Fear Dispositions and their Relationship to Political Preferences

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Abstract: Fear remains an important factor in political life. The vast majority of research in this area assumes that individuals start with the same baseline propensity to experience fear, yet the psychological and psychiatric literatures have established that people differ in their underlying fear dispositions. In this paper we argue that these differences hold important implications for political preferences. Using a large sample of related individuals, we explore the relationship between fear dispositions and political preferences. We find a significant but modest relationship between fear dispositions and a general conservative-liberal orientation, and a much stronger relationship between social fear dispositions and attitudes toward *out-groups*, and to a lesser extent *defense* issues. We extend the findings, by decomposing the covariation between fear dispositions and political attitudes, finding that the vast majority of the relationship between the two is due to shared genetic covariance, thus presenting a likely pathway from genetic influence to political attitudes.

The role of fear in politics appears endemic. Politicians attempt to arouse fear among their respective constituencies by raising the specter of unacceptable and intolerable assaults on cherished values by the outrageous other, however defined. Pundits invoke fear in hopes of mobilizing various groups to either support or oppose particular individuals or policies. Indeed, much work in political science has investigated the way elites use fear to manipulate mass publics into supporting particular individuals or policies (Abramson et al. 2007; Brader 2005).

Scholarship which has explored the influence of fear on political preferences in the arena of public opinion research has largely concentrated on media and elite manipulation of mass publics through the invocation of threats, anxiety, and other negative emotions designed to affect vote choice or support for particular issues (e.g., Ansolabahere and Iyengar 1997; Hetherington 1996; Huddy et al. 2005; Kushner and Gershkoff 2005; Lupia and Menning 2009; Marcus et al. 2000; Zaller 1992). The majority of these studies have focused primarily on the environmental cues which elicit fear and other emotions, and have largely assumed, either through linear models, or explicitly, that all people start from the same baseline propensity to experience fear, and have implied that people are influenced by fear in the same way or to the same degree. While it is critically important to identify environmental factors which are most likely to stimulate or manipulate fear, the delineation of such trigger mechanisms provides little information regarding underlying dispositional differences in fear which exist between individuals that may potentiate differential reactions to similar cues. That is, the majority of research in this area has yet to explore important information about *individual differences* in fear dispositions and how such differences are related to political orientations.

Given what we now know about the potential for genetic influences to account for differences in political attitudes (Alford, Funk and Hibbing 2005; Bouchard et al 1990; Eaves,

Eysenck and Martin 1989; Hatemi et al 2007; Martin et al 1986; Tesser 1993), we sought to utilize new approaches and tools which are now available to explore the relationship between individual differences in fear disposition and political attitudes and preferences. Employing a genetically informative sample, we seek to better understand the relationship between fear and attitudes and elucidate how this process emerges within a dynamic developmental context. Here we present a theory of fear which incorporates both genetic and environmental elements to explicate how dispositional differences in fear can lead to individual variance in political attitudes. Such a developmental delineation proves foundational to a comprehensive and accurate understanding of how genetics can influence political attitudes.

A great deal of work in psychiatry and psychology has demonstrated that people differ both in their underlying fear disposition and in their baseline propensity to experience fear in response to a given stimuli (Kendler et al. 2002a; Kolassa et al. 2009). These differences predict social preferences, demonstrating that as social fear declines, so too does racism (Balter 2010). There has been a great deal of recent work exploring genetic influences on political attitudes and behaviors (Fowler Baker and Dawes 2008; Hatemi et al., 2009ab; Hatemi et al., 2010). This research has yet to be directly incorporated into the research which investigates the relationship between fear and politics (Lupia and Menning 2009), or which explores the genetic sources of fear dispositions (e.g., Kendler et al 2008). Here we merge the research streams encompassing fear and politics, genetic sources of fear, and genetic sources of attitudes, to examine how individual differences in fear dispositions are connected to individual differences in political attitudes. People differ in their individual thresholds for experiencing fear, especially toward out-groups, and we explore the extent to which those differences derive from either shared genetic or environmental variance, or both. This approach is critical to understanding how it is that genes

influence attitudes, and how fear is connected to these differences. In this way we suggest a possible pathway by which genes influence political preferences through their impact on underlying emotional dispositions.

Psychological Approaches to Fear

Fear dispositions do not represent a preference. Rather, dispositional differences in fear, as in other characteristics, exert influences on downstream preferences and alter how one selects into and experiences specific environments. In examining the relationship between fear and political ideology, we concentrate on a developmental approach for the posited nature of the relationship between genes and behavior. This approach in the psychological literature has focused more on general social emotions, relationships and interaction without explicitly incorporating political content, although the applications to political topics appear evident, and we delineate that extension here. Regarding fear dispositions, our approach rests, in part, on a theoretical foundation developed by Bowlby and Ainsworth (1991). From this perspective, acute fears and phobias lead to increases in psychological discomfort. Those with greater fear dispositions will experience greater discomfort toward novel social situations or unfamiliar people and environments, and prove less willing to interact with new people or environments (Antony et al. 2005). For many years, Bowlby worked on processes of attachment; in particular, he investigated why some infants thrived while others died in British orphanages after the Second World War. This work was later extended and expanded. Bowlby and Ainsworth (1991) found that children could be placed into one of three attachment categories, labeled “secure”, “anxious” or “avoidant”, based on their response to being separated from their mother while in a novel or unfamiliar environment, or upon exposure to unfamiliar people. From infancy, children demonstrated reliable and predictable differences in their social and affiliative behavior,

measured by their reaction to unfamiliarity in these so-called “strange situations.”

Bowlby’s theoretical insight involved explicating this behavior in light of the trade-off between affiliative and exploratory motivations. Thus, every child manifests individual differences in terms of the balance they display between fear and sociability in the face of unfamiliar situations and individuals. These infant responses appear to due to innate factors, such as genetic, epigenetic, in-utero, and other physiological and early developmental processes, rather than social conditioning. Ohman and Mineka’s (2001) review, along with original studies, find that fear response is preferentially and automatically activated by aversive contexts that are relevant in an evolutionary perspective, and this activation is relatively impenetrable to cognitive control, and that such activation is due to dedicated neural circuitry. In this way evolutionary models provide a universal architecture of human fear disposition. Behavioral genetic techniques, on the other hand, have offer information on how individuals differ in fear dispositions, and have provided evidence that genetic influences account for up to 50% of the variation on phobic-fear dispositions (Kendler et al 1992ab, 2001, 2002). Extensions of this research found that these dispositional differences are ingrained in the psychological infrastructure of the individual, exert influence throughout one’s life, and emerge in varying contexts, particularly when confronting uncertainty (Gewirtz and Davis 1997; Kagan, Reznick and Snidman 1988).

One of the key innovations which developed from this work revolves around the notion of defensive exclusiveness, whereby fear anxiety prevents an individual from fully assimilating new information (MacLeod and Mathews 1991). Fear renders a person less able to attend to and assimilate new information; in a state of sensory overload from fear, a person defends against additional cognitive demands, such as would be entailed in the processing of new information.

Importantly, social processes related to attachment, and its associated feelings of exposure, risk of rejection or injury, and vulnerability, remain particularly susceptible to defensive exclusion. In particular, Bowlby posited that defensive exclusion was most likely to become activated under conditions of loss, or perceived threat of loss. That is, individuals who perceive a threat of loss will remain less comfortable around strangers, and less willing to subject themselves to new situations which might trigger fear precisely because such environments raise fear anxiety. In this way, fear anxiety prevents an individual from assimilating input which seems especially socially threatening (Garcia and Koelling 1966). However, the propensity to fear loss may emerge from experience, social conditioning and intrinsic differences in disposition; individuals who sustain severe or multiple early losses, such as the orphans of war which Bowlby originally studied, may also find the threat of additional loss particularly anxiety provoking.

Importantly, people are not simply passive recipients of their environments; rather, most actively seek and create the situations that make them most comfortable. Healthy people tend to self-select into environments in which they feel both competent and secure. Fear arousal triggers defensive exclusion and the subsequent rejection of new information in a way that prevents individuals from entering situations where they might learn that such novelty need not necessarily prove threatening. Because novel situations increase anxiety in more fearful individuals, such people avoid unfamiliar people and situations. When their fear is not triggered because they only select into environments with which they are familiar, their avoidance behavior is reinforced. This reinforcement encourages similar avoidance in the future. Thus, the applicability of this model to political preference formation in a western context should most profitably be explored by examining people's views on such topics as immigration, racial bias, or other explicit out-groups. We would expect fear arousal and defensive exclusion to be especially

pronounced among individuals with little exposure to people of different ethnic or social backgrounds.

More recent work has extended the insights provided by Bowlby and Ainsworth to attitudes toward out-group members. Antony et al. (2005) found that adults with a higher degree of social anxiety and increased fear of novel social situations were more likely to compare themselves to unfamiliar others across more dimensions and attributes in a manner consistent with a hypervigilant attention style. In other words, individuals with elevated fear dispositions have a higher threshold for perceived similarity and in-group affiliation. In addition, people with greater phobic-fear dispositions are less likely to compare themselves positively against others. However, even those individuals with only slightly elevated fear dispositions are more likely to avoid novel situations and strangers (Kolassa et al 2009). This view subtly refines the notion put forward by advocates of an Affective Intelligence Model (Marcus et al., 2000) which posits that greater anxiety increases a global search for more information. Developmental approaches further specifies the Affective Intelligence Model, indicating that fearful individuals differentially search for *particular* kinds of information, seeking out points of difference between themselves and unfamiliar others. Simultaneously, however, they prove less likely to take in new information within unfamiliar domains.

Connecting Fear Dispositions to Political Preferences

While we expect a general relationship between conservatism and fear dispositions, we expect the relationship between fear and political preference to reside more so in relationships between specific fear dispositions and specific attitude constructs. Bowlby and Ainsworth's (1991) work implies that individuals who experience greater temperamental levels of discomfort in response to novel people and unfamiliar situations are more "conservative" on certain

positions because of their natural aversion to novel environments. However, Bowlby and others only sought to explain the development of attachment styles. They were not interested in elucidating the origins of political preferences independently. Yet, from this perspective, we would not expect people to be more fearful because they are conservative; rather, those with higher levels of phobic-fear, particularly *social* fear, should choose more conservative positions in those *specific* areas that create anxiety for them. In particular, we would expect that unfamiliar people and issues related to self protection would most likely elicit conservative reactions among the most fearful individuals.

In translating these psychological constructs into a political frame, social fear assessments can be seen as constituting a measure for an individual's threshold for comfort with unfamiliar others, or *out-group* contact. We contend that concentrating on specific political attitudes or behaviors may prove particularly informative for exploring the relationship between fear dispositions and political preferences. *Social* phobias refer to discomfort with social situations, such as fear of speaking in public, as well as fear of other kinds of social situations. We expect *social phobias*, which manifest toward outsiders, strangers, or unfamiliar people and situations, to influence political attitudes toward *out-groups;* this is because unfamiliar others represent novel stimuli that more fearful people would be expected to find most threatening. This intuitive aversion should manifest itself in political preferences focused either on protection of the in-group through *defense* attitudes, or promulgation of punitive polices directed against *out-groups*, such as support for anti-immigration policies. If our theory is correct, then a common underlying factor influencing both emotional and political constructs would relate to how one perceives and manages relations with *out-groups*.

We might also expect some relationship, though weaker, between *agoraphobia, animal*

phobia and *out-group* and *defense* attitudes as well. Individuals with stronger phobic dispositions search the environment for threatening stimuli (Becker and Rinck 2004). This aspect of phobic-fear enables individuals to detect and react quickly to perceived or real threats. Since most threats come from outside the home environment, fear reactions might also be apparent in individuals with elevated levels of *agoraphobia*. In addition, most healthy individuals have a naturally avoidant response to unfamiliar animals such as snakes and spiders (Ohman and Mineka 2001). A relationship between *animal phobia* and *out-group* and *defense* attitudes makes sense from an adaptive standpoint, because animals represent a universal, recurring and important aspect of humans' social world. Animals such as snakes, spiders, and mice are unfamiliar and unpleasant to people, remain outside a person's control, and are often dangerous because these animals' bites can present a threat to one's health. For example, Kolassa et al. (2009) found that individuals with greater social or spider phobic dispositions were physiologically more aroused by angry faces than others. They attributed these findings to greater hypervigilance on the part of phobic individuals.

While identifying and exploring the nature of the relationship between individual fear dispositions and political preferences provides a valuable contribution if such a relationship exists, exploring the potential modes of transmission remains equally important. Are people mutually conditioned for fear disposition and political preferences? Or is it plausible that some part of the relationship between fear dispositions and political preferences could be genetically influenced? Growing evidence indicates that political orientations are genetically influenced (Alford, Funk and Hibbing 2005; Fowler and Schreiber 2008; Hatemi, Medland and Eaves 2009), and that such influence is stable over shorter (30 days, see McGue, Bacon and Lykken 1990) and longer periods (2 yrs, see Eaves and Hatemi 2008) of time. Additional evidence

suggests that there are neurological and physiological relationships between political orientation and emotions such as threat and fear of loss (Kaplan et al 2007; Oxley et al, 2008; Schreiber et al. 2008). However such explorations have provided little understanding of how it is that genes influence attitudes. As fear dispositions are genetically influenced, and attitudes are genetically influenced and fear stimuli and attitudes are related, we test whether a common genetic foundation between fear dispositions and political preferences exists.

Genetic influences are not solely determinative in expressing any particular trait or attitude. Rather, outcomes of interest, such as political preferences, represent the culmination and integration of all the events, life experiences and environmental triggers experienced by individuals, each of whom remains biologically unique. Perfectly capturing such interactions remain more complex than any one statistical method allows. However, with familial modeling we can partition the sources of individual differences on attitudes into meaningful estimates of genetic and environmental influence and how these sources are shared between traits. This method proves useful for exploring the nature and etiology of individual differences. If genes really do influence political attitudes and behaviors in a meaningful way, the most likely mechanism by which they may do so is through their influence on highly adaptive underlying psychological traits or responses, such as fear dispositions.

Here we focus on an individual's underlying fear disposition, which can manifest in modern societies in the form of a political ideology, or as a set of attitudes that constitutes a specific part of one's political orientation. We also propose that whatever psychological and physiological systems developed to respond to out-groups might be due, in some part, to genetic influences on fear dispositions; we measure such reactions in terms of political preferences. Specifically, to the extent that differences in genetic make-up differentially encode fear

dispositions, we expect such variance to emerge precisely under those conditions where fear of out-groups is salient. In this study, we expect factors related to *social* fears, and to a lesser extent, *animal* and *agoraphobic* fears, to have a phenotypic and shared genetic structure with political attitudes related to *defense*, and negative policies toward *out-groups*.

Data, Methods and Results

The sample consists of 29,682 kinships (8,636 families), including twins (14,753), non-twin siblings (3,184), parents (2,362), offspring spouses (4,390) and other relatives (4,993). This constellation of relatives in a very large sample has been shown to be particularly powerful in identifying modes of transmission for complex clinical and social traits (e.g., Eaves et al 1999). The sample was initially derived from a population registry which originated in the late 1970s when Virginia Commonwealth University, in collaboration with the Virginia's Vital Records Office, established the Virginia Twin and Family Registry (VTR) by accessing all birth records in the state. The sample was increased by a national mailer sent to the American Association of Retired Persons, which comprised 60% the original sample. In the 1990s, the VTR was merged with the North Carolina Population Registry (NCTR), which was developed by accessing automated birth records from the North Carolina Department of Environment, Health, and Natural Resources. The merger between VTR and the NCTR, along with birth records from the South Carolina Department of Health and Environmental Control, is now named the Mid Atlantic Twin Registry (MATR). A large questionnaire on "Health and Life Styles" (HLQ) was first administered to the MATR in the late 1980s. This study included measures on demographics, education, political attitudes, and diagnostic health measures, including a self reported phobic-fear scale.

Numerous studies utilizing the population followed, mostly focusing on health traits. Of

particular interest, Kendler et al. (2002a) assessed over 7,500 individuals, including 3,000 complete twin pairs, for a lifetime history of 5 categories of phobic-fears using a clinician administered adaptation of the Phobic Disorders section of the Diagnostic Interview Schedule III-A (see details below; Kendler et al. 1992a). Approximately 2,970 of the 7,500 twins assessed in the clinical sample were a subsample of the original population of 29,682 from the HLQ; the other half was newly ascertained as part of the developing population registry. Once combined, our sample is comprised of a very large population of relatives (29,300) who completed a *self report phobic-fear* index (SRP), and a subset of 2,970 twins with clinical assessments of 5 phobic-fears, all of which include self reports of political attitudes (see Web Appendix 1 for sample demographics).[1] For the overall population, initial response rates were 70% for the twins and 45% for first degree relatives (Truett et al. 1994). For the clinical phobic-fear subsample, the response rates were higher. More details on the ascertainment and other metrics are reported elsewhere in the literature (e.g., Kendler et al. 2000; Lake et al. 2000). Because the sample includes relatives, appropriate familial corrections were included in all analyses when applicable.

Political Attitudes

Political attitudes were measured by a 28 item Wilson-Patterson (1968) attitude index (see Web Appendix 3). This type of measure is more common in psychological studies than political science ones (Bouchard 2003). The design allows for a quick assessment of the multidimensionality of ideological issue positions. A single *conservatism-liberalism* factor can be derived from the scale and has been used in previous analyses of this population and many others (Bouchard et al. 1990; Eaves et al. 1997; Hatemi et al. 2009a; Posner et al. 1996).

[1] In order to ensure that the subsample was not biased in comparison to the population sample, we compared the means and standard deviations between the samples for relevant traits (see Web Appendix 2). Due to the selection criteria for the clinical sample, there was a significant difference in age between the groups. However, differences in demographics, attitudes and self reported phobic-fear were not significant.

However, the scale has received criticism for including attitudes not commonly defined as political (i.e., Modern Art, Astrology, and Divorce). Additional concerns focused on items that convoluted partisanship with attitudes (i.e., Democrats, Republicans, and Liberals). We removed those items, in favor of explicitly political items (e.g., Death Penalty, Gay Rights, Immigration, etc). Our confirmatory factor analysis using the 22 political items provided a single factor with a root mean squared error of approximation of .057, which suggests that our model accurately captures the intricacies of the data. The factor is unimodal, and normally distributed (see Web Appendix 4). The population leans slightly more "conservative", which is expected since 40% of the sample was from the greater Virginia, North and South Carolina areas while the remaining were over 50 years of age.

Comparison of our Wilson-Patterson (WP) *conservatism-liberalism* ideology factor to the more commonly used self-placed ideology (i.e., Strongly Liberal to Strongly Conservative) shows it to be equally predictive of party affiliation. Using data from the National Election Studies (NES) for the same years in which our sample was taken, ideological self-placement (7 point) correlated .21 with party identification (3 point) for respondents with less than high school education, .27 for high school-educated respondents, .37 for those with some college, and .57 for college graduates. In our population based sample, the results are nearly the same. The WP factor is correlated .23 with party identification (3 point) for respondents with less than high school education, .29 for high school-educated respondents, .39 for those with some college, and .57 for college graduates. Additional validity of the WP factor was reported by Smith et al. (2009) where the correlation between a 2008 version of the WP factor and the NES measure for self-reported ideology was greater than .72. Stability of the WP measure is also of interest. A follow-up study of all 22 attitudes was administered to a subset of our original sample

approximately two years after the initial assessment. The correlation between the 22 item *conservatism-liberalism* factor assessed in 1988 and then again in 1990 was .81 ($p<.001$, $n=3,997$). The correlation for self reported ideology using an NES panel study taken some years later, but also spaced two years apart (2000-2002), was somewhat smaller, .68 ($p<.01$, $n=428$).

Based upon the literature, research questions and subsequent hypotheses described above, we seek to largely focus on those attitudes where *defense* and *out-groups* are explicitly addressed, and to a lesser degree on the general *conservatism-liberalism* factor for comparison. Therefore we reduced the attitudes to two additional factors: 1) *defense* (The Draft, Military Drill, and Death Penalty); and 2) *out-groups* (Immigration and Segregation). Both items are measured by the raw sum scores, scaled 0-4 and 0-6, respectively, with 0 being the most conservative, and the highest being the most liberal responses.

Self Report Phobic-Fear Dispositions

In this study we employ a fear assessment instrument that was originally intended for use in clinical evaluation. Such an approach has proved invaluable in the study of many behavioral traits, and psychology is replete with uses of clinical traits and measures for the theoretical development of social behaviors and personality assessment. For example, early use of clinical traits designed to categorize neuroticism and social extraversion (Eysenck 1967) morphed into more finely honed measures used to assess normal populations, of which perhaps the best known is the Big Five personality scale (Costa and McCrae 1997). We seek to follow in the same path as our predecessors by beginning with a measure intended for psychological assessment in clinical populations in hopes of identifying some of the same mechanisms relating fear to political preferences within a normal population.

In invoking this strategy, we used the Symptom Checklist 90 (SCL90), which at the time

was a widely used instrument of self reported psychopathologies (Mattsson et al. 1969). The SCL90 administered to the population sample included a phobic-fear anxiety dimension (Derogatis et al. 1977). There are many uses of the word anxiety, from colloquial to technical. Here we focus on phobic-fear anxiety, defined as "a persistent fear response to a specific person, place, object, or situation—that is irrational or disproportionate to the stimulus and leads to avoidance or escape behavior" (Derogatis 1993:9). This definition is not to be confused with general anxiety disorder, or other versions of anxiety. Higher scores on the *self-report* phobic-fear measure (SRP) are typically associated with marked avoidant behavior. SRP is a blend of *social* phobia, *agoraphobia* and *situational* phobia and has reliability (alpha) of .85 (see Web Appendix 5 for specific questions, histogram and metrics). Respondents rated themselves on a 5 point scale ("Not at all" to "Extremely") regarding how much discomfort they experienced due to: "Feeling afraid to travel on buses or trains; Having to avoid things that frighten you; Feeling uneasy in crowds; Feeling nervous when left alone; and Feeling afraid in open spaces or on the streets". The scale ranges from 0-20, with higher scores indicating greater phobic-fear anxiety. Importantly, 40% of the population sample reported at least some level of discomfort as measured by the SRP. These numbers are consistent with other large studies on phobias. The vast majority of these individuals do not suffer from phobic anxiety disorders that would require treatment. Rather, they represent the normal public who has at least some level of fear discomfort in varying domains.

Clinically Diagnosed Phobic-Fear Dispositions

Clinical diagnostic interviews were conducted on a subset of the population to provide a more in-depth assessment of the degree to which individuals were affected by *agoraphobia, social* phobia, *situational* phobia, *animal* phobia, and *blood* phobias. The analyses here only

include *agoraphobia*, *social* and *animal* phobia due to their posited relationships to *out-group* and *defense* attitudes. The clinical interviewer had at least a master's degree in a mental health related discipline or a bachelor's degree with at least 2 years of clinical experience. In order to be given a positive assessment of a question related to a phobic-fear disposition, the fear or phobia must have resulted in at least one of the following: (1) reporting to the clinician that the fear or avoidance of the behavior interfered with life or activities; (2) seeing a physician or medical professional for treatment; or (3) taking medications for the phobia. Details of the interview and diagnostic process are reported in Kendler et al. (2000). Participants were scored as 1 or 0 on each category by the clinician (see Web Appendix 6 for the specific topics associated with each phobia). Similar to most clinical traits, both the self report and clinically evaluated phobic-fears have a distribution where most people are relatively unaffected, followed by a skewed distribution of decreasing numbers of people as the level of dispositional phobic-fear increases.

Greater statistical power might be obtained by combining all *clinically assessed* phobic-fears into a uniform measure, similar to the composite self report measure. There is some evidence that certain phobic-fears are related and share certain pathways of development. However, clinically evaluated measures are known to differ from self-reports for phobic-fears (Kessler et al 1994). Specifically, the nature of the clinical fear dispositions and their effects are not always uniform across fears and correlated traits (Kendler, Myers and Prescott 2002b). For example, Hettema et al. (2005) found high levels of phenotypic comorbidity (meaning they tend to occur together within particular individuals) between *agoraphobia* and *social phobia*, but only modest association between other phobias. The pathways to development are also somewhat unique to each phobic-fear. Kendler et al. (2001) found that *animal* and *situational* phobias have an earlier age of onset than other phobias. The majority of variance on phobic-fears has been

shown to be due to "phobia proneness" and not "social learning", with estimates of heritability ranging from 30% to 50%. Overall, only a small portion of the genetic and unique environmental variance was common to the five phobia subtypes we mention here. Kendler et al. (2001) concluded that *animal* and *situational* phobias appeared to arise from the joint effect of genetic vulnerability and specific traumatic events in childhood, while *agoraphobia*, and to a lesser degree *social phobia*, resulted from the combined effect of a slightly stronger genetic influence and nonspecific environmental experiences. Therefore, while some relationship exists between the clinical phobias, they are empirically and contextually distinct, and differ in modes of transmission. One dimension may not accurately capture both the phenotypic and genetic properties, particularly in multivariate models and combining them may not be suitable for this initial exploration of their relationship to political preferences.

The Relationship between Attitudes and Phobic-Fears

Table 1 provides evidence of significant, but modest, correlations between higher phobic-fear dispositions and more conservative attitudes. Specifically, *self report*, *animal* and *social* phobic-fears are significantly related to more conservative positions, while *agoraphobia* was not significantly related to any of the attitude dimensions. The magnitudes of the correlations are substantially greater when focusing on *defense* and *out-group* attitudes, supporting our initial expectations.[2] In particular, the relationship between *social* phobia dispositions and more conservative *out-group* attitudes was greater (.22) than any other relationship. However, the non-normal distribution of the phobic-fear measures requires additional analyses.

(Table 1 about here)

Figure 1 provides locally weighted robust scatter plot smoothing with confidence

[2] We also calculated the correlations between published subfactors of the Wilson-Patterson scale (Eaves et al 1999), removing the attitudes in the out-group and defense factors above. The Social/ Sexual, Religious, and Economic dimensions were either not significantly related to SRP and Social Phobia, or very weakly correlated ($r<.05$)

intervals (Cleveland 1979) for: a) *conservatism-liberalism* and *self report* phobic-fear; b) *out-group* attitudes and *social* phobia; and c) *defense* attitudes and *social* phobia. Table 1 provides nine different significant relationships between attitudes and fears. However, only the above pairings were selected for further analyses because each combination represents the greatest correlations between fears and attitudes, or in the case of *conservatism-liberalism* and *self report* phobic-fear, the greatest statistical power. None of the relationships are strictly linear, though they maintain a consistent direction, and the confidence intervals provide reassurance that the slope is significantly different as phobic-fear moves away from zero. However, there are important differences. Noting Figure 1a, for overall *conservatism-liberalism*, small increases in *self report* phobic-fear had only a modest influence on being more conservative; the slope is modest and fairly linear until phobic disposition reaches a score of 12, about 60% of the maximum score of *self report* phobic-fear. At this point the slope becomes a cliff, and has a much more pronounced downward (more conservative) trend. Indeed, there are only handful of cases where people with elevated phobic dispositions are more liberal, and none at the extreme phobic range (14 or greater). However, we note that there are relatively few individuals in this extreme phobic range (108). So, although only a small group within this population suffers from extreme phobic fear, these people are very defense oriented, pro segregation and anti-immigration.

Regarding *defense* attitudes and *social* phobic-fear dispositions (Figure1b), individuals with even the slightest elevation in *social* phobic-fear, 24% of the sample, have more conservative *defense* positions. This effect is fairly uniform across the range of phobic dispositions. However, similar to *self report* phobic-fear and overall *conservatism-liberalism*, there is a more dramatic effect for individuals at the highest level of *social* phobic-fear. Again,

very few individuals score in this range (Web Appendices 5-6).

Concerning *out-group* attitudes (Figure 1c), *social* phobic disposition has an increasingly stronger relationship with more conservative positions as phobic-fear increases; however the effect levels-off in the middle range, but continues on a greater downward slope (toward more conservative positions) once *social* phobia is at its highest value. In sum, it requires an almost extreme phobic disposition to have a substantive influence on one's overall conservative-liberal views. However, only slightly elevated levels of *social* phobic-fear have a substantial conservative influence on one's opinions toward *out-groups* and to lesser extent on *defense* issues. We recognize however, that the self report and clinical measures differ, and that the difference in results may in part be due to scaling differences. The data are also heteroskedastic. This is expected as most individuals do not have a phobic disposition while attitudes are normally distributed.

(Figure 1 about here)

In order to test the veracity of the correlations and further assess the significance of phobic dispositions on overall *conservatism-liberalism*, *out-group* and *defense* attitudes, multivariate robust regression analyses (Huber-White) with quadratic and cubic terms, along with covariates (*sex*, *age*, *religiosity*, *education*, *marital status*, and *income*) were conducted (see Table 2). All linear terms were significant. Cubic and quadratic terms were significant, though modest, for the relationships between *self report* phobic-fear and *conservatism-liberalism*, and *social* phobic-fear and *defense* attitudes. The relationships between fear dispositions and *out-group* attitudes were best explained using only the linear term, and along with *education*, *social* phobia was the strongest indicator of *out-group* attitudes.

(Table 2 about here)

Based on the correlations, plots and regression results, individual differences in phobic-fear dispositions have a significant relationship with political preferences. The size of the effect, while significant, is small for overall *conservatism-liberalism*, but increases when focusing on the relationships between *social* phobic-fear and *out-group* and *defense* attitudes. The findings provide support for the hypothesis that a higher degree of phobic disposition, especially *social* phobia, involving fear of unfamiliarity, results in stronger conservative support for positions on *out-groups* (anti-immigration and pro segregation attitudes in this study) and to more limited degree on *defense* attitudes.

While our fear disposition measures were designed to diagnose or identify phobic-fear anxiety, our clinical measures nonetheless show predictive power. Ideally, this recognition will encourage the development of more politically and socially relevant measures specifically tailored to identify social fear anxiety in a non-clinical manner. However, because many of the diagnostic criteria for measuring clinical phobic-fear dispositions address social contact with people or events which are unfamiliar and/or dissimilar to them, we can use the measures effectively in the current study. Just as earlier clinical measures demonstrated validity when employed in normal populations, we start with a measure designed to assess a clinical trait for fear, and employ it for its utility in assessing a constituent aspect, discomfort with unfamiliar persons and situations, which remains the essence of social fear. And indeed, our findings validate our approach. As fear escalates, so too does conservative opinions on the political issues we explore.

The Nature of the Relationship between Phobic-Fears and Political Attitudes

Not everyone will react the same way to identical stimuli, at least partly because not everyone starts from the same baseline level of fear disposition (Kendler et al. 1993). And, as we

have demonstrated, individual differences in fear dispositions exist, and these differences account for variance on political attitudes. The next step is to offer some insight into the source of the relationship between fear dispositions and attitudes.

Earlier we identified an approach to explaining *how* fears might influence political preferences at the individual level. This approach suggests that those with greater fear dispositions show increased anxiety specifically directed toward novel and unfamiliar people and situations. We thus found greater conservatism to manifest in those attitudes which tap into sentiments related to *out-groups* and *defense* in those individuals with elevated levels of social fear. Expressed in the political realm, these dispositional tendencies would lead to greater support for political positions which would seem to "protect" the individual from perceived harm, or appear designed to reduce exposure to unfamiliar peoples (e.g., positions on defense, punishment and immigration, etc.).

(Table 3 about here)

Fortunately, the nature of our data set allows us to explore the relationships between fear disposition and political preferences at both environmental and genetic levels. As previously noted, 60% of the sample reported no level of dispositional *self report* phobic-fear at all, and many were more conservative in their opinions. One of the benefits of our sample is that we can explore parent-child relationships. Table 3A provides evidence that there exists no relationship whatsoever between parents' *conservatism-liberalism* and their offspring's *self report* phobic-fear disposition. That is, parents who are more conservative do not have offspring with a greater fear disposition. But is the reverse relationship possible? Do parents with a greater fear disposition have more conservative offspring in general? To a modest degree, it appears so (Table 3B). If one or both parents have higher levels of *self report* phobic-fear, there is a

significant, but modest correlation (0.12 for both parents) with more conservative offspring attitudes. Using these two measures, combined with the distribution of the population that is conservative, and the distribution that have higher levels of phobic-fear, we find little evidence that conservatives in general are more dispositionaly phobic or fearful. Yet, we can infer that individuals raised by parents who are more temperamentally fearful are slightly more conservative. That is, more fearful people tend to be more conservative overall. However, when focusing only on *social* phobia's relationship with *out-group* and *defense* issues, the connection is much stronger and evident at even the lowest levels of *social* fear (Figure 1).

Sources of Covariance

Central to our exploration is the additional insight gained by identifying the sources of covariation between political attitudes and fear dispositions. Recent explorations of this population in both political science and psychiatry find political attitudes and phobic-fears are genetically influenced. The proportion of environmental and genetic variance accounted for roughly 30-50% each of individual differences on political attitudes (Hatemi et al. 2010), while genetic influences accounted for 20-50% of the variation on phobic-fear dispositions (Kendler et al. 2001). The proportion of variance accounted for by genetic and environmental influences is quite stable in longitudinal samples of adults for attitudes. However, the prevalence of extreme phobic-fears is not as reliable as attitudes (Kendler et al. 2008). The lower levels of test-retest reliability of phobias in subsequent assessments are due to a combination of factors, including treatment, exposure (increased familiarity), recall, salience, and social desirability, among many other factors.

In our sample, the familial correlations for attitudes are quite high, and are reported elsewhere in the literature (Web Appendices 7-8). For *self report* phobic-fear (SRP), husband-

wife pairs and non-twin siblings are significantly and modestly correlated. A large portion of the sample is comprised of twin pairs. For both attitudes and SRP the monozygotic twin pair correlations are much larger than the dizygotic twin pair correlations (Table 4). The twin correlations are not significantly changed for the attitude measures taken two years later (Hatemi et al 2010). Such patterns provide a strong reason to suspect genes play some role in both traits and are consistent with previous analyses on phobic dispositions and attitudes. Given that we have a genetically informative sample, we can further elaborate on the relationships between phobic-fears and political attitudes by testing how the genetic and environmental influence on fears are related to the genetic and environmental influence on political preferences. That is, how much of the relationship between political attitudes and phobic-fear dispositions are due to mutual genetic influence and how much results from mutual environmental influence?

(Table 4 about here)

The availability of twin pairs raised together allowed for quantitative genetic model fitting and the separation of the observed phenotypic variance into genetic and environmental components (Neale and Cardon 1992; for a detailed explanation of the theory and algebraic equations, see Fisher 1918; Holzinger 1929; Jinks and Fulker 1970). The classical twin design decomposes variance into additive genetic variance (A), shared (common) environmental variance (C), and specific (unique) environmental variance (E). A general univariate genetic model can be represented by the following linear structural equations:

1) $Pi = aA_i + cC_i + eE_i$
2) $V_P = a^2 + c^2 + e^2$

where P is the phenotype of the *i*th individual, scaled as a deviation from zero. A, C, and E can be conceived of as uncorrelated latent factors with zero mean and unit variance. a, c, and e are factor loadings of the observed variable on the latent factors and V_P is the phenotypic variance.

Squaring of the factor loadings yields the different components of variance. Correlations between the latent additive genetic factors were 1 for monozygotic twins (MZ) and 0.5 for dizygotic twins (DZ). Correlations between the latent common environment factors were 1 in both MZ and DZ twin pairs. Unique environment is a free parameter. Similar models used to explore the genetic influence on political attitudes and voting behaviors in the political science, psychology, sociology and behavior genetics literatures have become increasingly common (e.g., Boardman et al. 2010; Bouchard 2003; Eaves et al 2008a; Fowler, Baker and Dawes 2008; Hatemi Medland and Eaves 2009c; Hatemi et al. 2009ab). An explanation of the methods tailored to political scientists was presented by Medland and Hatemi (2009). Extension to a bivariate analysis, named a Cholesky decomposition, allows for exploration of the source of the covariance between two or more phenotypes (Neale and Cardon 1992).[3]

We applied a bivariate Cholesky structural equation model estimated in Mx to the twin data to assess the magnitude of the genetic and environmental influence shared between phobic-fear and political preferences (for recent examples of the model applied to voter preference and partisanship see Hatemi et al. 2007; 2009b). The bivariate Cholesky imposed a stratified structure on the latent factors hypothesized to determine the measured phenotypes, with one set of factors (A_1,C_1, E_1) influencing both phobic-fear and political preferences, and the second set (A_2, C_2, E_2) accounting for residual influences specific to political preferences. The cross paths (A_{12},C_{12}, E_{12}) account for the shared covariance of each latent factor (Figure 2). Any variance accounted for by the second factor in the model (political attitudes) is anything left after variation is accounted for by the first factor (phobic-fears). This factor structure is modeled as a lower diagonal matrix (containing the path coefficients), multiplied by its transpose to produce the full factor model. This factor pattern is repeated for each of the three (ACE) concurrently

[3] For a more detailed explanation of the Cholesky please see Web Appendix 9.

modeled sources of variation.

$$\begin{bmatrix} x_{11}^2 & x_{11}x_{21} \\ x_{11}x_{21} & x_{21}^2+x_{22}^2 \end{bmatrix} \div \begin{bmatrix} \text{var v1} & \text{cov v1v2} \\ \text{cov v1v2} & \text{var v2} \end{bmatrix} = \begin{bmatrix} \text{heritability v1} & \text{\% of } r \text{ due to A} \\ \text{\% of } r \text{ due to A} & \text{heritability v2} \end{bmatrix}$$

The relationship between *conservatism-liberalism* and *self report* phobic-fear utilized a continuous data model, and the relationship between *out-group and defense* attitudes and *social* phobic-fear, utilized a threshold model.[4] The Cholesky's ability to accurately estimate the nature of covariance between traits is improved when the correlations are not small and the sample is large. The correlation between *social* phobic-fear and *out-group* attitudes was the largest (.22), while the sample size for *self report* phobic-fear and *conservatism-liberalism* was the largest (25,488). While increased parsimony is beneficial, we report only the saturated ACE (additive genetic, common environment, unique environment) models. A general bivariate model with phobic-fear was entered as the first variable and attitudes as the second variable were fit to the data. Ordering was based on the assumption that phobic-fear dispositions would preclude the development and maintenance of political preferences. However, the ordering in our bivariate model is less of a concern as our interest is in the nature of the covariation. Latent factors were divided into environmental and genetic factors: 1) specific to fears; 2) common to fears and attitudes; and 3) specific to attitudes. Table 5 provides estimates on what part of the correlation between phobic-fears and political attitudes are accounted for by mutual genetic influence and mutual environmental influence. In every instance, the greater part of the covariation between the phobic-fears and attitudes was due to genetic influence, with only modest unique environment shared, and negligible mutual common environmental influences.

[4] Due to the combination of a normally distributed score for *conservatism-liberalism* and a 20 point index for *self report fear* we validated the results by using two additional techniques: 1) We calculated the point biserial and asymptotic correlation matrices and used these matrices in a continuous model: and 2) we converted c*onservatism-liberalism* into an ordinal measure and used a threshold model. There were no substantive differences in the results from these two models and the continuous raw data model.

(Table 5 about here)

Limitations

While a similar relationship between political attitudes and fear dispositions have been recently reported by the *American Association for the Advancement of Science* (Balter 2010), it is premature to make a definitive generalization, and replication on additional populations must be pursued. While the population is large, the biases introduced from using a population based study, to include a follow up on a subsample of the population, are unknown. Twin and kinship studies are not random by design, and clinical measures are difficult to obtain in a random sample. These results may only be valid for this population. However, the availability of repeated measures to assess attitude stability, and the multiple measures of fear, both self report and clinically diagnosed, provide confidence to our results. However, while the clinical phobic-fears measures in this sample were reliable in the short term (α=0.85, see Kendler et al. 2001), in the longer term they were less reliable (α=0.60) than political orientations (α=0.81). Nevertheless, the *self report* phobic-fear measure was slightly more statistically reliable than political attitudes (α=0.85). The advantage of using Diagnostic and Statistical Manual of Mental Disorders criteria lies in their clinical relevance, and they are widely published and replicable. The disadvantage is that they are consensus based, and their classifications of a particular behavior or profile are tailored toward clinical diagnoses. The challenge for research lies in the fact that clinical traits exist for purposes of treatment and management, and therefore are not uniformly manifested or reported. Future measures tailored for political and social preferences may alleviate these limitations.

The theoretical and mathematical foundation of variance components modeling on twin pairs reared together has been widely discussed, together with its limitations (Kendler et al 1993; Medland and Hatemi 2009; Neale and Cardon 1992; also see Exchange in *Perspectives on*

Politics June 2008). While there is no need to replicate those discussions in full here, of primary concern was the potential for unequal environmental influence on twins. Kendler et al. (1993) directly explored the potential for unequal environments on phobias. Moreover, Hatemi et al.'s (2009a) longitudinal study of twins from childhood to adolescence found no evidence of unequal environmental influences on political attitudes. Additional studies found that similar treatment in childhood had no influence on political attitudes by zygosity type later in life (Smith et al 2010), and that for most attitudes, twin specific environmental variance was not significant (Hatemi et al 2010). Taken together, these studies provide strong evidence that influences of political socialization are not in fact unequal by zygosity type, with regard to political attitudes. However, we did not have both political attitudes and clinical phobic-fears in multiple waves in the same sample and could not assess multivariate longitudinal models in this study. Additionally, estimates from our structural models do not estimate the potential effects of gene by environment interaction, gene-environment covariation, or epigenetic processes. Longitudinal, extended kinship, and molecular designs are required for such an undertaking, and offer an important next step to further clarify the nature of the relationship between fear dispositions and political preferences.

Discussion

Here we investigated how differences in fear dispositions may help account for differences in individual political preferences; we also explored the source of that relationship in a genetically informative sample. We found that the majority of the population showed no manifestation of phobic-fear disposition; however, some 40% of the population does have at least some elevated level of fear and, as the level of fear increases, so too does the degree of conservatism. Specifically, a small increase in *social* phobia substantially increased political

conservatism in the areas of *defense* and *out-group* attitudes. However, for the relationship between a more general measure of fear and overall *conservative-liberal* views, a very modest slope exists until one reaches the more extreme ranges of fear disposition, at which point essentially everyone is more conservative in their attitudes. That is, we do not observe a substantial effect of fear disposition on overall political conservatism unless individuals have an extreme phobic disposition. Furthermore, we find that the greater part of the relationship between fear dispositions and political attitudes is accounted for the genetic covariance between the two constructs. Finding a significant relationship between fear disposition and political ideology in this sample is especially impressive because these fear measures were developed in a completely apolitical context.

We show that while most conservatives are not phobic, most true phobics, who are rare, are conservative; overall, it is not the case that conservatives are more fearful, but rather that fearful people are more conservative. While our findings carry no suggestion that conservatism is a rationalized response to social phobia, people with certain psychological propensities may become attracted to conservatism for reasons related to their genetic dispositions. In other words, people can be attracted to social and political movements for reasons that have no direct relationship to the legitimate political aims of those movements.

The results of the variance components decomposition suggest three possible pathways by which fear dispositions and political attitudes might be related. The first, most often assumed in linear models and hypothesized in the literature, is that fear dispositions directly cause differences in ideology and attitudes. This view fits well with a great deal of the extant literature regarding the relationship between fear and conservatism (e.g., Jost et al 2008). The second possibility is that phobic-fears, specifically *social* fear, and *out-group* and *defense* attitudes, in

part represent different manifestations of a similar underlying phenomenon that reflects discomfort with novel situations and unfamiliar others. In this model, *social* phobia and more conservative positions represent reflections of a single underlying common factor, a largely genetically influenced discomfort with novel situations and people. The third possibility is a subtle difference from the second; that phobic-fear provides a measure of the anxiety individuals experience toward unfamiliar others, and, further, that this fear and political conservatism covary because they share a common genetic origin. In this model, phobic-fear does not mediate the effect of genes on political attitudes; rather, genes influence both anxiety and political attitudes directly. The findings reported in the Cholesky decomposition, specifically the large genetic covariance between fears and attitudes, provides evidence that none of these possibilities can be discounted, and future explorations, including longitudinal data, are required to more fully identify the relationship between fear dispositions and attitudes.

Importantly, the total phenotypic correlation between phobic-fears and attitudes in our measures is at greatest .22. While the greater portion of that correlation is due to shared genes, the amount of genetic relationship is small on an absolute scale. This matters because fear dispositions offer just one pathway by which non-inclusive beliefs or practices might emerge, and only one of the pathways by which genes might be related to attitudes. Such dispositions clearly pose implications for racial and ethnic attitudes (Balter 2010). But it remains necessary to make clear that while genes may affect racial or immigrant attitudes indirectly by the way in which generalized fear dispositions influence environments one selects into, and their eventual political preferences, the relationship between any specific gene, fear disposition and a particular social or political attitude is not hard-wired. Rather, people may have divergent predispositions to be fearful of unfamiliar others, but long term exposure to the unfamiliar makes it unfamiliar

no more. Indeed, the definition of unfamiliar may shift across time and location and such influence is hardly permanent or fixed. In this sample, at this time, it is expressed as opposition to immigration and support of segregation. In the future, it could be manifest in entirely different ways. We in no way suggest that racism, for example, is inevitable or "genetic". The absolute variance of attitudes explained by a shared genetic relationship with fear dispositions is small, suggesting that a host of non-genetic, environmental, developmental, epigenetic, and other factors are critical in the development and maintenance of these forces in American society.

Furthermore, work in this vein has often been misinterpreted and it is important to state that we find little support for conservatives being fearful in general. Rather, individuals who possess a greater fear of unfamiliarity have slightly more ideologically conservative positions, specifically on attitudes regarding policies that have some *out-group* or *defense* component. Knowing that a greater part of the relationship between an individual's fear disposition and political attitude is accounted for by shared genetic variance, we must next consider what mechanisms might underlie these dispositions and what function those processes might serve. Twin and kinship modeling offer a first look at the structure of the relationship. What we label at the extremes as "phobic-fear" has, in the normal range, proved quite useful for exploring effects on political attitudes. Fear is an adaptive trait; without it, the human species would not exist. However, too much fear can inhibit function through induced paralysis, just as too little can lead to disastrous consequences. Much like what Orbell et al.'s (2004) simulation demonstrated with regard to cooperation, the population distribution for optimal success with regard to fear, as well as other factors, may operate across a range and combination of behaviors and dispositions. That is, different fear thresholds are equally good *and* equally bad, for differing reasons, in varied circumstances, and we can only speculate on the evolutionary design that fostered an optimal

distribution of both phenotypes.

From our perspective, political preferences represent a manifestation of a partially genetic imperative expressed within the context of modern circumstances. At present, for a majority of western populations, threats emerge in different forms than those which confronted our evolutionary ancestors. If emotion evolved to help regulate social functioning, fear anxiety would have emerged largely in response to perceived threats, or to encounters which regularly co-occurred with threatening events in the past. Some people come differentially predisposed to remain more or less sensitive to such threats, and more or less primed to acquire fears in response to novel circumstances (Kendler et al. 2008). It is precisely because such fears emerge in response to strange situations involving unfamiliar people and contexts that fear anxiety, which inspires avoidance in the face of such situations, could provide protection when out-groups members do intend harm. In this way, it becomes possible to hypothesize a unified underlying psychological construct which produces both a continuum of fear in response to *out-groups* and a generally calibrated divergence across a *conservative-liberal* ideological spectrum. Both serve to balance the need for society to incorporate and benefit from some individuals who affiliate with unfamiliar others (cooperate) and explore (and thus risk threatening encounters), and some who do not, in order to offer the best protection for the individual and the group. While we find a relationship between phobic-fear and the specific nature of an individual's political ideology, context remains critically important. The specific nature of stimuli becomes important in determining which features of the environment affect individual political ideological predispositions, and which elicit particular ideological responses in given individuals.

We suggest that one of the most important reasons why political scientists should care about the possibility that individual differences in fear dispositions are related at a genetic level

to political preferences is precisely because so much of the fear literature ignores this implication. Whether the pathway between the two variables is mediated or malleable remains important, but largely irrelevant to the outcome, which is that people differ in their basic underlying fear disposition. These differences may manifest as both divergences in baseline level of fear as well as in different reactions to the same stimuli. That is, systematically assessing individual differences in fear dispositions might show differing trajectories in the influence of fear stimuli on particular groupings of individuals.

If researchers include some type of fear disposition in future experimental work, it may be possible to discern differences in slope and intercept of the experimental effects across groups with different fear dispositions. Such an approach will allow researchers a chance to examine how the same stimuli affect people differently, based on their initial fear sensitivity. For example, McWilliams and Admundson's (2007) use of underlying differences in fear sensitivity revealed different perceptions in facial expression of others. While the clinical phobic measures used here may not be ideal, without some knowledge about fear dispositions prior to experimentation, important information would have been lost. Developing measures of fear dispositions more specifically suited to political and social evaluation might uncover even stronger, clearer and more nuanced relationships between the traits we explore here. This, after all, is how a good portion of the personality literature surrounding neuroticism, social extraversion and other characteristics developed. A great deal of this research first explored these traits in the clinical realm, and then modified and extended the measures to normal populations to explore those characteristics for other research purposes.

Political pundits often talk about the impact of fear on the public mindset as though its dynamics were self-evident. Yet the nature of such effects is not transparent. Fear does not affect

individuals in similar ways. Rather, individuals possess different fear dispositions and react to similarly threatening or novel people or environments in diverse ways based, in part, on heritable differences. Here we have shown that differences in phobic-fear propensity, specifically *social* phobia, systematically relates to predictable divergences across a basic spectrum of *conservative-liberal* policy preferences with particular sensitivity to *out-group* and *defense* issues. While phobic-fear dispositions have a significant influence, and in this study most of the relationship between phobic-fears and political attitudes was accounted for by genetic covariation, the vast majority of variation on political attitudes and fears is not related to one another. That is, *social* phobic-fear constitutes a small, but important, part of the ideological spectrum, with more attention directed toward the *out-group* and *defense* attitude domains. This insight appears especially significant in light of the fact that political science has yet to generate an agreed upon theory for individual variation in responses to political out-groups, despite a great deal of attention paid to questions and measures surrounding identity politics more broadly (Abdelal et al. 2009). Our findings indicate that *social* phobic-fear might serve as a foundation for some part of the edifice of certain aspects of political ideology, which helps explain not only one of the ways in which emotion undergirds more complex cognitive structures, but also identifies an important pathway by which genetic differences influence political attitudes.

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Table 1: Correlations between Phobic-Fears and Attitudes

	Conservative-Liberal Index	Defense Attitudes	Out-Group Attitudes	N
Self Report Fear	-0.08*** (-.09 , -.07)	-0.09*** (-.10, -.08)	-0.12*** (-.13, -.11)	25,488
Animal Phobia	-0.06** (-.10 , -.02)	-0.07** (-.11 , -.03)	-0.08** (-.12 , -.04)	2,808
Social Phobia	-0.08*** (-.12 , -.05)	-0.12*** (-.16, -.08)	-0.22*** (-.25, -.18)	2,808
Agoraphobia	-0.03 (-.07 , 0.01)	-0.03 (-.07 , 0.01)	-0.03 (-.07 , 0.01)	2,805

Notes: *** p <.001, **= p<.01, *=p<.05. Self Report Fear and Conservatism-Liberalism are continuous and the correlation is calculated by Pearson's r. The remaining correlations between the clinical phobic-fear measures and the attitude sub factors are calculated by Kendall's tau (SAS9.2).

Table 2: Regression Results: Attitudes on Phobic Fear Dispositions

Conservative-Liberal Attitudes	Linear	Linear+Quadratic	Linear+Quad+Cube
Intercept	-1.53 (0.05)***	-1.43 (0.07)***	-1.28 (0.12)***
Self Report Phobic-Fear	-0.07 (0.01)***	-0.18 (0.05)***	-0.23 (0.05)**
Self Report Fear Quadratic	-	-0.03 (0.01)*	-0.15 (0.08) *
Self Report Fear Cubic	-	-	-0.02 (0.01)
Sex	0.18 (0.01)***	0.18 (0.01)***	0.18 (0.01)***
Age	-0.01 (0.00)***	-0.01 (0.00)***	-0.01 (0.00)***
Religiosity	-0.23 (0.00)***	-0.23 (0.01)***	-0.23 (0.01)***
Education	0.23 (0.01)***	0.23 (0.01)***	0.23 (0.01)***
Marital Status	-0.17 (0.01)***	-0.17 (0.01)***	-0.17 (0.01)***
Income	-0.02 (0.01)***	-0.02 (0.01)***	-0.02 (0.01)***
R2	0.23	0.23	0.23
N			24,964
Defense Attitudes			
Intercept	2.47 (0.06)***	2.47 (0.06)***	2.48 (0.06)***
Social Fear	-0.07 (0.01)***	-0.14 (0.02)***	-0.24 (0.07)**
Social Fear Quadratic	-	0.00 (0.01)	0.02 (0.01)*
Social Fear Cubic	-	-	-0.04 (0.02)**
Sex	0.19 (0.01)***	0.19 (0.01)***	0.19 (0.01)***
Age	-0.01 (0.00)***	-0.01 (0.00)***	-0.01 (0.00)***
Religiosity	-0.01 (0.00)	-0.01 (0.00)	-0.01 (0.00)
Education	0.03 (0.01)***	0.03 (0.01)***	0.03 (0.01)***
Marital Status	-0.02 (0.02)	-0.02 (0.02)	-0.02 (0.02)
Income	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
R2	0.11	0.11	0.11
N			2,803
Out-Group Attitudes			
Intercept	1.93 (0.17)***	1.93 (0.17)***	1.93 (0.17)***
Social Fear	-0.39 (0.06)***	-0.48 (0.11) ***	-0.49 (0.14) ***
Social Fear Quadratic	-	-0.03 (0.01)**	-0.01 (0.10)
Social Fear Cubic	-	-	-0.00 (0.02)
Sex	0.03 (0.04)	0.03 (0.04)	0.03 (0.04)
Age	-0.01 (0)*	-0.01 (0)*	-0.01 (0)*
Religiosity	-0.03 (0.01)**	-0.03 (0.01)**	-0.03 (0.01)**
Education	0.32 (0.02)***	0.32 (0.02)***	0.32 (0.02)***
Marital Status	-0.05 (0.05)	-0.05 (0.05)	-0.05 (0.05)
Income	-0.05 (0.02)*	-0.05 (0.02)*	-0.05 (0.02)*
R2	0.16	0.16	0.16
N			2,753

Notes: Robust standard errors in brackets (computed in SAS 9.2).

Table 3: Parent-Child Correlations

A. Correlations between Parent's Conservatism-Liberalism and Offspring's Self Reported Phobic-Fear Disposition

	Offspring Fear		
Parental Conservatism-Liberalism	Pearson's R	p value	N
Mother	0.02	0.56	2150
Father	-0.03	0.49	1453
Mother –Father Mean Score	0.01	0.76	1278

B. Correlations between Parents Self Report Phobic-Fear Disposition and Offspring's Conservatism-Liberalism

	Offspring Conservatism-Liberalism		
Parental Phobic-Fear	Pearson's R	p value	N
Mother	-0.07	0.04	2271
Father	-0.05	0.10	1464
Mother –Father Mean Score	-0.12	0.03	1298

Notes: Conservatism-Liberalism is coded with lower scores being more conservative. Fear is coded with the greater score having a higher fear disposition.

Table 4: Co-Twin Correlations for Self Report Phobic Fear, Clinically Assessed Phobic Fears and Attitudes

	MZ	DZ	Number of Twin Pairs
Self Report Fear	.34***	.13***	2,561/2,984
Social Phobia	.21***	.10***	823/2,228
Animal Phobia	.21***	.11***	823/2,220
Agoraphobia	.17***	.11***	823/2,230
Conservatism-Liberalism factor	0.67***	0.43***	2,191/2,531
Defense	0.43***	0.24***	2,575/2,981
Out-Groups	0.39***	0.21***	2,626/3,016

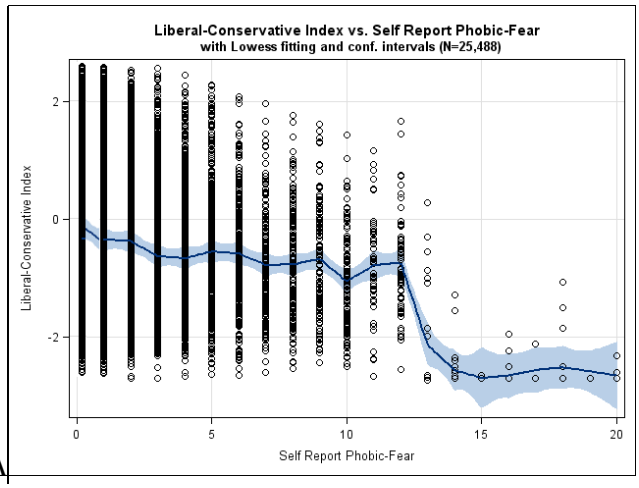
Notes: ***=p<.001, ** =p<.01, *=p<.05. Self Report Fear and Conservatism-Liberalism are continuous and correlations calculated by Pearson's R. The clinical phobic-fear and attitude measures are ordinal and calculated by Kendall's tau.

Table 5: Magnitude of the Different Sources of Covariance between Phobic-Fear and Political Attitudes (Standardized with 95% Confidence Intervals)

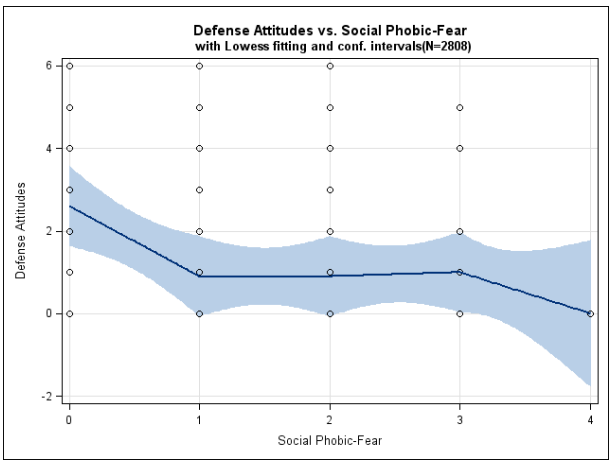
		Percent of Correlation due to Mutual:		
Disposition	Attitudes	Additive Genetic	Shared Environment	Unique Environment
Self Report Fear Index	Conservatism-Liberalism	0.62 (0.55-0.71)	.09 (.02-.14)	0.29 (0.16-0.44)
Social Phobia	Defense	0.71 (0.56-0.96)	.10 (.00-.19)	0.19 (0.10-0.41)
Social Phobia	Out-Group	0.75 (0.59-0.97)	.04 (.00-.12)	0.21 (0.13-0.39)

Notes: Estimates obtained by the statistical package Mx (Neale et al 2003).

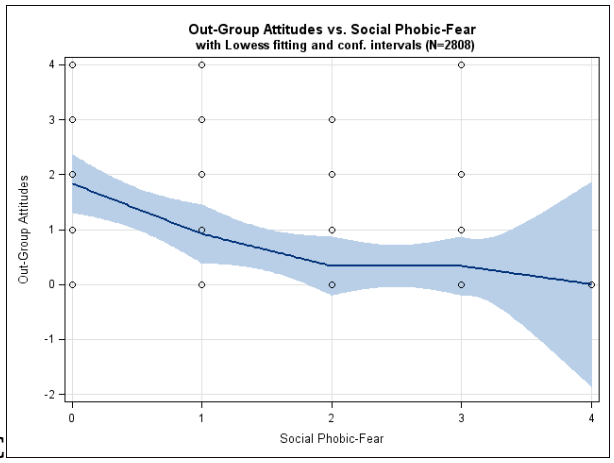
Figure 1


Liberal-Conservative Index vs. Self Report Phobic-Fear
with Lowess fitting and conf. intervals (N=25,488)
Liberal-Conservative Index
Self Report Phobic-Fear
2
0
-2
0
5
10
15
20

A

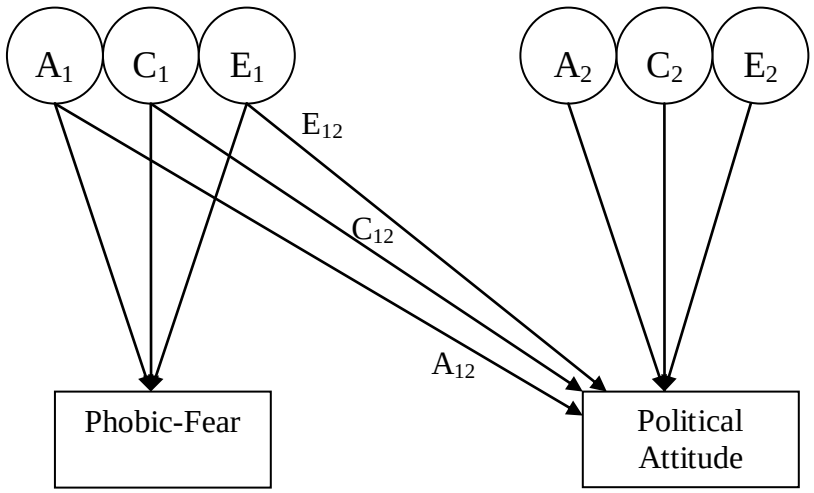

Defense Attitudes vs. Social Phobic-Fear
with Lowess fitting and conf. intervals(N=2808)
Defense Attitudes
Social Phobic-Fear
6
4
2
0
-2
0
1
2
3
4

B


Out-Group Attitudes vs. Social Phobic-Fear
with Lowess fitting and conf. intervals (N=2808)
Out-Group Attitudes
Social Phobic-Fear
4
3
2
1
0
-1
-2
0
1
2
3
4

C

Figure 2. Bivariate Cholesky



Notes: In this model, the observed phenotypes for twin 1 and twin 2 are shown in rectangles, and latent factors are shown in circles. Factor loadings of observed variables on the different latent factors are depicted beside the arrows. Correlations between the latent genetic factors in both models are 1 in MZ and 0.5 in DZ twins. Figure taken from Medland and Hatemi (2009).

Web Appendix 1. Demographics of the Population Sample

Age	
Minimum	18
Maximum	94
Mean	49.54
Std. Deviation	17.60
Sex	**Percent**
Male	40.30
Female	59.70
Political Affiliation	
Republican	36.50
Democrat	31.80
Varies	22.80
No answer/don't know prefer not to say	8.90
Church Attendance	
> 1 x per week	14.66
1 x per week	28.19
Monthly	10.74
A few times a year	17.20
Rarely	19.27
Never	7.80
Missing	2.14
Education	
4+ yrs college	32.36
1-3 yrs college	25.06
High school degree	28.62
Did not finish HS	11.71
Missing	2.25
Marital Status	
Married/living together	73.75
Single / not living together	25.97
Missing	00.28

Web Appendix 2. Comparison of Means and Std. Deviations between the Self Report Population (SRP) and the Clinically Assessed Subset (CAP)

	Conservatism-Liberalism Factor				
	N	Minimum	Maximum	Mean	Std. Deviation
SRP Population	29,682	-2.56	2.99	0.00	1.00
CAP Subset	2,982	-2.51	2.84	0.01	0.97

	SRP Fear Index				
	N	Minimum	Maximum	Mean	Std. Deviation
SRP Population	29,682	0	20	1.23	.438
CAP Subset	2,982	0	20	1.28	.514

	Age				
	N	Minimum	Maximum	Mean	Std. Deviation
SRP Population	29,682	18.0	94.0	49.5	17.6
CAP Subset	2,982	20.0	53.0	31.0	7.34

	Education				
	N	Minimum	Maximum	Mean	Std. Deviation
SRP Population	29,682	2.00	7.00	5.75	1.15
CAP Subset	2,982	2.00	7.00	5.79	1.02

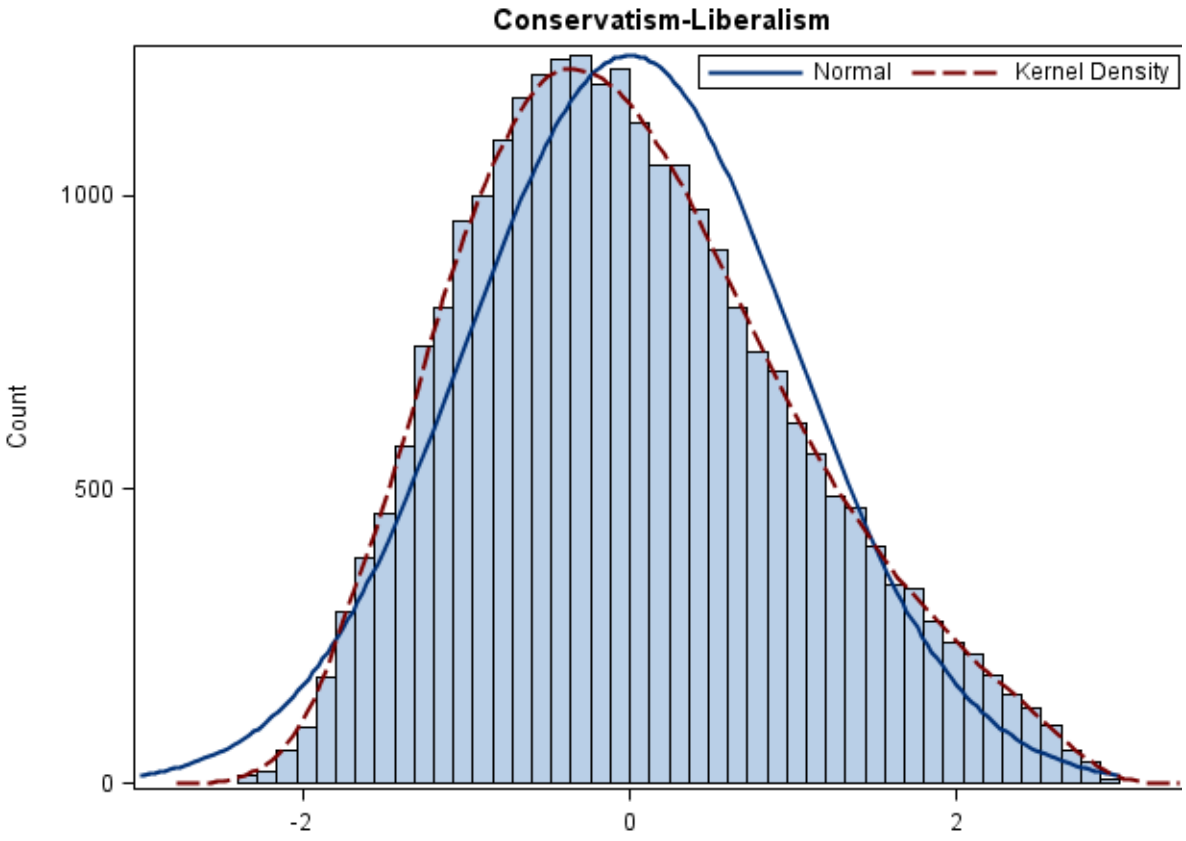
	Live with Partner				
	N	Minimum	Maximum	Mean	Std. Deviation
SRP Population	29,682	1.00	2.00	1.74	.480
CAP Subset	2,982	1.00	2.00	1.59	.492

Web Appendix 3. The Wilson-Patterson Conservatism-Liberalism Attitude Index (exact question format)

Here is a list of various topics. *Please indicate whether or not you agree with each topic by circling Yes or No as appropriate. If you are uncertain, please circle ?.* Again, the best answer is usually the one which comes to mind first, so just give us your first reaction and don't spend too long on any one topic.

	1	2	3		1	2	3
(1) Death penalty.....	Yes	?	No	(15) Immigration.....	Yes	?	No
(2) Astrology.....	Yes	?	No	(16) Capitalism.....	Yes	?	No
(3) X-rated movies.....	Yes	?	No	(17) Segregation.....	Yes	?	No
(4) Modern art.....	Yes	?	No	(18) Moral majority.....	Yes	?	No
(5) Women's liberation.	Yes	?	No	(19) Pacifism.....	Yes	?	No
(6) Foreign aid.....	Yes	?	No	(20) Censorship.....	Yes	?	No
(7) Federal housing....	Yes	?	No	(21) Nuclear power.....	Yes	?	No
(8) Democráts.....	Yes	?	No	(22) Living together....	Yes	?	No
(9) Military drill.....	Yes	?	No	(23) Republicans.....	Yes	?	No
(10) The draft.....	Yes	?	No	(24) Divorce.....	Yes	?	No
(11) Abortion.....	Yes	?	No	(25) School prayer.....	Yes	?	No
(12) Property tax.....	Yes	?	No	(26) Unions.....	Yes	?	No
(13) Gay rights.....	Yes	?	No	(27) Socialism.....	Yes	?	No
(14) Liberals.....	Yes	?	No	(28) Busing.....	Yes	?	No

Web Appendix 4. The Conservatism-Liberalism Attitude Factor



Notes: The CFA included only those individuals with >80% response rate.

N	Valid	26382
	Missing	3300
Mean		.0000000
Std. Error of Mean		.00615667
Std. Deviation		1.0000000
Minimum		-2.55943
Maximum		2.98968

Web Appendix 5. Self Report Phobic-Fear Index

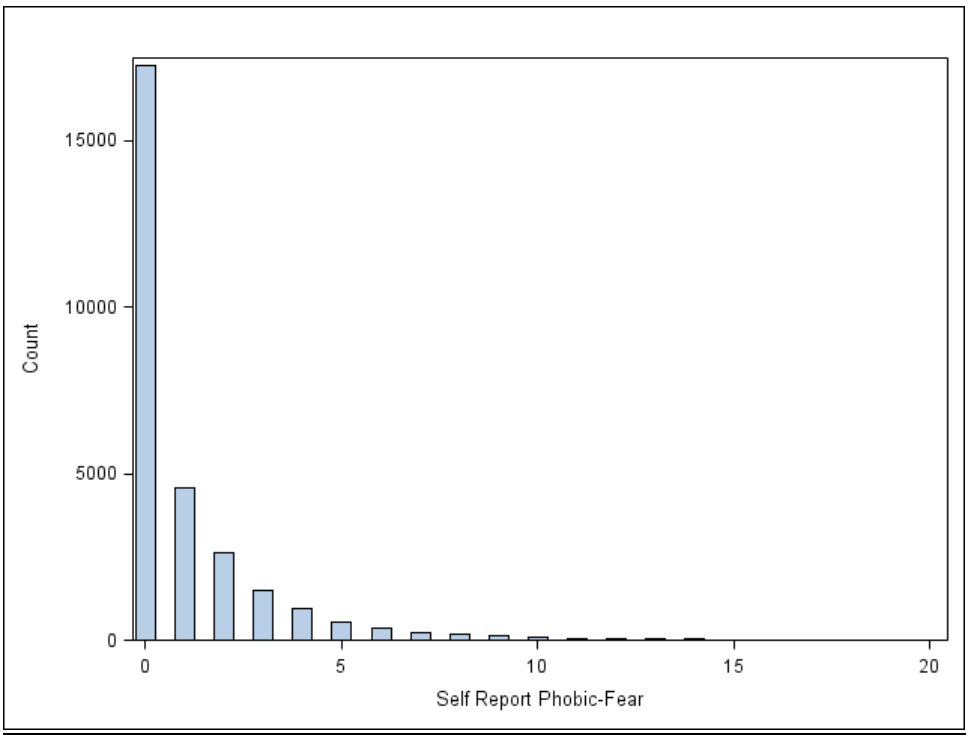
Below is a List of problems and complaints which people sometimes have. Read each one carefully , and circle the number [5 pt scale ranging from “Not at all” to “Extremely “) which best describes HOW MUCH DISCOMFORT THAT PROBLEM HAS CAUSED YOU DURING THE PAST 30 DAYS, INCLUDING TODAY

HOW MUCH WERE YOU DISTRESSED BY:

Self Report Phobic- Fear Index

Feeling afraid to travel on buses or trains
Having to avoid things that frighten you
Feeling uneasy in crowds
Feeling nervous when left alone
Feeling afraid in open spaces or on the streets

N	Minimum	Maximum	Mean	Std. Deviation	Alpha
25488	0.00	20.00	1.23	2.21	.848



Notes: There are cases in the 15-20 range that are not visible due to scaling.

Self Report Fear Index

	Frequency	Percent
.00	17263	60.0
1.00	4580	15.9
2.00	2631	9.2
3.00	1510	5.3
4.00	937	3.3
5.00	526	1.8
6.00	364	1.3
7.00	244	.8
8.00	193	.7
9.00	131	.5
10.00	116	.4
11.00	55	.2
12.00	65	.2
13.00	31	.1
14.00	37	.1
15.00	14	.0
16.00	15	.1
17.00	14	.0
18.00	13	.0
19.00	4	.0
20.00	11	.0
Total	28754	100.0
Missing	938	
Total	29692	

Web Appendix 6. Clinician Assessed Phobic-Fear Categories

	Agoraphobia	Social Phobia	Animal Phobia
	fear of going out of house alone	fear of meeting new people	fear of spiders
	fear of being in crowds	fear of giving a speech	fear of bugs
	fear of being in open spaces	fear of using public bathrooms	fear of mice
		fear of eating in public	fear of snakes
			fear of bats
			fear other animals
Mean	.11	.46	.45
Std Dev.	. 35	.61	.76
Range	0-3	0-5	0-6
Alpha	.56	.61	.62

Notes: Kendler et al. (2001) noted that the interviewer-based assessment of behavioral impairment, though objective, in some instances may have differed from the criteria for phobias than the *DSM*. The interviewer measure at times provided a higher or lower threshold for interference than the self report measure. In comparison to the Epidemiological Catchment Area Study (Eaton et al 1991) a lifetime prevalence for any phobia in men was about half of what Kendler et al (2001) found in the sample used here. However, the National Comorbidity Study (Kessler et al 1994) found much higher rates of Social Phobia in men (11.1%) then Kendler.

Agoraphobia

		Frequency	Percent
Valid	.00	2614	90.7
	1.00	226	7.8
	2.00	39	1.4
	3.00	3	.1
	Total	2882	100.0
Missing		88	
Total		2970	

Social Phobia

		Frequency	Percent
Valid	.00	2030	70.5
	1.00	693	24.1
	2.00	130	4.5
	3.00	26	.9
	4.00	2	.1
	Total	2881	100.0
Missing		89	
Total		2970	

Animal Phobia

		Frequency	Percent
Valid	.00	1943	67.5
	1.00	684	23.8
	2.00	154	5.3
	3.00	63	2.2
	4.00	25	.9
	5.00	8	.3
	6.00	2	.1
	Total	2879	100.0
Missing		91	
Total		2970	

Web Appendix 7: Familial Correlations for Conservative-Liberal Attitudes

	Non-Twin Siblings			Dizygotic Twins			Monozygotic Twins		Parent-Offspring			
Item	MM	FF	MF	DZM	DZF	DZMF	MZM	MZF	M-D	M-S	F-D	F-S
Death Penalty	.28	.31	.27	.41	.37	.33	.52	.54	.35	.19	.26	.18
Astrology	.25	.25	.16	.23	.31	.23	.48	.47	.17	.23	.15	.14
X-rated movies	.34	.31	.26	.35	.40	.31	.58	.59	.22	.15	.20	.25
Modern art	.22	.26	.20	.27	.32	.23	.43	.43	.22	.14	.14	.09
Womens' liberation	.25	.32	.23	.20	.35	.16	.31	.52	.29	.19	.25	.25
Foreign aid	.20	.23	.20	.28	.21	.23	.41	.46	.20	.22	.21	.15
Federal housing	.18	.15	.16	.25	.25	.16	.28	.40	.21	.21	.13	.18
Democrats	.17	.27	.24	.29	.37	.27	.43	.48	.38	.26	.29	.30
Military drill	.18	.17	.17	.19	.24	.10	.40	.36	.20	.14	.17	.15
The draft	.28	.21	.21	.29	.17	.25	.49	.36	.16	.11	.19	.18
Abortion	.42	.46	.41	.42	.56	.43	.55	.68	.48	.34	.43	.37
Property tax	.23	.26	.25	.22	.29	.27	.50	.45	.21	.24	.18	.12
Gay rights	.31	.45	.35	.37	.49	.39	.57	.60	.48	.33	.30	.32
Liberals	.24	.31	.26	.32	.37	.24	.36	.47	.29	.21	.16	.25
Immigration	.26	.24	.23	.30	.28	.20	.45	.46	.22	.21	.20	.20
Capitalism	.34	.24	.24	.36	.31	.23	.62	.47	.28	.21	.26	.27
Segregation	.21	.20	.23	.21	.26	.14	.38	.38	.19	.19	.21	.11
Moral Majority	.20	.24	.17	.19	.24	.17	.41	.43	.23	.23	.18	.23
Pacifism	.10	.14	.15	.14	.14	.18	.36	.31	.08	.07	.05	.04
Censorship	.29	.17	.15	.15	.27	.15	.43	.37	.17	.09	.12	.03
Nuclear power	.26	.12	.14	.20	.26	.18	.45	.33	.22	.18	.13	.20
Living together	.39	.52	.44	.51	.50	.36	.56	.70	.45	.29	.36	.32
Republicans	.26	.22	.21	.24	.33	.28	.47	.48	.33	.31	.29	.27
Divorce	.21	.27	.24	.32	.35	.19	.42	.49	.25	.25	.22	.24
School prayer	.50	.44	.42	.45	.46	.44	.67	.66	.47	.52	.48	.45
Unions	.20	.18	.12	.25	.25	.14	.46	.42	.26	.23	.20	.25
Socialism	.13	.16	.19	.22	.26	.26	.38	.45	.16	.12	.15	.05
Busing	.20	.23	.18	.36	.27	.26	.45	.42	.21	.14	.19	.14
N (pairs)	4462	1564	3701	610	1273	1397	814	1982	4802	3233	3166	2315
S^2	17.73	7.67	13.75	20.13	15.50	28.48	7.56	2.39	.40	.34	.68	1.35

Source: Table taken from (Hatemi et al 2010)

Key:
MM=male siblings; FF=female siblings; MF=male and female siblings; DZM=male dizygotic twins; DZF=female dizygotic twins; DZMF=mixed gender dizygotic twins; MZM=male monozygotic twins; MZF=female monozygotic twins; M-D=mother-daughter; M-S= mother-son; F-D=father-daughter; and F-S=father son

Web Appendix 8. Correlations between Relatives for Self Report Phobic-Fear

	Husband Wife	Mother Son	Mother Daughter	Father Son	Father Daughter	Non-Twin Siblings
Self Report Fear	0.12***	0.13*	0.01	0.05	0.07	0.13*
Sample Size	690	1031	1409	613	695	1259

Notes: *** p <.001, **= p<.01, *=p<.05

Web Appendix 9. Notes on the Cholesky Decomposition

The following Appendix is paraphrased from Hatemi, Peter K. 2007. The Genetics of Political Attitudes. PhD Dissertation, University of Nebraska-Lincoln, Chapter 3. A version of this chapter is also published in Medland and Hatemi 2009. For a more complete description please see Medland and Hatemi 2009.

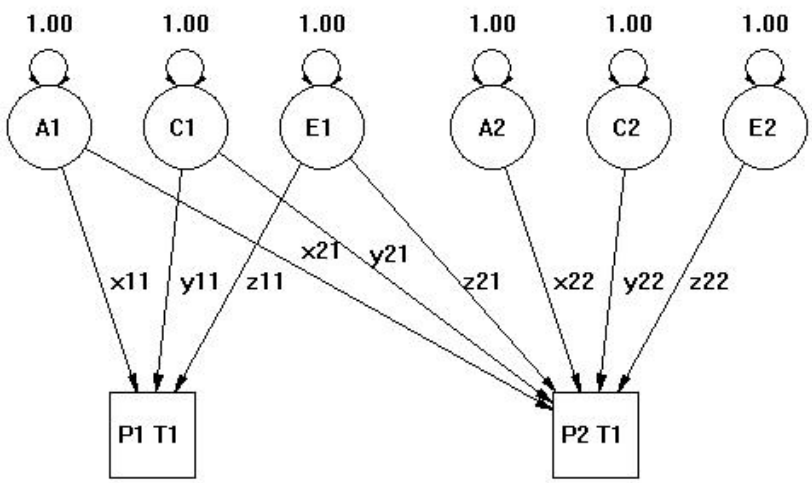
Genetic analyses draw their explanatory power from the information contained in the variances, cross trait (within individual phenotypic covariance), cross twin (MZ and DZ co-twin) and cross twin-cross trait covariances. These elements are shown schematically below. The magnitude of the cross trait covariance elements provides an indication as to whether the traits under analysis share common etiological influences. The relative magnitude of the MZ and DZ cross twin-cross trait covariances provide information regarding whether these causal influences are likely to be genetic or environmental in nature.

Schematic rep of bivariate variance/covariance matrix

		Phenotype1 (P1)	Phenotype2 (P2)	Phenotype1 (P1)	Phenotype2 (P2)
Twin 1	Phenotype1 (P1)	Variance P1 $a^2_{P1}+c^2_{P1}+e^2_{P1}$	Cross trait Covariance $r_A a_{P1} a_{P2}+r_C c_{P1} c_{P2}+r_E e_{P1} e_{P2}$	Within trait cross twin covariance $(.5/1)a^2_{P1}+c^2_{P1}$	Cross trait cross twin covariance $(.5/1)r_A a_{P1} a_{P2}+r_C c_{P1} c_{P2}$
	Phenotype2 (P2)	Cross trait Covariance $r_A a_{P1} a_{P2}+r_C c_{P1} c_{P2}+r_E e_{P1} e_{P2}$	Variance P2 $a^2_{P2}+c^2_{P2}+e^2_{P2}$	Cross trait cross twin covariance $(.5/1)r_A a_{P1} a_{P2}+r_C c_{P1} c_{P2}$	Within trait cross twin covariance $(.5/1)a^2_{P2}+c^2_{P2}$
Twin 2	Phenotype1 (P1)	Within trait cross twin covariance $(.5/1)a^2_{P1}+c^2_{P1}$	Cross trait cross twin covariance $(.5/1)r_A a_{P1} a_{P2}+r_C c_{P1} c_{P2}$	Variance P1 $a^2_{P1}+c^2_{P1}+e^2_{P1}$	Cross trait Covariance $r_A a_{P1} a_{P2}+r_C c_{P1} c_{P2}+r_E e_{P1} e_{P2}$
	Phenotype2 (P2)	Cross trait cross twin covariance $(.5/1)r_A a_{P1} a_{P2}+r_C c_{P1} c_{P2}$	Within trait cross twin covariance $(.5/1)a^2_{P2}+c^2_{P2}$	Cross trait Covariance $r_A a_{P1} a_{P2}+r_C c_{P1} c_{P2}+r_E e_{P1} e_{P2}$	Variance P2 $a^2_{P2}+c^2_{P2}+e^2_{P2}$

Notes: Figure taken from Medland and Hatemi 2009; within twin covariances shown in grey, cross twin covariances shown in black.

When beginning multivariate genetic analysis it is useful to begin by fitting a Cholesky decomposition to the data. The Cholesky is a simple factor model in which there are as many orthogonal factors, *n* as there are variables. All variables load on the first factor, *n*-1 variables load on the second factor and so forth, until the last variable loads on the *n*th factor only. This factor structure is modeled as a lower diagonal matrix (containing estimates of the factor effects known as path coefficients) which is multiplied by its transpose to produce the full factor model. This factor pattern is repeated for each of the three concurrently modeled sources of variation, additive genetic (A), common environment (C), unique Environment (E). The path diagram for a bivariate ACE Cholesky decomposition is given below



Bivariate Cholesky (ACE)

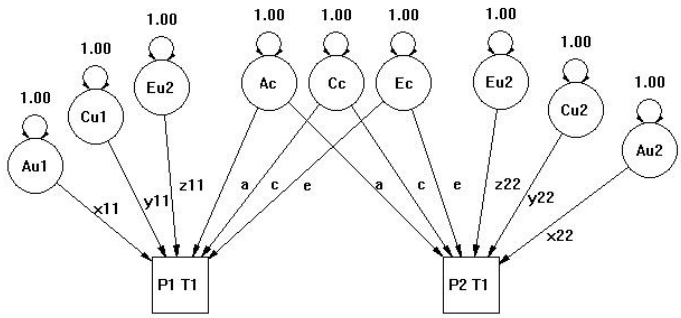
Notes: Figure taken from Medland and Hatemi 2009

The Cholesky decomposition is the saturated model and will have the best fit of any multivariate model, but by definition will also be the least parsimonious model. Thus, it provides the comparison point for other more restrictive models. Generally speaking, the difference in fit between the Cholesky and another nested multivariate model should be compared to a chi-square distribution with the degree of freedom equal to the difference in the number of parameters being estimated.

The ordering of variables within a Cholesky or any multivariate analysis should be based on theoretical expectations, i.e., we hypothesized that the covariation between measures of phobic fear and attitudes was due to a single latent genetic construct and that fear preceded

attitudes. Interpretation of the results depends on the model fitted and what the specific study wished to convey. However, there are three common ways to address the covariation between relatives. Firstly, one may consider the standardized path coefficients and the extent to which covariation between variables is due to each factor.

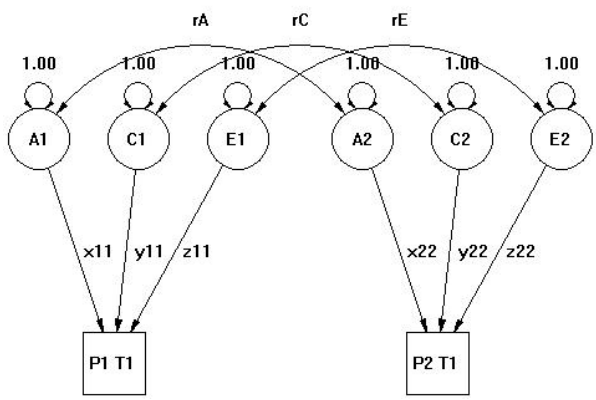
Standardized path coefficients and covariation between variables



Notes: Figure taken from Medland and Hatemi 2009

Secondly, one may discuss the proportions of variance explained and the percent of the phenotypic correlation (r) due to additive genetic effect or environmental effects.

Proportions of variance explained and the percent of the phenotypic correlation (r) due to additive genetic effects (A).



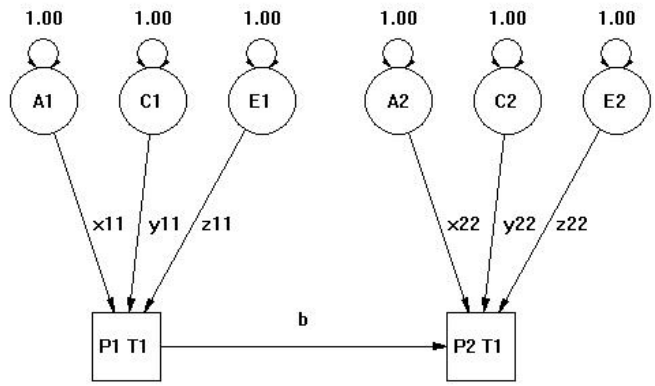
Notes: Figure taken from Medland and Hatemi 2009

To do this divide the estimates of the variance due to A by the total variance:

$$\begin{bmatrix} x_{11}^2 & x_{21}^2 \\ x_{21}^2 & x_{22}^2 \end{bmatrix} \div \begin{bmatrix} \text{var v1} & \text{cov v1v2} \\ \text{cov v1v2} & \text{var v2} \end{bmatrix} = \begin{bmatrix} \text{heritability v1} & \text{\% of r due to A} \\ \text{\% of r due to A} & \text{heritability v2} \end{bmatrix}$$

Thirdly, one may also discuss the genetic correlations, which are the correlations between the genetic effects of the variables.

Genetic correlations



Notes: Figure taken from Medland and Hatemi 2009

The additive genetic correlation between the first and second variables can be calculated using the following formula: $r_g = \frac{x_{21}x_{11}}{\sqrt{x_{11}^2 * \left(x_{21}^2 + x_{22}^2\right)}}$. Alternatively, using matrix algebra we can obtain a genetic correlation matrix by pre- and post- multiplying the estimates of the variance due to A by a matrix containing standard deviations on the diagonals. It is important to keep in mind the proportion of variance that is being explained by A when interpreting the additive genetic correlation, an additive correlation of .95 has very little practical meaning when additive genetic effects are only accounting for 5% of the variation in a trait.