

Do Genes Contribute to the “Gender Gap”?

Peter K. Hatemi Virginia Commonwealth University
Sarah E. Medland Queensland Institute of Medical Research
Lindon J. Eaves Virginia Commonwealth University

The nature and mechanisms underlying the differences in political preferences between men and women continues to be debated with little consideration for the biology of sex. Genetic influences on social and political attitudes have been reported for each sex independently, yet neither the magnitude nor sources of genetic influences have been explored for significant differences between males and females. In a large sample of adult twins, respondents indicated their attitudes on contemporary social and political items. Finding significant differences in the magnitude of genetic, social, and environmental variance for political preferences, and the potential for different genes in males and females to influence these phenotypes, we provide evidence that sex modulates the effects of genetic and environmental differences on political preferences.

It is undeniable that human males and females tend to behave differently. It is widely accepted across disciplines that both physiology and the environment make profound contributions to behavioral differences, and there is considerable evidence that these differences are in part due to genetic variation, which may differ between the sexes (Eaves, Eysenck, and Martin 1989). While it is widely held that humans have evolved to possess the ability to transcend their biology (Lumsden and Wilson 1981) and enjoy the capacity to do what they choose, their *preferences* are biologically influenced. However, relatively few studies have explored the role of endogenous differences on political preferences (for exceptions see Alford, Funk, and Hibbing 2005; Fowler, Baker, and Dawes 2008; Hatemi et al. 2007; Hatemi et al. N.d.). Those which exist provide little clarity on whether or how these mechanisms differ between the sexes.

In the biological sciences, sex is a term related to fundamental reproductive ability; simply whether one is male or female. In political research most studies combine gender and sex and primarily view gender as a social construct. Thus, most examinations of sex differences focus on social conditions, such as gender roles. Political scientists typically assume that sex differences reflect differences in social identity, which are primarily due to differences in socialization (Chodorow 1995). As such, the vast majority of political studies convolute the independent effects of social forces and anatomical sex.

While the concept of sex is explicit, the sources of inherent differences between males and females are not. In addition to hormonal and chromosomal differences (females have two X chromosomes while males inherit one X and one Y chromosome), behavior differences may arise from variation in the timing or magnitude of gene action, at times triggered by environmental stimuli. Differences observed between males and females are likely due in part to a combination of these effects. For example, females are two to three times more likely to suffer from migraines and differences in hormones such as estrogen explain some of this variation (Ligthart et al. 2006). In some instances only with certain environmental factors, such as stress, are sex differences in hormonal and genetic influences on migraines present (Brandes 2006). Thus, even for biomedical traits, by no means is the environment unimportant. It very well may be that for social traits the environment is the most salient influence, as social behaviors take place in a social context.

While the topic of sex differences is highly charged in politics and the media, a more complete understanding of the interplay between biology and culture in the convoluted developmental pathway from DNA to complex social behavior is a necessary step towards resolving the biological and social origins of sex differences. Merely demonstrating that there are different genetic pathways to behavior between the sexes and that this may explain some of the manifest

differences in behavior in no way implies that the role of gender defined socially cannot in turn modulate the expression of otherwise similar biological influences on behavior. Ultimately “gender roles” may modulate the expression of “genes” as a function of social context. However, whether stimulated by different environmental pressures or different hormonal and neurochemical pathways, the same gene or group of genes may exert different influences on political preferences for each sex. Genetic influence is no more deterministic than social influence, and in order to better explain the source of differences in political preferences between men and women, both genetic and social influences that affect political behavior are considered.

Gender and Politics: the Traditional Discourse

Most literature on political behavior assumes sex differences are socialized and remains silent about genetic or biological influences (Carroll 1988; Chodorow 1978, 1995). The main focus in the literature points toward the greater attraction of the Democratic Party to women than men and the greater support women give to liberal issue positions (Cook and Wilcox 1991). Explanations of this “gender gap” focused on policy preferences such as abortion, equal rights, violence, foreign policy, minority rights, equity, and criminal justice (Manza and Brooks 1998; Norrander 1999; Smith 1984; Togeby 1994). Men were more likely to support the use of force or violence whereas women were less willing to use force in foreign policy and less apt to support war (Carroll 1988). It was argued that women were more concerned with crime as they see themselves as more vulnerable, were more in favor of stronger punitive measures for rape and domestic violence, and were more likely to convict those accused of violent crimes. However, women were also more supportive of prevention policies, gun control measures, and treatment for criminal behavior (Applegate, Cullen, and Fisher 2002; Hurwitz and Smithey 1998; Lambert 2003; Lerner and Keltner 2000). On public protection or “compassion” issues such as education, welfare, minorities, the poor, sick, elderly, or unemployed, women were substantially more likely to support liberal positions (Shapiro and Mahajan 1986; Trevor 1999).

A considerable portion of the research on sex differences for political preferences has been based on Gilligan’s (1982) theoretical premise: women and men approach values from different perspectives. Women’s “psychology” is based on an ethic of care versus men’s

ethic of rights or justice (e.g., women are caretakers and nurturers whereas men are not). While these differences are believed to be socially constructed, even Gilligan acknowledges that “Clearly these differences arise in a social context where factors of social status and power combine with reproductive biology to shape the experience of males and females” (1982, 2).

Neuropsychological factors, physiological differences, genetic influences, or differences in the biological environment (e.g., hormones introduced in utero) largely remain unaddressed as either directly influencing political preferences, or providing a source for the differences in “psychology” (Bussey and Bandura 1999; Correll 2004). This is inconsistent with scholarship outside of political science. For example, Money and Ehrhardt (1972) reported that females who were treated with androgens when still in the womb (normally only present in male fetuses) displayed similar behavior patterns as males throughout their lives. The ‘treated’ females were more vigorously active, self-assertive and competitive, preferred outdoor activities, played with “male” toys, and took greater interest in hierarchical positioning. In contrast to their peer group, once reaching adulthood, romance and marriage took second place to career advancement and personal achievement.

With few exceptions, the literature examining sex differences on political behaviors have taken little note of these and similar findings and seldom addressed the importance of biological conditions related to sex. Rather, the focus remained on social, cultural, personal, and economic conditions (Howell and Day 2000). However, an important leap in the political science literature opened the door to incorporate physiological, biological, and evolutionary theses. Building upon the work of Eaves (1977), and Martin et al, (1986), Alford, Funk, and Hibbing (2005) found substantial genetic sources of variation for a wide array of political attitudes. However, while implying differences in genetic variation may exist between the sexes, the study did not test for significant differences in the magnitude of genetic influence or explore the potential for different genes to account for the genetic influence on political attitudes between men and women.

An Evolutionary Explanation for Sex Differences in Political Behavior

Interdisciplinary scholarship offers alternative theories to explain sex differences on modern day social roles by including inherent sources of behavior (Campbell

2002; Corning 2004; Cosmides, Tooby, and Barkow 1992; Johnson 1993). The field of evolutionary psychology stresses that modern roles, including political behaviors, are evolutionarily novel. Consequently, evolutionary selection pressures have modified brain structures, hence behavior, and too little time has passed since prehistoric conditions for most of these structures and foundations of behaviors to have been substantially modified. Specifically, human abilities to mitigate the problems of today did not evolve as an adaptation to today's environment, but are modifications of previously evolved skills from a prevailing environment that occurred over the last 2 million years. This evolutionary model has been used to explain the pathways of a wide variety of contemporary behaviors including: the nuclear family, antipathy for strangers, self-motivated learning, exploratory behavior, territoriality, fear, ethical behavior, authority acceptance, cooperation, play, group affiliation, aggression, competitiveness, and hierarchical groups (e.g., Fehr and Fischbacher 2003; Fehr and Gächter 2000).

Accordingly, evolutionary forces in certain domains differed between males and females in prehistoric societies, and these differing forces have led to innate processes which contribute to behavioral differences between the sexes. Because males and females shared most adaptive problems in primitive societies, the majority of human behavioral and physical adaptations are sexually anamorphic (e.g., all healthy humans have a prefrontal cortex, sleep, etc.). However, adaptive problems which were continually disparate between the sexes, such as child bearing, are expected to have led to sexually differentiated specializations and preferences (Buss 1999; Tooby and Cosmides 1990).

A core evolutionary pressure for women has been childbirth and childcare. Thus, it is argued that women have evolved greater sensitivity than men to those in need, a stronger focus on mate selection, and a more acute empathetic disposition (Gangestad and Simpson 2000; Gangestad and Thornhill 1997). In similar fashion, men have evolved psychological mechanisms that place more value on social status, increased competitiveness, and risk taking because the limiting resource of males' reproductive success had to do with the availability of fertile women, and because women had a propensity to choose males who are of higher status (Low 2005; McBurney, Zapp, and Streeter 2005; McDermott, Fowler, and Smirnov 2008). Moreover, the need for cooperative alliances and regard for status and hierarchy in hunting and warfare has heightened the desire for males to establish group alliances (Huberman, Loch, and önculer 2004; Wrangham et al. 1999). According to Pratto (1996),

males' greater interest in political activities is a reflection of these evolved preferences with specific concern for the establishment and maintenance of social dominance and status.

Contemporary observations in early childhood reinforce these theories. Cross cultural studies of children found that the largest behavior differences between the sexes occurs in children between three and six years old, providing evidence that complex social behaviors are inherited as well as learned (Maccoby and Jacklin 1974; Money 2002). Males develop stronger aggressiveness, outwardly directed predispositions, greater self assertiveness, contentious tendencies, adventurousness, and the need for individual achievement early on. Whereas females develop a more actively sympathetic disposition, inward directed demeanor, maternal impulses, heightened domestic, social, and personal concerns, as well as more interest in art, linguistics, and literature at a very early age (Cosmides and Tooby 2000; Geary 1998). Political scientists typically attribute these differences to socialization. However, if socialization were the determinant, the gap should widen with age or have a more acute effect when children are fully aware of and immersed in their social environment, and not in the three-to-six-years-old range.

The Heuristic Value of Genetics

Evolutionary psychology strives to explain inherent differences in behavior by reference to the long history of evolutionary adaptation. However, empirical tests of this theory require approaches different from traditional social science designs (e.g., Alford, Funk, and Hibbing 2005). The greater complexity and heterogeneity of modern society compared to the Pleistocene era (e.g., dating websites, abortion clinics, defense of marriage acts, condoms, suicide bombers, etc.), presents a problem for the use of evolutionary explanations on modern political preferences. Specifically, the evolutionary psychology focus on universals offers limited scope for empirical exploration and it is not readily apparent how to test if "yesterday's" biology is influencing "today's" political behaviors differently for each sex (Kanazawa 2001; Oota et al. 2005).

However, there are clues that the genetic study of individual differences may provide some insight into evolutionary history and modern behavior because natural selection modifies the expression of genetic and environmental differences differently in response to different adaptive challenges (Fisher 1930; Lerner 1954; Mather 1966). While the relationship between "heritability" and "selection" is unresolved

in population genetics, human or otherwise, if sex really has been responsible for major differences in evolution we expect the genetic system of today to bear some footprints of natural selection.

Although there are no studies we know that empirically examine the potential for different genetic pathways on political attitudes between men and women, or differentiate the variance for political traits between biological sex and social forces, behavior geneticists have been addressing similar issues for some time (Martin et al. 1986). Behavioral genetic techniques developed in an attempt to understand why individuals in a population differ from one another and include both genetic and environmental influences (Medland and Hatemi forthcoming). These analyses are concerned with accounting for variation around a population mean, but estimate effects of covariates on means. Instead of testing to see if opinions on the death penalty are genetic, one would test if *individual differences in opinions on the death penalty are influenced by genes*. Variance is partitioned into estimates of genetic, social, and unique environmental influences, thereby providing a means to explore whether genetic and social influences on certain behaviors are more or less pronounced in either sex and if the source of genetic influence differs between males and females.

The potential for differences in genetic influence between the sexes have been explored for many social traits (e.g., Eaves, Eysenck, and Martin 1989), however heritable differences between the sexes on political preferences have not. The trait most commonly associated with political preferences in the psychology and genetics literature is personality. There is overwhelming evidence, in numerous large-scale studies across cultures and continents, that personality is substantially influenced by genes (e.g., Bouchard 1997; Jang, Livesley, and Vernon 1996). However, the evidence is mixed regarding different genetic influences by sex. Finkel and McGue (1997) found no evidence that different sets of genes influences personality in each sex, nor did they find that the same genes influence each sex differently for the higher order dimensions of Emotionality. However for dimensions of Alienation, Control, and Absorption the same genes contributed differently to the total variance for males and females. In one of the largest studies on personality, Eaves et al. (1999) found that the magnitude of genetic influence differed for Extraversion, but not Neuroticism, and provided confirmatory evidence that while the magnitude of genetic influence differed, the same genes were influencing personality in males and females.

Variance components analyses are highly informative in identifying genetic influence, but they cannot identify exactly which genes are responsible for the genetic influence. Genome wide and allelic analyses identify regions of the genome seemingly correlated with a given trait, and how a specific gene influences a trait, respectively. Numerous candidate genes have been identified in the study of personal temperament and social behaviors and offer a starting point for exploring which genes could be related to political phenotypes. For example, the androgen genes ADRA2 and PNMT have been found to influence harm avoidance and cooperativeness (Deupree et al. 2006); dopamine receptors DRD3, DRD4, COMT, and MAOa are correlated with risk-taking behavior, inattention, impulsivity, spirituality, self-transcendence, high neuroticism, low extraversion, anxiety, reward dependence, aggression, antisocial behavior, and voter turnout (Chen et al. 1999; Fowler and Dawes 2008; Harpending and Cochran 2002). In the glutamate and nicotinic systems, GRIN1 and CHRNA4 have been shown to be related to cooperativeness; and in the serotonin system, 5-HT2a, SLC6A4, 5-HTTLPR, and TPH are related to impulsivity, harm avoidance, assertive behavior, anxiety, aggression, creative expression, and depression (Caspi et al. 2003; Hariri et al. 2002).

The most profound genetic sex differences exist in the vasopressin and oxytocin systems. The genes OXTR (oxytocin), and AVPR1a (vasopressin) are related to affiliative behaviors, mating, pair-bonding, parenting, and trust. These neuropeptides play an important role in the regulation of affiliation, social attachment, and social recognition. While there is very limited exploration of vasopressin and oxytocin in human social behavior (for an exception see Prichard et al. 2007 and Gordon et al. 2008), the investigation of the neurobiological pathways underlying complex social behaviors are widely explored in animal studies (Williams et al. 1994). Repeated experiments find oxytocin promotes pair bonding and mating in female prairie voles, but has no significant effect on males (Young et al. 2001). However, in males, but not females, higher vasopressin uptake increases pair bonding and has been shown to be associated with increased investment in childcare (Hammock and Young 2005; Pitkow et al. 2001; Winslow et al. 1993). Humans and voles share certain neurochemical pathways, and the aforementioned studies offer a basis to explore the potential for different genes in human males and females to influence similar behaviors.

Rather than ignore the potential for endogenous influences that differ between the sexes, we challenge

the assumption that biological pathways to political behaviors are the same for both sexes. Males and females are biologically different and should interact with and respond to the environment differently. The relationship between the genetics of “now” and what may or may not have happened historically remains ambiguous. However, if human’s current genetic dispositions are the result of their evolutionary past, we expect significant differences to be present in the magnitude of genetic influence between men and women on many political issues, similar to studies which explored personality. More importantly, for political preferences expected to be modern representations of constructs that were under intense selection pressures which differed between the sexes, it is likely that *different* genes are responsible for differing genetic variation between the sexes. This expectation is strengthened by the recent findings on the vastly different role vasopressin has in males and oxytocin in females for pair bonding, mating, and childcare. Therefore, we expect political preferences which affect reproductive success and mating to be influenced by different genes in males and females.

Methods

Behavior genetic population samples are often centered on twins, and the family members and peers of twins. While intentionally sampling nonindependent individuals violates statistical assumptions of independence, explicitly modeling the degree of relatedness for the individuals in the sample corrects for these violations. The power of twin samples is based on the knowledge that monozygotic twins are genetically identical, whereas dizygotic twins arise from two different eggs fertilized by different sperm. Using twin pairs raised by the same parents in the same environment provides a natural experiment controlling for the familial environment (see Medland and Hatemi forthcoming).

Using structural equation modeling (SEM), variance can be decomposed into additive genetic (A), common environment (C), and unique environment (E) and tested for sex differences. “Additive genetic” is the combined genetic effect of all genes (inherited traits). “Common environment” includes that which is shared by family members and includes cultural norms and familial socialization. “Unique environment” refers to all environmental stimuli that are unique to the individual (i.e., personal experience). Without retest measures unique environment includes measurement error.

Variance components estimates provide a means to partition the relative importance of individual variation for each trait. However, any trait with a significant genetic influence does not mean that there is “a” gene for that trait or that the trait is an item under intense evolutionary selection. One school of thought suggests that traits strongly related to fitness should be less heritable because genetic differences are removed by selection. Extensive published literature reviews give only partial support for this view. It is also suggested that nonadditive genetic effects will predominate for so called “fitness traits” (Keller 2007). This view has some empirical support in other species but is difficult to demonstrate in humans due to the absence of controlled mating. Among the many mechanisms that have been invoked to account for the persistence of genetic polymorphisms are: adaptive interdependence of traits; adaptive significance of allele changes with shifting environment; frequency dependent selection; disruptive selection; and gene by environment interaction. Any or all of the above may prevail in a given historical context. While any attempt to relate the presence or absence of genetic variation to adaptive significance of particular traits should be met with caution, it is clear that strong directional selection will, if anything, eradicate genetic differences and not enhance them.

Sample

The Virginia 30,000 Health and Life Style Questionnaire (VA30K) consist of the kinships of twins aged 18–88 years. Here we limit our analyses to the 14,763 twins, including opposite sex twin pairs. The VA30K includes assessments of political and social attitudes, sociodemographics, personality traits, and life events. Completed questionnaires were received from 70% of twins invited to participate (for details on sampling technique and demographics see Lake et al. 2000).

The political attitudes assessment consisted of a 28-item contemporary attitudes inventory based on the Wilson-Patterson (1968) format. Three items (*Democrats, Republicans, Liberals*) were excluded as a more appropriate item, *Party Identification*, was available. Church attendance (*Religiosity*) was also included (see Table 1 for the list of 27 items used in the analyses). Previous analyses of the differences in attitudes between sexes for the VA30K are consistent to findings in the general political behavior scholarship. Attitudes on the *Death Penalty, Living Together, Abortion, Nuclear Power, Capitalism, the Draft, Republicans, Property Tax, and Military Drill* were supported more by males, whereas attitudes on *Gay*

TABLE 1 Quantitative Sex Limitation Variance Components (95% confidence intervals)¹

	Model ^a	Parameter Estimates							Δa^2	Δc^2
		Females			Males					
		a^2	c^2	e^2	a^2	c^2	e^2			
Live Together	ACE ^{bc}	.51 (.41-.68)	.16 (.10-.24)	.33 (.30-.37)	0 (.00-.34)	.48 (.21-.54)	.52 (.52-.58)	.51	.32	
Busing	ACE ^b	.31 (.16-.31)	.09 (.08-.20)	.60 (.55-.65)	.12 (00-.40)	.30 (.06-.45)	.58 (.50-.66)	.19	.21	
Divorce	ACE ^{bc}	.25 (.16-.29)	.23 (.08-.38)	.52 (.47-.57)	.42 (.31-.42)	0 (.00-.07)	.57 (.53-.65)	.17	.23	
School Prayer	ACE ^b	.32 (.16-.48)	.37 (.22-.51)	.31 (.27-.36)	.47 (.22-.62)	.21 (.09-.41)	.32 (.26-.40)	.15	.16	
Capitalism	AE ^b	.47 (.43-.52)	—	.53 (.48-.57)	.61 (.54-.67)	—	.39 (.33-.46)	.14	.00	
Abortion	ACE ^{bc}	.26 (.12-.41)	.41 (.27-.53)	.33 (.29-.37)	.38 (.16-.51)	.19 (.10-.37)	.43 (.36-.50)	.12	.22	
Foreign Aid	ACE ^b	.40 (.29-.45)	.01 (.00-.10)	.59 (.55-.64)	.31 (.08-.49)	.11 (.00-.31)	.58 (.51-.66)	.09	.10	
Women's Lib	ACE ^{bc}	.34 (.18-.49)	.18 (.05-.18)	.48 (.44-.53)	.31 (.23-.39)	0 (.00-.03)	.69 (.61-.76)	.03	.18	
Religiosity	ACE ^{bc}	.48 (.32-.67)	.26 (.09-.41)	.25 (.22-.29)	.47 (.00-.65)	.18 (.04-.56)	.35 (.35-.45)	.01	.08	
Censorship	AE ^{bcd}	.38 (.33-.42)	—	.62 (.58-.67)	.38 (.33-.42)	—	.62 (.58-.67)	.00	.00	
Death Penalty	ACE ^{bd}	.35 (.22-.48)	.21 (.10-.31)	.44 (.40-.48)	.35 (.22-.48)	.21 (.10-.31)	.44 (.40-.48)	.00	.00	
Pacifism	AE ^{bd}	.31 (.27-.35)	—	.69 (.65-.73)	.31 (.27-.35)	—	.69 (.65-.73)	.00	.00	
Segregation	AE ^{bcd}	.37 (.32-.37)	—	.63 (.59-.68)	.37 (.32-.37)	—	.63 (.59-.68)	.00	.00	
Draft	AE ^{bd}	.37 (.32-.41)	—	.63 (.60-.68)	.37 (.32-.41)	—	.63 (.60-.68)	.00	.00	
X-Rated	AE ^{bcd}	.51 (.47-.56)	—	.49 (.46-.54)	.51 (.47-.56)	—	.49 (.46-.54)	.00	.00	
Modern Art	AE ^{bcd}	.40 (.36-.43)	—	.60 (.57-.64)	.40 (.36-.43)	—	.60 (.57-.64)	.00	.00	
Moral Majority	AE ^{bd}	.42 (.38-.47)	—	.58 (.53-.62)	.42 (.38-.47)	—	.58 (.53-.62)	.00	.00	
Property Tax	AE ^{bd}	.42 (.41-.46)	—	.58 (.58-.63)	.42 (.41-.46)	—	.58 (.58-.63)	.00	.00	
Socialism	AE ^{bd}	.38 (.34-.38)	—	.62 (.58-.66)	.38 (.34-.38)	—	.62 (.58-.66)	.00	.00	
Immigration	AE ^{bd}	.46 (.46-.49)	—	.54 (.51-.54)	.46 (.46-.49)	—	.54 (.51-.54)	.00	.00	
Party ID	CE ^{bcd}	—	.81 (.78-.84)	.19 (.16-.22)	—	.81 (.78-.84)	.19 (.16-.22)	.00	.00	
Astrology	AE ^b	.47(.43-.47)	—	.53 (.48-.57)	.47 (.39-.54)	—	.53 (.46-.61)	.00	.00	
Gay Rights	ACE ^{bd}	.34 (.24-.45)	.25 (.22-.34)	.41 (.39-.45)	.34 (.24-.45)	.25 (.22-.34)	.41 (.39-.45)	.00	.00	
Military Drill	AE ^{bd}	.36 (.31-.40)	—	.64 (.63-.69)	.36 (.31-.40)	—	.64 (.63-.69)	.00	.00	
Unions	AE ^{bd}	.41 (.36-.46)	—	.59 (.54-.64)	.41 (.36-.46)	—	.59 (.54-.64)	.00	.00	
Fed Housing	AE ^b	.41 (.36-.46)	—	.59 (.54-.64)	.41 (.36-.46)	—	.59 (.54-.64)	.00	.00	
Nuclear Power	AE ^{bd}	.34 (.30-.39)	—	.65 (.61-.65)	.34 (.30-.39)	—	.65 (.61-.65)	.00	.00	

Notes: (a) Only best fitting models shown (thresholds corrected for age). ACE represents a model in which all three variance components are significant; CE represents a model in which common and unique environmental influences are significant; AE represents a model in which genes and unique environment are significant; a^2 , c^2 , and e^2 represent additive genetic, common environmental, and unique environmental influence respectively; Δ represent the difference between males and females (b) equated thresholds for MZ and DZ pairs (c) equated thresholds for males and females (d) equated variance components for males and females.³
¹Portions of the quantitative sex limitation analyses were initially included as part of a larger dissertation project (see Hatemi 2007).

Rights, Federal Housing, Liberals, Democrats, Busing, Censorship, Modern Art, Unions, Divorce, School Prayer, Socialism, Moral Majority, and Pacifism were supported more by females (Eaves et al. 1999).

The Wilson-Patterson (WP) inventory is administered by presenting subjects with a stimulus phrase such as “Abortion” and eliciting an “agree,” “disagree,” or “uncertain” response. As with any measure, it can be argued that individual WP items may not be ideal measures to test biological, evolutionary, or even political hypotheses. From an evolutionary perspective, items which affect reproductive success (fitness) are the most likely to be influenced by different genes, and many of the attitudes do not appear to be items on which divergent selection pressures would have taken

place between males and females. However, while not all items are ideal, the index is constructed of a wide variety of items based on five underlying factors: sex and mating, force and militarism, economics and property, politics and group affiliation, and religion (see Eaves et al. 1999). Items related to mating and sex (*Living Together, X-rated, Divorce, Abortion, Gay Rights*) are appropriate for fitness hypotheses, while the items that are not provide the opportunity to falsify the hypotheses.

Analyses

Employing a maximum likelihood approach minimizes the discrepancies between observed and predicted

covariance/variance matrices (i.e., the goodness-of-fit), estimates the model fit of the data for a range of parameter values, and converges at the solution when it locates the parameters which produce the lowest log-likelihood. The parameter values that produce the best solution are estimates of the magnitude of the latent sources of variance (A, C, and E). The reliability of these estimates expressed as 95% confidence intervals are the deviations from the estimates that result in a significant change in the fit of the model. This approach to the estimation of genetic and environmental variance is commonly used for the analysis of genetic and environmental components in twin data (Medland and Hatemi forthcoming).

Genetic models were fit to the political items; Mx 1.60, a matrix algebra application widely used for genetic analysis, was used for model fitting. The path model for twin resemblance is represented in Figure 1. Correlations between the latent additive genetic factors (A) are 1.0 for monozygotic twins (MZ) who share 100% of their genes and 0.5 for dizygotic twins (DZ), including opposite sex pairs, who share on average 50% of their discriminating genes. Correlations between the latent common environment factors

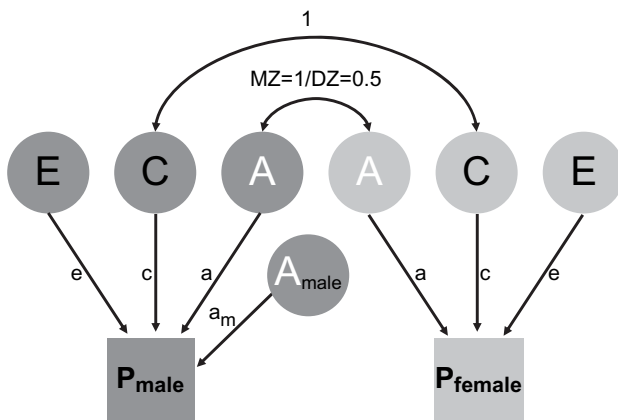
(C) were 1.0 in both MZ and DZ twin pairs, as both twins were raised by the same parents, in the same environment. The latent factor for the unique environment (E) is uncorrelated. The difference between the genetic correlation of MZ and DZ twins provides the leverage for estimating the genetic contribution to individual differences.

Common in behavior genetic analyses, observed frequencies for the ordinal political attitude measures were calculated and incorporated into a threshold model that assumes that each variable has an underlying normal distribution of liability. In order to correct for age effects, we used a full-information approach fitting the structural models to the raw data. Thresholds are expressed as z values which discriminate between categories that correspond to the frequency of the political attitudes. Thresholds were tested for similarity across sex and twin zygosity groups and corrected for age effects.

In order to investigate the presence and nature of genetic differences in the variance between the sexes, a sex limitation parameter is included (noted as A_{Male} in Figure 1). The general approach to fitting a sex-limitation model to twin data is described by Heath, Jardine, and Martin (1989). The full sex-limitation model permits *quantitative* sex differences, which assumes the same sources of variation for males and females (*same genes*), but allows for *differences in the magnitude* of genetic and environmental effects for each trait, and *qualitative* sex differences, where the model allows for *different genes* to influence the behavior for each sex. Opposite-sex twins are necessary in this process as they share the same familial environment, but experience it as members of the opposite sex, thereby providing a natural experiment to examine sex differences. The correlation between genetic effects in unlike sex pairs will be a function of the extent to which the same genes affect both males and females. In the extreme case, where completely different genes are expressed in males and females, the genetic correlation is expected to be zero.

The genetic correlation between opposite-sex twin pairs (OS) may be less than 0.5 if there are qualitative sex specific genetic effects. If dropping the sex specific genetic effect does not significantly alter the fit of the model (if the difference in fit between the models is not significant), this indicates that although the genetic effects may differ in their magnitude between males and females, the influence is from the same genetic source regardless of sex. Alternatively, if the model which includes the separate sex specific “A” parameter results in a better fitting model, the results indicate that some, but not necessarily all, the genetic influences on

FIGURE 1 Sex Limitation ACE Model



Notes: This path diagram is an explicit representation of the model where the expected covariance between two variables is computed by multiplying together all the coefficients in a chain, and then summing over all possible chains. For example, the variance of a phenotypic trait for a MZ twin is calculated as: $(a * 1 * a) + (c * 1 * c) + (e * 1 * e) = a^2 + c^2 + e^2$. “A” is additive genetic $2*(r_{MZ}-r_{DZ})$, “C” is common environment $(2*r_{DZ}-r_{MZ})$ and “E” is unique environment $(1 - r_{MZ})$. As indicated by the sex specific subscript for the path coefficients (A_{male}) the model allows a, c, and e, to be estimated separately for each sex. The sex specific parameter can be placed on either one of the sexes (but only one, males in this example) and provides the same results.

the trait are specific to one sex (i.e., a qualitative sex difference).

Model Fitting

Model fitting is used as a method of hypothesis testing to determine the relative importance of genetic and environmental influence. The full model, which includes three sources of variance (ACE), (a fourth sex-specific source in the qualitative model), was tested against progressively reduced models by comparing the fit of the model in which the component (A, C or E) is freely estimated to the fit of the model in which either the A or C parameter has been set to zero. The difference in model fits, assuming that the models are nested, is asymptotically distributed as a chi-square distribution with the degrees of freedom equal to the difference in the number of estimated parameters between the two models. For example, to compare the difference in fits between an ACE model (in which the covariation is due to the combination of additive genetic, common environmental and unique environmental effects) and a CE model (in which the covariation is due to common environmental and environmental effects only) against a χ^2_1 distribution, the A parameter is dropped from the full model and model fit is compared. Quantitative sex differences (different magnitude of genetic influence) were tested by comparing the fit of nested models that equated the separate path coefficients for males and females to the full model. Qualitative sex differences (different genes) were assessed by comparing the fit of Model 1, in which correlations between genetic or environmental latent factors were estimated to the fit of Model 2 in which these correlations were fixed to 0.5 and 1.0, respectively.

Model Limitations

Consistent with all empirical analyses, there are assumptions and limitations built into sex-limitation twin analyses. Univariate estimates do not account for the possibility of gene by environment interaction (GxE) or gene-environment covariation (rGE). More advanced twin models that include the effects of genes and environments can provide information on how genetic influences are expressed through and by environmental conditions (for more on GxE and rGE, see Medland and Hatemi forthcoming). Importantly, as with all population-based samples, results are population specific, and generalizations should be made only after the results are replicated on different populations. Our sample is from a U.S. population in the

1980s. Defined sex roles are present in many aspects of U.S. culture, and populations from other regions of the United States in different time periods are necessary for replication.

Sex-limitation models assume that opposite-sex twin pairs are influenced by the common environment to the same extent as same-sex twin pairs for the trait under analysis. While it is implausible that parents' would raise their opposite-sex offspring in a dissimilar manner for political behaviors, it is also likely that boys grow up as "future men" and girls as "future women." Differences in peer groups, social activities, and other social processes may influence environmental similarity. However, any dissimilarity would have to affect the trait of interest. While there is no indication that potential sex differences in rearing exist for political behaviors (e.g., parents raising daughters to be pro-choice and sons pro-life, etc.), a more extended family model including parents would provide more insight.

It is also assumed that any differences in the similarity of environments between DZ and MZ co-twin pairs do not affect the trait under examination. Empirical support for this assumption and its implications have been widely discussed, and numerous methods have been employed to validate the assumption (for a review see Kendler and Gardner 1998). These include testing twin environmental similarity by controlling for perceived zygosity versus true zygosity (rated by self-reports, parents, friends, teachers, etc.), modeling self-report and parental report of parental treatment, including ratings of physical similarity, as well as specific environmental measures. There are extremely few traits in which unequal environments have an influence and none so far reported for political preferences. While unequal environments may be found for dressing alike as toddlers, it has no influence on co-twin similarity of political behaviors later in life. Rather, what scholarship is available provides evidence that MZ and DZ co-twin correlations for political preferences are statistically the same in adolescence, but greatly differ once children leave home (Hatemi et al. 2008). Critics of the CTD claim childhood is precisely the time period where differences in the shared environment influence MZ and DZ twin pairs differently for political preferences (see Charney 2008). This is apparently not the case. Rather, it appears that the parental (shared) environment is responsible for keeping DZ co-twins more similar. However, despite these findings, and the numerous explorations of the twin method, and its acceptance in the genetic, psychiatric, and general science scholarship, the "twin debate" has

found a new home in political science (e.g., Charney 2008; Suhay, Kalmoe, and McDermott 2007). This is not unsurprising, as political scientists are only now becoming more familiar with the genetics methodology and literature. However, the focus of these challenges are to a large degree limited to those committed to a theory that only social forces influence social behaviors. These include philosophical objections to applying scientific methods to the analysis of political behavior (e.g., “They’re trying to make political science into a science, when really it’s not”; Evan Charney quoted in Cohen 2008). Often, critics choose not to address the most recent and relevant literature on familial modeling, including models which provide estimates of twin-specific environmental variance (e.g., Eaves et al. 1999; Eaves and Hatemi 2008; Hatemi et al. 2007b). Nor have they addressed DNA based techniques that validate the use of twin designs. Visscher et al. (2006) used nontwin sibling’s exact genetic similarities (DNA) in a variance components model, thereby removing the assumption of equal environments. Using this method Visscher et al. (2006) reported genetic estimates for height similar to those reported using twin models. While the method has not yet been used for political attitudes, the method provides strong evidence that MZ/DZ models are robust. The method is free from the criticisms assigned to twin models and is available for critics to falsify the equal environment assumption on a trait-level basis. This is important as none of the critiques (e.g., Beckwith and Morris 2008; Charney 2008; Suhay, Kalmoe, and McDermott 2007) provide any empirical evidence of unequal environmental bias on political traits or attempt to empirically test the potential for unequal environments.

Disregarding the overwhelming evidence that necessitates the inclusion of inherent influences on human behaviors, there are also those who believe that the exploration of inherent mechanisms which influence social behaviors is equivalent to the sexist, xenophobic, and racist eugenics movements of the last century. Beckwith maintains that exploring genetic influences for social traits can only lead to “absolving of society of any responsibility for its inequities” (1993, 332). However, this moralistic argument is highly selective, and ignores important genetic discoveries that have led to *increased* social tolerance, including the now discredited *refrigerator mother* hypothesis, which blamed autism on mother’s emotional frigidity (see Bettelheim 1967). Rather, twin studies are credited with changing the discourse of the medical community and public image of mothers with autistic children, “The heritability of autism has been

one of the most important changes in our conception of the condition since the first pioneering descriptions” (Hill and Frith 2003, 282).

Results

The magnitude of genetic variance differed between males and females for most traits, providing strong evidence confirming the hypothesis that social forces cannot account for all the differences in individual variation within and between males and females (see Table 1). Rather, there is substantial evidence that for many political preferences genes are having markedly different influences on behavior in males and females. In 9 of the 27 items significant sex differences in the magnitude of genetic variance were present: *Living Together* (.51), *Busing* (.19), *Divorce* (.17), *School Prayer* (.15), *Capitalism* (.14), *Abortion* (.12), *Foreign Aid* (.09), *Women’s Lib* (.03), and *Church Attendance* (.01).

While the difference in the magnitude of genetic influence found between the sexes on political attitudes confirms the need to address sex when exploring genetic sources of political preferences, interpreting the quantitative results to address specific hypotheses based upon evolutionary foundations are not as straight forward.¹ The magnitude of genetic variance was not necessarily greater or lesser in females for political items that address those in need, evoke emotional responses, build stronger domestic support systems or tap into an “ethic of care.” Nor was there less or more genetic influence on attitudes regarding the use of force, status, or group alliances in males or that men have more genetic variance for most political items. The findings are trait specific, akin to sex differences on personality, and offer little recognizable pattern.

However, the remarkable difference in the genetic estimates of *Living Together* solicits further discussion. In the full model (all sources of variation included), genetic influence on *Living Together* accounted for 0% of the variance in males, but over 50% in females. Though not intended to identify different genetic

¹Highly adaptive traits are expected to show smaller genetic variability if the traits were under intense selection (Falconer 1981; Fisher 1930). If males or females were faced with certain selection pressures for political preferences unique to one sex, the amount of genetic variance should actually be very small. This does not undermine genetic influences; while the variance is not genetic, the mean effect may be. However counterintuitive, evolutionary designs may predict lower genetic variance in the sex for which the item is most likely related to selection, as the traits that matter most are the most tightly regulated.

sources, when quantitative analyses result in sizeable genetic influence for one sex, while none for the other (absent of model fitting), the findings offer reason to suspect that different genetic influences are present on the trait, or that possibly gene by gene interaction specific to one sex may be present.

Furthermore, in most items (20 out of 27) the magnitude of common environmental influence was similar between males and females. In general, the common environment accounts for individual differences in females to the same degree as males, but affects the sexes differently for each specific item. Unique environmental influences accounted for the majority of the variance in all attitudes except *Party Identification* for males and *School Prayer*, *Abortion*, and *Party Identification* for females. Whether evaluating traditional social science theories or evolutionary theories, there is no evident pattern to the quantitative variance component analyses, except to say that for individual differences in political preferences, in general genes matter, and often influence males and females to differing degrees depending on the trait. In many ways, this finding runs contrary to what is inferred by the extant literature. Any attempt to adopt a universal explanation for the magnitude of sex differences on all political behaviors is not supported by the data. Rather, a theory specific to each item or possibly each group of related items appears to be appropriate.

Qualitative Results: Different Sources of Genetic Influence

Possibly the most intriguing aspect of sex limitation modeling is the potential that different genes may be influencing political preferences for either sex. Table 2 presents the results of the qualitative model fitting for sex differences on the 27 social and political items and provides evidence that different genes may be influencing the preferences of males and females for one attitude, *Divorce*. A model in which genes specific to one sex fits marginally better than a model where the same genes are influencing attitudes on *Divorce* ($3.62 \Delta\chi^2$ for 1 *d.f.*, $p=.057$).²

If the evolutionary psychology theses are to be believed, for certain traits females and males have been under divergent natural selection pressures for tens of thousands of years, and it is not surprising that different genes, potentially on the sex chromo-

somes, influence political behaviors that directly or indirectly influence reproduction (i.e., *Divorce* and *Living Together*). However, it might equally be argued that attitudes toward *Abortion*, *Gay Rights*, and *X-rated* are also what one might expect to be connected with fitness, equally evolutionarily novel, and under divergent selection pressures for males and females. If true, these items would also be expected to be potentially influenced by different genes. This is apparently not the case. Thus, while not presuming to make a general claim in the absence of overwhelming evidence that different genes for males and females influence all political traits related to fitness, the findings on *Divorce* and *Living Together* offer a *prima facie* case for considering the evolutionary rationale for sex differences on political preferences related to fitness.

However, the reduced DZ opposite-sex correlation does not by itself preclude the critical importance of sex roles, because it might be argued that the sex limitation of genetic differences may be a (phylogenetically) recent response to greater social emphasis on the differentiation of sex roles. While we can find no evidence in our analyses to support this claim, it is possible to consider that social gender roles are so important that they even modify the expression of genes differentially in the two sexes.

In summary, the analyses provide empirical evidence that the same genes influence males and females differently for many political preferences. The data also support the conclusion that modern political preferences related to sexually dimorphic adaptive traits (such as reproduction), are the most likely candidates for different sources of genetic influences in males and females; a finding which supports themes long suspected by evolutionary theorists.

Discussion

Cultural and biological theorists agree that there are basic differences in the outlooks and preference formation of males and females, but the source of these differences remains an area of disagreement. The analyses here provide evidence that differences between men and women go beyond obvious superficial anatomical contrasts or how they are treated by members in society. For better or worse, genetic influences are manifested in many aspects of political behaviors and these influences differ for males and females, both in magnitude and sources of variation.

The findings support the conclusion that the tortuous developmental pathway from genes to

²We found no evidence of significantly different sources of common environment influence across sexes on any attitudes. However, for attitudes on *Divorce* and *Women's lib*, no such test was possible, as the common environmental estimate was zero in males.

TABLE 2 Qualitative Sex Limitation Model Fitting for Political Attitudes

Model	-2LL		Model comparison	Estimates of correlations
	Sex Specific A (1)	fixed A to.5 (2)	p-values 1 vs. 2 (1df)	Genetic correlation between males and females
Divorce	24250.37	24253.99	.057	.000
Living Together	21937.77	21939.81	.153	.085
Federal Housing	22572.87	22572.91	.847	.135
Womens' Lib	24217.81	24217.81	1.000	.160
Abortion	23248.04	23249.16	.290	.288
Military Drill	21946.05	21946.16	.747	.306
Gay Rights	22456.74	22456.76	.916	.475
Moral Majority	24986.62	24986.63	.924	.435
Socialism	21453.74	21453.74	1.000	.500
Censorship	24511.31	24511.31	1.000	.500
Unions	24969.25	24969.25	1.000	.205
Death Penalty	19070.80	19073.59	.095	.141
Nuclear Power	24720.96	24720.96	1.000	.500
Capitalism	23238.28	23238.28	1.000	.245
Immigration	24915.10	24915.10	1.000	.186
Segregation	20363.50	20363.50	1.000	.257
School Prayer	18162.34	18163.85	.219	.292
Modern Art	25000.80	25000.80	1.000	.498
Astrology	24346.51	24346.51	1.000	.500
Foreign Aid	25379.29	25379.29	1.000	.500
Busing	22814.54	22814.58	.838	.430
X-rated Movies	18650.62	18650.82	.656	.407
Draft	22264.83	22264.83	1.000	.500
Property Tax	21270.39	21270.39	1.000	.500
Pacifism	22172.78	22172.78	1.000	.500

Notes: Significant qualitative sex-specific genetic effects noted in bold. Columns 2 and 3 give the - twice log likelihood (-2LL) for model (1) in which the correlation between the latent A variables are estimated for the DZ opposite sex twins, and model (2) in which the correlation between the latent A variables are set to .5 for the DZ opposite sex twins. Column 4 gives the p-values for the 1 degree of freedom chi-square test comparing the -2LL from Model 1 to that of Model 2. Column 5 provides the estimated A correlation between males and females.

political preference cannot be simplified to a universal theory that explains all differences between and within the sexes, or even the preference on one attitude. Rather, differences in the magnitude of genetic and environmental variance between the sexes occur for some political attitudes, but not others. Thus, the data do not support the broad application of social psychology or evolutionary psychology theories to explain behavior differences, or even explain all behaviors suggested as appropriate to either given theory. Accordingly, we suggest it is necessary to examine political preferences on an individual item basis for each sex. The findings support the claim that the environment (social or other) cannot be used in isolation to explain behavior differences between males and females, nor can all differences in modern political behaviors between the sexes simply be attributed to genes or presumptions about primitive man.

By no means do the findings infer that the social environment or personal experience does not have explanatory capacity, or that it is not the strongest determinant in behavior differences. In certain cases such as *Party Identification*, it appears the social environment is almost all that matters, for either sex. Rather, the social environment does not account for the majority of variance in most political preferences in the population sampled. Environmental, familial, and heritable influences each account for different amounts of the variance on a trait level basis and are likely interactive. Genetic influences for social traits may only be apparent under social conditions. More complex models, with specific measures for environmental influence, tailored to each individual trait are required to explore this possibility.

The qualitative analyses provide a much clearer finding and possibly more radical departure from

traditional social science beliefs. Considering that different genes act in a different manner for males and females to influence political preferences offers an explanation that addresses human biology as well as the social environment people live in. If the results are to be believed and replicated, the need to investigate genetic systems that act differently in males and females for a host of political and social traits is apparent, with a specific focus on issues related to mating and reproductive success.

The links between genes, neurological chemical pathways, emotive and cognitive processes, and social behaviors remain understudied. Controlled mating and repeated experiments provide evidence that vole pair-bonding behavior is strongly influenced by inducing or blocking vasopressin uptake in males and regulating oxytocin uptake in females. Only two attitudes, *Divorce* and *Living Together*, resulted in qualitative sex differences for genetic influence. The finding is provocative, as these two attitudes are also the issues most related to pair bonding in our 27-item index. Existing studies on humans are limited, and the findings here justify the need for additional research on the relationship between these neuropeptides, human affiliative behaviors, and political preferences.

Human behavior is influenced partly by biological factors; the precise amounts and mechanisms are partly dependent upon sex. This does not mean genetic sex differences predetermine behavior; quite the contrary, the effect of the environment is equally strong or stronger and significantly different between men and women. Nor should we consider variance components estimates as absolute mutually exclusive values. Genetic and environmental influences are interactive. Here we report findings from an initial univariate classical twin model; future models may provide more clarity on how these components interact with important covariates. Genetic differences in social behavior can only be elucidated in a social context, and it could be that social roles are modulating the expression of genetic sex differences.

We are only in the early stages of employing genetic models to explore political preferences, and more sophisticated analyses with broader environmental and neurological measures, specific to each sex, are needed to explore the heuristic value and implications of these initial findings. However, it is clear that the etiology of political behavior is not homogeneous for the sexes. Genes matter and they matter differently for each sex. The evidence implies that sex differences for political preferences are best explained using an approach which includes a combination of factors and theories unique to each topic, with a particular focus

on issues related to reproductive fitness. Specifically, the findings support the use of a more nuanced theory that addresses the roles of genes and environment, but also one that is embedded within a model that is consistent with the complex social, environmental, developmental, and biological elements specific to each sex. Doing so will challenge existing political behavior models which only consider social determinants. However, ignoring the influence of inherent sources of political behavior renders contemporary research on sex differences incoherent at a time when the issue of sex remains central to the U.S. electorate.

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Peter K. Hatemi is an assistant professor of political science, Virginia Commonwealth University, Richmond, VA 23298. Sarah E. Medland is a Ph.D. candidate in genetic epidemiology, Queensland Institute of Medical Research, Brisbane, QLD 4029, Australia. Lindon J. Eaves is a distinguished professor of human genetics and psychiatry, Virginia Commonwealth University, Richmond, VA 23298.