscore, in political behavior genetics, the distinction between sex and gender is clearer.

Sex is a well-established correlate of political opinions and behavior. Women are consistently more likely to support the Democratic Party, report greater enthusiasm for social welfare programs, and offer greater opposition to government use of force than do men (Sapiro 2003; Dolan, Deckman, and Swers 2007; Huddy, Cassese, and Lizotte 2008). A va-

riety of social science disciplines also investigate differences between men and women, using this familiar gender distinction. Women appear to be less selfish than men (Eckel and Grossman 1998), develop a greater concern for others and are more attuned to social relationships (Baron-Cohen 2003), embody a stronger reciprocity norm (Croson and Buchan 1999), and react differently to signals for trustworthiness (Zak, Borja, Matzner, and Kurzban 2005). Beyond this, women tend to focus more on harmony in interpersonal relationships, while men are more focused on independence in interpersonal relationships and interdependence in intergroup contexts (Baumeister and Sommer 1997; Cross and Madson 1997; Gabriel and Gardner 1999; Maddux and Brewer 2005). In terms of personality, Costa and colleagues (2001) found small but robust gender differences in four of the Big Five personality factors in a cross-cultural study. Women scored higher on neuroticism, agreeableness, the warmth component of extraversion, and openness to feelings which is a subscale of openness to experience. Men scored higher on the assertiveness subcomponent of extraversion, and openness to ideas, a subscale of openness to experience (see also Eagly and Carli 2007).

Behavioral genetics provides a parallel set of insights, rooted in the biological concept of sex differences, comparing males and females. Females are more likely than males to experience depression (Nolen-Hoeksema 2001) and post-traumatic stress disorder (Silver et al. 2002). Females also tend to be risk-averse, while males are risk-seeking (Croson and Gneezy 2009) – a difference linked to the D4 dopamine receptor gene and the enzyme monoamine oxidase (e.g., Zuckerman and Kuhlman 2000).

Perhaps the most controversial work in this area involves scholastic aptitude. Much of this research considers whether sex differences in aptitude for math and science stem from anatomical, neurological and hormonal factors – such as androgen levels and cortical organization (e.g., Baron-Cohen 2003; Kimura 2000; Haier et al. 2005). This work traces sex differences in representation and performance in science, technology, engineering, and mathematics (STEM) fields back to these basic biological differences between the sexes (for

reviews, see Ceci and Williams 2010, Baron-Cohen 2003).

Scholars disagree about the origins of these differences. Work in evolutionary psychology posits stable and universal differences between males and females across cultures. This theoretical perspective identifies differences linked to sex-specific evolved mechanisms arising from the Pleistocene Era, which cause males and females to differ psychologically and ultimately occupy different social roles (e.g., Buss and Kenrick 1998). These differences are most apparent where men and women faced different kinds of adaptive problems, as in the case of mate selection and reproduction. Hatemi, Medland, and Eaves (2009) refer to this explanation for sex differences in their study of political orientations. They recount the argument that while males and females adapted with great similarities, sharing most environmental problems and pressures, females “evolved a greater sensitivity than men to those in need, a stronger focus on mate selection, and more acute empathetic disposition” while men “place more value on social status, increased competitiveness, and risk taking because the limiting resource of males’ reproductive success has to do with the availability of fertile women, and because women had a propensity to choose males who are of higher status” (Hatemi, Medland, and Eaves 2009: 264).

An implication frequently drawn from this theoretical story is that there are essential or inherent differences between males and females. Hatemi, Medland, Eaves (2009) do not assert this conclusion, nor do they claim that genetics determine sex differences. In fact, they demonstrate contemporary environments are quite influential for the phenotypes (i.e., the behavioral or psychological variables of interest) they study, a battery of political attitudes and orientations. Nonetheless, the dominant evolutionary psychological story is interpreted by many to suggest essential sex differences that bear some relation to contemporary gender roles. Cross-cultural regularities in the sex-based division of labor reinforce this idea, and have led some evolutionary psychologists to conclude gender-based social, political and economic inequality is a universal outcome stemming from early selection pressures (Pratto

1996; Buss 1995).

Feminist scholars charge evolutionary psychologists with errors of gender essentialism – a perceptual bias in which gender differences are seen as innate, unalterable, exaggerated, and universal (Miller and Scholnick 2000; Crenshaw 1991; Chamallas 2003). Sex differences of genetic origins are linked to a powerful biological imperative and are thought to be hard-wired into human beings. These ideas seem to offer direct support for an essentialist view – particularly to the extent that they reflect an exaggerated sense of genetic influence and downplay contemporaneous social-structural influences on men and women (Dreyfuss and Nelkin 1992; Chamallas 2003). By setting up rigid group boundaries or genetic categories based on gender and searching for universal patterns of difference, this work tends to ignore the contingency of phenotypic expression on context. To be sure there is tremendous heterogeneity among women in their political attitudes. In many cases, divisions among subgroups of women are larger and more consequential than average differences between men and women (Huddy, Cassese, and Lizotte 2008).

Many feminist scholars express concerns that assertions of genetic differences between males and females might undermine feminism as a political movement. This movement has relied on similarity as a path to equality, by minimizing gender difference and attributing differences that do exist to external, socio-structural factors (Eagly 1995). The kinds of intrinsic genetic differences posited by evolutionary psychologists seem antithetical to these efforts, particularly in the context of a broader androcentric culture in which differences can be seen as deficiencies. This work fans feminist anxieties that genetic difference offers an ostensibly neutral and scientific justification for different treatment or different outcomes. Chamallas' work on feminist legal theory exemplifies this perspective: "Particularly when it comes to analyzing women's choices with respect to work and family, evolutionary writers seem happy to have a crisp answer ('it's in the genes') to explain why women would voluntarily choose paths that produce poverty, expose them to violence, and accord them low social

status and esteem” (Chamallas 2003:123). This kind of genetic determinism is dangerous to feminists as it naturalizes gender inequality, rendering the need for social programs aimed at equality moot because inequality appears to be a natural and inevitable facet of human societies (Bem 1993).

Social Structures and Gender Differences

While perhaps the dominant theoretical understanding of sex differences among behavioral genetics researchers is interpreted – or misinterpreted – by some to suggest rigid, essential differences between males and females, some evolutionary psychologists are developing an explicit alternative, a contingent effects paradigm. Proponents of this perspective argue the phenotypic expression of any particular gene is contingent upon aspects of the contemporary environment. Sex differences with evolutionary origins are most evident in situations where contemporary environments match primeval environments, but are least pronounced where these environments diverge sharply (Crawford 1998). For example, cross-cultural studies demonstrate that the expression of the heritable component of obesity varies as a function of socio-economic status (SES) and level of industrial development (Kopelman 2000). Similarly, expression of the heritable component of IQ is conditioned by SES (Turkheimer, Haley, Waldron, D’Onfrio, and Gottesman 2003). When applied to the study of sex differences, this perspective suggests differentiation between males and females will vary across environments which differentially evoke the expression of certain genetically based traits (Janicki 1998; Oyama, Griffiths, and Gray 2003; Caporael 2001).

This notion of contingent effects is largely consistent with social structural theories of gender difference, which privilege contemporary contextual factors over common historical pressures. According to this perspective, it is the contemporary sex-based division of labor rather than man’s early environment which contributes most to gender divergence. An example of this social structural approach can be found in Eagly and colleagues’ biosocial

role theory (Eagly 1987; Eagly and Wood 1999; Eagly, Wood and Diekmann 2000; Wood and Eagly 2002). Biosocial role theory suggests psychological differences arise because men and women tend to occupy different social roles. The process of adapting to and performing these roles produces qualities and behaviors consistent with widely held, culturally specific gender norms. This process serves to reinforce common gender stereotypes, creating the perception that a sex-based division of labor is a natural expression of differences among men and women. Genes, and biology more generally, play a role here, but work in concert with social structural factors. In this respect, the biosocial role theory of gender difference is consistent with the more general contingent effects paradigm, which is concerned with the interaction between genetic and environmental factors.

Biosocial role theorists point to cross-cultural variation in their critiques of evolution-based explanations. Eagly and Wood (1999) argue social-structural explanations can even explain mate preferences, which have been one of cornerstones of work on gender from evolutionary psychology (Trivers 1972; Caporael 2001). Using indices of gender empowerment and gender-related development, the authors show that mating preferences thought to be universal (e.g., women's preference for older men with status and wealth, men's preference for younger women) vary as a function of social context. This is particularly true where the traditional "gendered" division of labor breaks down and women exert more control over reproduction – in postindustrial societies these preferences are more muted (see also Perusse 1993). Beyond this, phenomena like male sexual jealousy can be linked not to "selfish gene" theory but to property transmission through paternal lines (Reiss 1986). Results such as these undercut evolutionary arguments and stress the roles law, institutions, and other contemporary social arrangements play in maintaining a gender-based social hierarchy.

Environments and Expressions of Heritability

The classical twin design contemplates at least three sources of variance in explaining variance of a phenotype (an observed trait): an additive genetic component (A), the influence of the common environment experienced by twins (C), which signifies the influence of families and the broader culture, and the unique environment experienced by each twin separately (E), which captures all other sources of variance (see Medland and Hatemi 2009).¹ Consequently, twin models, which inform most insights in the nascent field of political behavior genetics, anticipate effects of both genes and environments, often misunderstood by critics who cast this research as biological determinism (e.g., Charney 2008).

Extending this basic design, many behavior geneticists and social scientists are interested in the interaction of genes and environments to affect variation in behavior, personality, psychiatric disorders, and other observed phenotypes. Shanahan and Hofer (2005) catalogue four potential ways environments could interact with predispositional genes. Environments may **trigger** the expression of a genotype. For example, stressful experiences appear to affect the onset of a genetic predisposition for depression among female twins (Kendler and Kessler 1995). While this genetic risk is present among many in the population, stressful life events may activate the liability for depression. A complement to this is context acting as **compensation** for a genetic liability; e.g., a nurturing family environment might help prevent the expression of a genetic predisposition for anti-social behavior (Caspi et al. 2002). Further, environments might **enhance** genetic predispositions. Heath et al. (1985) demonstrate that the expression of heritability of educational attainment for males in Norway increased after liberalizing educational reforms that increased access. Shanahan and Hofer (2005) also identify a variety of studies that cast social context as providing a kind of **social control** that diminishes the expression of a genetic predisposition.

¹Twin models may also estimate the influence of dominance genetic effects (D). Many twin studies are limited to the analysis to either common environment or dominance genetic effects, unless data are available for twins reared apart.

This kind of thinking is familiar to political scientists who are well aware that even seemingly distal institutional rules shape the behavior of individuals, making some actions more or less likely. For example, rules that add difficulty to voter registration process depress political participation (Mitchell and Wlezien 1995). Applied to the expression of genetic predispositions, these kinds of institutional and contextual effects moderate the variation in expressed phenotypes: “in circumstances marked by high levels of social control, a large percentage of the sample — irrespective of their genetic diversity — exhibits the same phenotype; in settings marked by low social control, people’s choices and behaviors are more apt to reflect their genotype” (Shanahan and Hofer 2005: 68). The upshot is that expanding the opportunities available to people allows their genetic predispositions to be expressed more strongly.

This basic pattern of environment moderating genetic influences has been demonstrated for a variety of phenotypes and a variety of contexts, ranging from proximal family contexts to more distant systemic variation. Families may provide a direct kind of social control. Boomsma, de Geus, van Baal, and Koopmans (1999) show that people who are raised in strict, religious households exhibit far less heritability for disinhibition than people raised in less strict households. Similarly, Hatemi et al. (2009) find that genes appear to explain more variance of political ideology as people age. Importantly, they associate the increase in the importance of genetic influences with leaving the home of parents – the influence of the common environment decreases and the influence of additive genetics increases in tandem.

The characteristics of families may also condition opportunities and constraints without direct action on the part of parents. Turkheimer, Waldron, D’Onofrio, and Gotesman (2003) demonstrate that the heritability of intelligence decreases as socio-economic status decreases, along with the opportunities social status provides. Genetic influences on IQ are more pronounced among adolescents in affluent homes, whereas shared environmental influences are stronger in poorer homes (Harden, Turkheimer, and Loehlin 2007). Guo and Sterns (2002)

find that educational attainment is more heritable for some than others, along lines political scientists would often map to differences in efficacy and power: Males exhibit more heritability than females, whites more than non-whites, people with high socio-economic status more than people with lower SES. They attribute these differences to differences in levels of social constraint. In addition, seemingly more distal types of context can condition the expression of genetic predispositions. Reduced social mobility and the constraints on the availability of friends and social activities at the municipal level depress the heritability of alcohol use among adolescents (Dick et al. 2001). State-level policy affects the relationship between genes and tobacco use. Higher state sales taxes on cigarettes attenuate the heritability of adolescent smoking (Boardman 2009).

In our case, we are interested in how political and economic opportunities and constraints in a person's contemporary context condition the genetic expression of political trust. Economic and political opportunities available to women vary substantially at the state level. Arceneaux (2001) shows that attitudes about the role of women, a measure he calls *feminism*, is associated with the presence of women in state legislatures. He measures state-level feminism using aggregated responses to questions from the General Social Survey cumulative file, 1974-1996, agreement or disagreement with two statements: "Women should take care of running their homes and leave running the country to men" and "Most men are better suited emotionally for politics than are women. " He pools the GSS data, averaging observations at the state level and identifies stable and generalizable scores for 38 states in a manner similar to Erikson, Wright, and McIver's (1993) estimated state-level measures of ideology (also see Brace, Butler, Arceneaux, and Johnson 2002). We replicated Arceneaux's analysis and found that his measure is significantly correlated both with the percentage of state legislative seats held by women ($r = .68, p < .0001$) using data from the Center for Women and Politics (1999) and with state-level median income for women ($r = .50, p < .01$), as reported by the U.S. Census (2000).

In sum, a person’s environment can heighten or depress gene expression. The direction of the effect and the underlying mechanism varies with the particular trait and type of environment under consideration (Friend, DeFries and Olson 2008; Shanahan and Hofer 2005; Turkheimer, D’Onofrio, Maes, and Eaves 2005). Given that males and females enjoy different constraints and opportunities, as a function of social or economic inequality, we expect to find genetic expression diverges among men and women in systematic ways. For a class of politically relevant phenotypes, males have a broader set of opportunities than females. Males in general can choose among a variety of political options in the U.S. while the opportunities afforded women are more constrained. For example, a pair of authors observe: “Good girls go to the polling booth, bad boys go everywhere.” (Hooghe and Stolle 2004: 1). We follow research in this vein to anticipate sex differences between males and females in sources of variance for political trust, as well as a gene-environment interaction.

Expectations

We investigate the heritability of political trust among young U.S. adults by testing the following hypotheses: First, we expect there to be a significant genetic underpinning to political trust, which is congruent with prior research finding that the psychological correlates of trust are strongly heritable (Freese 2008), as is interpersonal trust (Sturgis et al. 2010). Second, genetic and environmental contributions to political trust will vary as a function of sex. Males should demonstrate a higher heritability estimate relative to females. Third, variation in economic and political opportunities enjoyed by women will influence the expression of heritability. Women in higher quality environments featuring more economic and political opportunities will express a greater heritability estimate. Ultimately, these expectations assume that sex differences are not exclusively due to biological sex differences, but that contemporary environments provide opportunities and constraints that shape the expression of gene-influenced predispositions.

Methods

To test these expectations, we rely on Add Health data, a nationally representative longitudinal survey of adolescents interviewed at four waves beginning in the 1994-1995 school year, and most recently re-interviewed in 2008-2009 as young adults (Harris 2009). The Add Health project has proven to be a useful resource for political scientists interested in the genetic foundations of political opinions and behavior (e.g., Fowler, Baker, and Dawes 2008). We focus on Wave III respondents interviewed in 2001-2002. At this point, the respondent reached young adulthood (ages 18-26). The Wave III survey is particularly useful for our purposes, as it included a battery of civic involvement and political attitudes questions to gauge respondents' attitudes upon recently entering the electorate. Only Wave III included political trust questions.

The Wave III Add Health data include interviews from 14,979 respondents interviewed in the original Wave I panel, as well as 218 respondents not interviewed at previous waves, yielding a total sample size of 15,197 respondents. A subset of these data included sibling pairs. Specifically, monozygotic (MZ) and dizygotic (DZ) twin pairs were interviewed, as well as non-twin siblings (Fowler et al. 2008). In the Add Health data, we identified 1,062 MZ and DZ twins interviewed at Wave III (531 pairs). Of these twins, 626 were DZ twins, 436 were MZ twins. Seventy-seven percent of the twin pairs were same sex pairs. The remaining 23 percent were opposite sex dizygotic pairs.

Using these pairs, we focus on three political trust items. Trust in state government was assessed from a single question, "I trust my state government" coded from 1 (strongly agree) to 5 (strongly disagree). Trust in the federal government was assessed from, "I trust the federal government" ranging 1 (strongly agree) to 5 (strongly disagree). And, trust in local government was similarly measured from "I trust my local government" again ranging from 1 (strongly agree) to 5 (strongly disagree). Prior to analysis we recoded these variables to range from 1 to 5, where high scores denote more trust. These items are internally consistent

($\alpha = 0.93$; average inter-item correlation: $r = 0.81$).² Descriptive statistics and correlations between the trust items are presented in Table 1. No mean differences emerged for gender across the four trust scales and the estimated correlations between twin pairs is statistically significant from 0 in all cases ($p < 0.05$). Given the high correlation of our trust items, we first estimate models which treat federal, state, and local government as separate indicators, and then extend our analysis to test whether sex differences exist when combining these items into a single scale. Finally, we explore the opportunity structure hypothesis by estimating a Gene x Environment (GxE) model across sexes.

INSERT TABLE 1 ABOUT HERE

The Genetic and Environmental Foundations of Trust

Published research using basic twin model paradigm has recently grown in political science (e.g., Fowler et al. 2008; Hatemi et al. 2008; Medland and Hatemi 2009), though it is worthwhile to reiterate the underlying methodological assumptions of this method. The twin model paradigm is traditionally used to estimate the proportion of the variation in an expressed phenotype attributable to genes (Plomin, DeFries, McClearn, and McGuffin 2001). This is accomplished by comparing the covariances of identical, or monozygotic (MZ) twins, to fraternal, or dizygotic (DZ) twins. MZ twins share all their genes, whereas DZ twins share 50% of their genes, on average. A central assumption of twin research is that since both twins are reared together, they share equal postnatal environments. This is the *equal environments* assumption. By making this assumption, one can then compare the correlation between MZ twins to DZ twins, and if MZ twins are more similar, it is assumed that the similarity is due to genes over the environment. As such, heritability is the proportion of the variance

²These statistics were calculated by generating one of two random integers and then using one of these integers to calculate scale properties. We did this to account for the presence of non-independent observations in the twin data. We also calculated scale properties separately for each twin pair, as well as on the entire sample. Regardless of the approach used, alpha remains at an acceptable level, as does the average inter-item correlation.

in the expression of a trait due to *all* genetic factors. This is often referred to as *A* in twins research, or the “additive genetic influence” (Plomin et al. 2001). The variation not due to heritability can subsequently be decomposed into variance due to the common environment (*C*) – that is, variance shared by each individual in the twin pair – as well as environmental variance unique to each twin (*E*). Traditionally, these three ACE “variance components” are estimated using structural equation models (SEM) (Medland and Hatemi 2009)

Specifically, we decompose the total variance into *A*, *C*, and *E* components by first specifying the following parameter constraints: (1) the *A* covariance between twins is set to 1 for MZ twins and 0.5 for DZ twins; (2) the *C* covariance between MZ and DZ twins are both set to 1, since twins are reared together and *C* represents the common environment; (3) no covariance is specified for *E*, since it represents environmental variance unique to each twin in the pair. Following these specifications, the SEM was estimated using maximum likelihood with bootstrapped standard errors.³ We standardize our results by reporting the proportion of the total variance attributed to each component. That is $a^2 = \frac{a^2}{a^2+c^2+e^2}$; $c^2 = \frac{c^2}{a^2+c^2+e^2}$; $e^2 = \frac{e^2}{a^2+c^2+e^2}$. When we report the estimates separately for males and females, we report the proportion each component accounted for among males, and separately, the proportion accounted for among females.

We focus on responses to three political trust questions – trust in the federal government, trust in state government, and trust in local government. We start by estimating a univariate ACE model averaged across men and women. Since this model, by construction, fails to account for sex differences, we follow this by relaxing the constraint that ACE estimates are constant across sexes and allow additive genetic and environmental variance to vary across males and females.

³Failing to bootstrap standard errors when parameters reach boundary values (e.g., a variance that approaches 0) can lead to a non-positive first-order derivative product matrix and incorrect standard errors. We bootstrap standard errors from 10,000 simulated draws. We estimated our models with other estimators – mean and variance adjusted weighted least squares and robust maximum likelihood – and obtain substantively identical results.

Table 2 demonstrates that for trust in federal, state, and local government, the average contribution of genetic variation in explaining total variation in these variables is negligible. In all three cases, the point estimate is not significantly different from 0, and dropping A from the model does not significantly worsen the overall model fit. The average contribution of the shared environment is also non-significant in two out of the three models. The only variable where the shared environmental influence is significant is federal trust ($a^2 = 0.32, SE = 0.32, \Delta\chi^2(1) = 1.08, ns$). The vast majority of variation in trust in government can be attributed to unique environmental factors. Roughly two-thirds of the variance in these variables is explained by within twin environmental factors. While the a^2 and c^2 do not independently explain much of the variance in trust, they jointly contribute a large amount to the total variance. This is evident in the significant worsening of model fit by constraining both a^2 and c^2 to equal 0, the last column of Table 2.⁴

INSERT TABLE 2 ABOUT HERE

It is conceivable – indeed, quite likely – that the sample averaged estimates in Table 2 mask differences in A, C, and E between males and females. According to our second hypothesis, estimates of A should be much higher for males and females. On the other hand, C should be much greater for females than males. To explore this possibility, we now turn to re-estimating these models to systematically explore sex differences in the genetic and environmental foundations of trust.

⁴This is inevitably a consequence of a lack of power in our tests. While it would be erroneous to conclude that genetic and common environmental factors do not matter, individually they do not account for a significant portion of the variance. Because we are operating in a gray area of whether we should retain or drop these components, and because the hypothesis tests do not indicate which one should be dropped, we feel the most accurate approach is to retain all three components, noting this caveat.

Sex Differences in Political Trust

Neale and Cardon (1992) outline the various forms of sex differences in the twins literature, highlighting the fact that genetic and environmental factors may vary across males and females. We explore sex differences by estimating a sex limitation model where the magnitude of environmental and genetic variance differs across sexes. In the behavioral genetics literature, this model is traditionally referred to as the *quantitative sex limitation* model. We also estimated a series of *qualitative sex limitation* models, which allows one to determine whether the same set of genes contribute to variation in a trait, but we did not find that the *qualitative sex limitation* models significantly improved the overall model fit.⁵ As such, we only explore quantitative sex limitation in the remaining analyses.

To explore sex differences, we analyze same sex MZ and DZ twins, examining whether parameter estimates vary across males and females. All models were estimated using maximum likelihood with bootstrapped standard errors. The estimates are standardized, in that we report the proportion of the variance accounted for by the three components separately for males and females – that is, the estimates are separately standardized by sex. Diagnostic tests revealed non-significant mean differences in trust across males and females, so we constrained the means in our univariate models to be equal across sexes.

INSERT TABLE 3 ABOUT HERE

A consistent pattern of sex difference emerges in Table 3. The additive genetic variance ex-

⁵Since opposite sex DZ pairs are available, we explored qualitative sex limitation, affording us leverage to examine whether the same set of genes contribute to a trait in males and females (Hatemi, Medland, and Eaves 2008). Qualitative sex differences are explored by specifying a “sex-specific” A parameter for males or females in opposite sex DZ pairs. If the inclusion of this parameter significantly improves model fit, as indicated by a significant change in the model’s log-likelihood, this provides evidence for qualitative sex limitation. We estimate the qualitative sex limitation model by including opposite sex DZ pairs and including an added A parameter (A') for males in the Add Health sample. A significant improvement in model fit by including A' provides evidence that there are qualitative sex differences in the data. For federal trust, we do not find that including A' increases the overall model fit ($\chi^2(1) = 0.197, p < 0.65$). We similarly do not find a evidence for qualitative sex differences regarding state trust ($\chi^2(1) = 0.391, p < 0.53$), local trust ($\chi^2(1) = 2.293, p < 0.12$), or average trust ($\chi^2(1) = 1.387, p < 0.24$). Subsequently, we only explore quantitative sex limitation in the remaining analyses.

plains very little of the total phenotype variance among females, whereas it explains roughly half of the variance among males. For instance, 41% of the total variance in trust in the federal government is explained by additive genetic variance among males, whereas additive genetic variance does not significantly explain any of the variance among females. The difference between these estimates is significant ($\chi^2(1) = 19.95, p < 0.01$). On the other hand, common environmental variance explains a great deal for females, but not males. Roughly 32% of the variance associated with trust in the federal government is explained by the common environment for females, and the estimate is approximately 0 for males, a difference which is significant ($\chi^2(1) = 25.52, p < 0.01$).

A similar pattern emerges for trust in state and local government. Approximately 5% of female variance for state trust, and 0% for local trust is explained by additive genetic variance, with the remainder of the variance attributed to the common and unique environment. On the other hand, 39% and 53% of male variance in state and local trust, respectively, can be attributed to additive genetic variation, with a negligible amount being explained by the common environment. Again, we find that (relative to females) more of the variance in these traits can be explained by additive genetic factors for males (State Trust: $\chi^2(1) = 2.63, p < 0.10$; Local Trust: $\chi^2(1) = 34.40, p < 0.01$). To demonstrate the average contributions of genes, common environment, and unique environment on political trust, we also examined a scale constructed by taking the participant's average score on the state, local, and federal trust items. As one would expect given the results for each of the individual components, the additive genetic component is negligible for females; it is pronounced for males, whereby roughly half of the variance in average political trust is explained by genetic factors for males.

The final two columns in Table 3 similarly demonstrate that the difference in a^2 ($|\Delta a^2|$) and c^2 ($|\Delta c^2|$) between males and females is substantively large and statistically significant. For federal trust, additive genetic factors account for 41% more of the total phenotypic

variance for males ($\Delta = 0.43, SE = 0.18, p < 0.01$). The associated differences for state and local trust are 34% ($\Delta = 0.34, SE = 0.21, p < 0.10$) and 53% ($\Delta = 0.53, SE = 0.09, p < 0.01$), respectively. For average trust, the difference between males and females is 49% ($\Delta = 0.49, SE = 0.11, p < 0.01$). Likewise, the common environment explains much more of the variance for females than males, again supported by significant differences in estimates of a^2 for males and females (Federal Trust: $\Delta = 0.38, SE = 0.15, p < 0.01$; State Trust: $\Delta = 0.23, SE = 0.16, ns$; Local Trust: $\Delta = 0.37, SE = 0.13, p < 0.01$; Average Trust: $\Delta = 0.33, SE = 0.09, p < 0.01$).

These findings illustrate important differences in the genetic and environmental foundations of trust among males and female, which are consistent with our expectation that because males have greater social, economic, and political opportunities, they should also display a higher heritability estimate of trust. In the next section we extend this finding by examining whether economic opportunities for women further modulate the expression of environmental and genetic expression.

A Gene x Environment Model of Trust

Our findings lend strong support to the expectation that the expression of genetic and environmental components on trust vary depending upon whether the respondent is male or female. A much higher proportion of the variation in trust is explained by genetic variance for males than females; whereas, a higher proportion of variance can be attributed to common environmental factors for females. Given our interest in the relationship between opportunity structure and genetic expression, we extend the basic ACE model that varies across sex to a model where A, C, and E vary across both sex and a factor strongly related to trust in government – women’s state-level average income. As discussed above, we employ state-level income as a proxy for the opportunity structure available to females. We anticipate that as female income increases in a respondent’s state, so too will the likelihood that genetic

variation will be more pronounced among females in these contexts. This occurs because genetic expression is magnified in high-quality environments. *When females are embedded in high-quality environments – those with sufficient resources and opportunities – additive genetic factors should explain a much larger portion of variation in trust than for women in comparatively impoverished contexts.*

To test whether the opportunity structure available to females moderates the expression of A, C, and E, we estimate a GxE structural equation model.⁶ We anticipate that genetic expression will vary as a function of the opportunities afforded to males and females. Accordingly, genetic variation underlying individual variation in trust should increase as the environment becomes more favorable to females – for instance, as females are embedded within higher socioeconomic conditions. We expect there to be a GxE interaction, whereby the genetic and environmental contribution to phenotype variation in trust will vary depending upon environmental characteristics

The GxE model can be written as:

$$P = iZ + (a + a'Z)A + (c + c'Z)C + (e + e'Z)E$$

where P denotes phenotypic variation, which is a function of the main effect of the environmental covariate, as well as additive genetic variance (A), common environmental variance (C), and unique environmental variance (E). All three variance components are also allowed to vary according to the level of the environmental covariate. Inclusion of the main effect of Z is important in case there is a genotype-environment correlation (r_{GE}) (Harden et al., 2007; Purcell 2002).

⁶Since these three constructs – trust in state, federal, and local government – are reasonable indicators of the same construct, and because our analysis in Table 1 indicate that these items scale together well ($\alpha=0.92$), we model GxE interactions among males and females using a summary scale of the trust items.

Figure 1 provides a graphical depiction of equation (1), where the covariate is allowed to have a main effect on the phenotype, as well as moderate the A, C, and E variance components.

INSERT FIGURE 1 ABOUT HERE

We identified average state-level female income as a candidate for an environmental variable that should moderate the contribution of genes and environments to political trust, given its relationship to variations in political opportunity structure for women and gender role attitudes. We use a state level indicator because states define important units of context and political culture (Elazar 1966, Erikson, Wright, McIver 1993). Consequently, they provide a meaningful set of political and cultural constraints and opportunities for women, with substantial variation in their representation and political power (Cammisa and Reingold 2004). We operationalize opportunity structure for women using state-level median income data for women over the age of 16.

Ideally, we would apply a more direct indicator of political opportunities for women. However, the Add Health data includes income data and restricts access to actual geographic identifiers. However, given demonstrated relationships between median incomes for women, women in state legislatures, and state-level attitudes about women, we are confident that median income for women provides a useful surrogate for the economic and political opportunities afforded women. We also underscore that we hypothesize a broad structural, systemic effect, rather than the effects of more proximal context, like individual income or the socio-economic status of a person's childhood home.

In order to test the opportunity structure hypothesis, we interact state-level median female income with the A, C, and E components of our model, and expect that it will moderate the expression of environmental and/or genetic variation. In other words, we extend the quantitative sex limitation model to a GxE model where we estimate unique A',

C', and E', for both females and males. In effect, we are modeling a three-way interaction, in that the basic ACE components are allowed to vary across sex and across average female income where the respondent resides.

The estimates from this model are presented in Table 4. On the whole, including A', C', and E' provides a non-significant improvement in model fit relative to a model where these parameters are not estimated and all that is estimated is the quantitative sex limitation model with a main effect of state level female income on trust ($\chi^2(6) = 4.28, ns$). However, this non-significant improvement in fit is because nearly all of the added parameters – A', C', and E' for both sexes – exert a non-significant impact on trust. Comparing the model in Table 3 to a model where only A' is estimated for females, however, significantly improves the overall model fit ($\chi^2(1) = 4.28, p < 0.05$), suggesting that the genetic expression of trust varies according to state-level female income. This result is consistent with our opportunity structure hypothesis. When women are situated in high quality environments, in this case states with high average female incomes, genetic expression is more pronounced.

INSERT TABLE 4 ABOUT HERE

This relationship is presented graphically in Figure 2, which shows the proportion of the variance in political trust explained by genetic and common environmental factors by median female income. The figure only presents estimates for females, since only A' was only statistically significant for females. The figure suggests that average female income is picking up an aspect of the opportunity structure or social context that has an effect on women. Our proxy for opportunity structure appears to specifically affect the expression of genetic and environmental influence among women. In theoretical terms, this result is consistent with work by Eagly's biosocial role theory. A traditional sex-based division of labor is associated with income inequality, as women perform a disproportionate share of unpaid domestic labor. Pronounced income inequality should correspond to pronounced gender differences in other domains (e.g., personality). Where inequality is more muted and

women have more economic and political opportunities, gender differences should be more muted, which is what we observe here.

INSERT FIGURE 2 ABOUT HERE

Discussion

This research makes two important contributions to the burgeoning research program investigating political behavior genetics. We demonstrate that political trust is partially heritable. This is important for two reasons. First, theorists of trust in government have generally considered this to be rooted in learned judgments (Miller 1974, Citrin 1974) or perhaps political socialization (Uslaner 2002), but not associated with personality or other “innate” individual differences. Certainly we find that political trust is substantially influenced by environments, both the common environment that represents family and cultural influence, as well as the unique environments experienced by twin study participants in the Add Health project. Nonetheless, these orientations are partially heritable, consistent with the general expectations of a ubiquitous partial heritability model of social and political orientations (Freese 2008).

More importantly, we hypothesize and empirically show a GxE interaction with implications for political scientists in this relatively new field. While females display much lower levels of genetic influence for political trust, we anticipate this is a function of social roles and opportunities. We test this expectation by interacting the components of an ACE model with female income. Complementing recent innovations (Hatemi, Medland, and Eaves 2009), we find sex differences in the heritability of political trust.

The women’s median income measure we use is associated with important aspects of the constraints and opportunities women experience across the states. This income data is associated with state-level perceptions and views of the role women should play in politics –

whether they are suited at all for public life. Median female income is also associated with the extent to which women actually have representation and political power by controlling legislative seats. In no state legislature do women observe representational parity, but around the time of the Add Health data collection, some women saw much more representation in the state house (e.g., Washington with 41 percent of seats held by women in 1999) and others saw less (8 percent in Alabama). Our findings suggest strongly that – consistent with Eagly’s biosocial role theory – the political and social roles deemed appropriate for women to occupy have a profound influence on the expression of heritability for political trust among women. Additional research should consider these kinds of power and opportunity structures to shed more light on how environments and institutions can affect the expression of heritability. In addition, we think it would be useful to decompose the importance of economic success, political opportunity, and descriptive representation (e.g., Ulbig 2007), among other potential structural factors.

Of course, our current findings may be time bound to the early 2000s and we may identify a social-genetic process that operates only among young males and females. It is likely the case that the heritability of political trust increases over people’s life span, similar to other political orientations (Hatemi et al. 2009), but this should be investigated. Clearly additional research is needed. Given the importance of political trust and the considerable variation in political trust among nations (Newton 2007), future work in this area would usefully consider cross-national political behavior genetic comparisons. It will be useful to explore the heritability of political trust in other countries, but also more extensively test our theoretical expectations about economic and political opportunities comparing political systems that provide much more variation in gender discrimination and opportunities for women than we observe comparing across the American states.

Additional research is also needed to unpack even further the relative importance of deep-rooted evolutionary differences between males and females and the influence of contemporary

social structures, as well as the important elements of social, economic, and political environments. We are not able to rule out the possibility that males and females have evolved different patterns of genetic expression of trust, reciprocity, altruism, and sociability that influence trust in government. At best we show that contemporary social structures influence the heritability of political trust too. That said, our findings do lend support to the general assertion that failing to consider the role of contemporary gender roles limits the understanding behavioral geneticists and evolutionary psychologists have of sex differences. Relative opportunities, constraints, and power moderate the effects of genes on political phenotypes.

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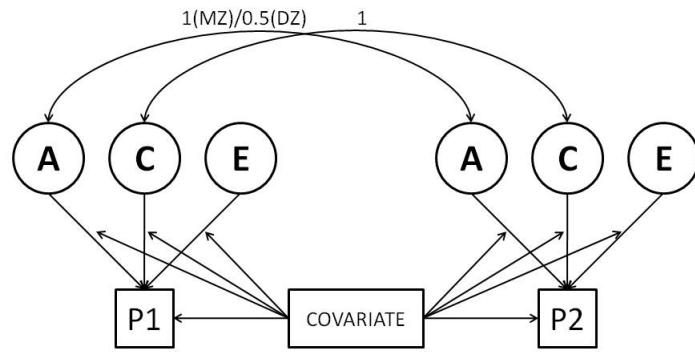


Figure 1: Gene x Environment Interaction.

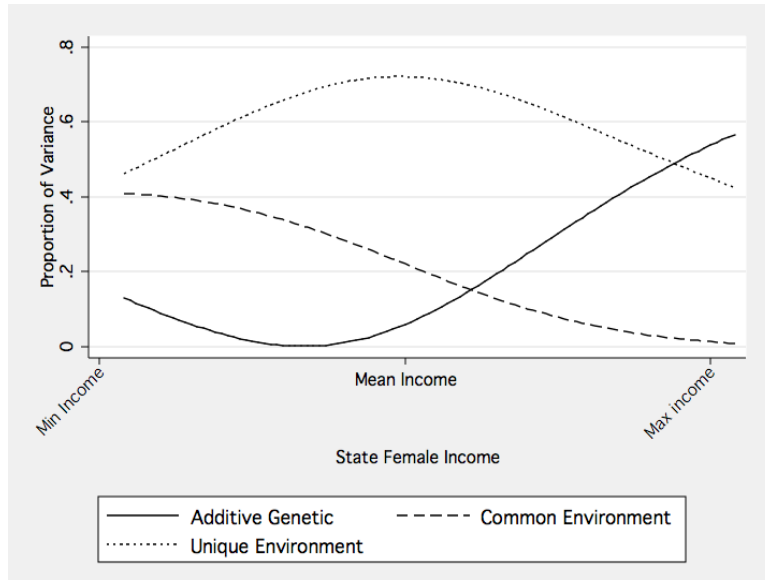


Figure 2: Simulated female ACE estimates predicted from state-level median female income.

	Mean (SD)		MZ pairs		DZ pairs		
	\bar{Y}	\bar{Y}_{Males}	$\bar{Y}_{Females}$	r_{Males}	$r_{Females}$	r_{Males}	$r_{Females}$
Federal Trust	3.32 (.97)	3.32 (1.03)	3.29 (.91)	0.41	0.39	0.19	0.37
State Trust	3.39 (.92)	3.42 (.97)	3.36 (.86)	0.41	0.29	0.17	0.24
Local Trust	3.40 (.90)	3.41 (.95)	3.39 (.85)	0.53	0.23	0.24	0.31
Average Trust	3.36 (.87)	3.38 (.93)	3.35 (.83)	0.49	0.33	0.20	0.33

Table 1: Descriptive statistics for the twin subsample of the Add Health data. All variables have been recoded such that high scores denote greater trust. Each variable ranges from 1 to 5 and the Trust row is a summary measure of Federal, State, and Local trust items. Standard deviations are in parentheses. # $p < 0.10$, * $p < 0.05$, ** $p < 0.025$, *** $p < 0.01$

	a^2	c^2	e^2	$a^2 = 0$	$c^2 = 0$	$a^2, c^2 = 0$	$a^2_{Female} \neq a^2_{Male}$	$c^2_{Female} \neq c^2_{Male}$	$\bar{Y}_{Female} \neq \bar{Y}_{Male}$
Federal Trust	0.24# (0.15)	0.15 (0.12)	0.61*** (0.06)	1.93	1.09	64.09***	3.32#	1.51	0.70
State Trust	0.26# (0.14)	0.07 (0.09)	0.67*** (0.07)	2.02	0.24	41.28***	4.72**	5.52**	0.60
Local Trust	0.18 (0.15)	0.19 (0.12)	0.63*** (0.06)	1.03	1.65	56.72***	5.27**	4.02*	0.27
Average Trust	0.26# (0.15)	0.14 (0.12)	0.60*** (0.06)	2.36	0.90	68.19***	4.35*	3.01#	0.48

Table 2: Sample average model. Bootstrap standard errors from 10,000 simulations are in parentheses. # $p < 0.10$, * $p < 0.05$, ** $p < 0.025$, *** $p < 0.01$

	a^2	c^2	e^2	a^2	c^2	e^2	$a_f^2 = a_m^2$	$c_f^2 = c_m^2$	$ a^2 $	$ c^2 $
Federal Trust	0.00 (0.09)	0.32*** (0.10)	0.62*** (0.07)	0.41*** (0.14)	0.00 (0.11)	0.59*** (0.08)	19.95***	25.12***	0.41*** (0.18)	0.38*** (0.15)
State Trust	0.05 (0.14)	0.23* (0.12)	0.73*** (0.08)	0.39*** (0.16)	0.00 (0.10)	0.62*** (0.10)	2.63#	1.06	0.34# (0.21)	0.23 (0.16)
Local Trust	0.00 (0.01)	0.26*** (0.07)	0.74*** (0.07)	0.53*** (0.09)	0.00 (0.03)	0.47*** (0.08)	34.40***	13.04***	0.53*** (0.09)	0.26*** (0.09)
Average Trust	0.00 (0.04)	0.33*** (0.08)	0.67*** (0.07)	0.49*** (0.09)	0.00 (0.03)	0.52*** (0.08)	29.32**	20.21***	0.49*** (0.11)	0.33*** (0.09)

Table 3: Sex limitation model. Univariate estimates constraining intercepts and factor means. No sex differences were found for mean differences on the four variables. Means are held equal across sexes, as no mean differences were found (see Table 2 above). Bootstrapped standard errors from 10,000 simulations are in parentheses. # $p < 0.10$, * $p < 0.05$, ** $p < 0.025$, *** $p < 0.01$

	Females	Males
A	0.19 (0.26)	0.62*** (0.16)
A'	1.15** (0.50)	-0.21 (0.59)
C	-0.37*** (0.14)	-0.16 (0.52)
C'	0.51 (0.56)	-0.33 (1.43)
E	0.67*** (0.04)	0.67*** (0.05)
E'	0.06 (0.20)	0.10 (0.26)
I	-0.34 (0.29)	-0.02 (0.30)
-2LL	1943.22	
AIC	1972.3	
BIC	2032.6	
ssBIC	1984.57	

Table 4: GxE model. The ACE components are allowed to vary across median female income of each respondent's state.

$p < 0.10$, * $p < 0.05$, ** $p < 0.025$, *** $p < 0.01$