



On the genetic basis of political orientation

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Scholars have long been interested in the underpinnings of political ideology. Over the past fifteen years or so, political scientists, psychologists, sociologists, and economists have started to take seriously the idea that ideology might be influenced by genes. In this article, we review the literature on the genetics of ideology. We begin by describing twin studies and more sophisticated approaches that have now emerged, which consistently show that ideology is about 40% heritable. Next, we examine the state of research on genetic influences on ideology over the life cycle and mechanisms that could link genes and ideology. We conclude by discussing the preliminary genome-wide studies that have been conducted. Existing research has provided important insights into the link between biology and ideology, but additional research is needed in order to provide a more nuanced understanding of the role of biology in the formation of political ideology.

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Current Opinion in Behavioral Sciences 2020, 34:173–178

This review comes from a themed issue on **Emotion, motivation, personality and social sciences** *political ideologies*

Edited by **John Jost**, **Eran Halperin** and **Kristin Laurin**

<https://doi.org/10.1016/j.cobeha.2020.03.012>

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Introduction

Political scientists and psychologists have long been interested in the underpinnings of political orientations. Scholars have been especially fascinated with political ideology, which is generally thought of as a set of beliefs about proper societal order and how to achieve it [2,54]. Ideology is often viewed as a unidimensional construct—typically measured on a continuum ranging from liberal to conservative—but has also been demonstrated to be multidimensional (e.g., social and economic dimensions) [1]. Political ideology is related to a wide range of outcomes at the individual level and thus it is important to develop an understanding of why people adopt certain ideologies over others. Researchers in

psychology have tended to focus on the influence of personality traits and motivational factors in shaping ideology [2]. Political scientists have looked at a variety of factors that might influence ideology, including family socialization, demographic variables, and more recently personality traits [3–5].

Motivated by behavior genetics research demonstrating the heritability of traits related to ideology, like personality, there has been a recent growing interest among social scientists in the genetic underpinnings of ideology. In fact, there are now several studies showing that political ideology is, at least in part, influenced by genes [6[•],7^{••},8,9[•],10–12,14–19,20[•],21^{••},24,25,26^{••},29,30[•],31–35,36,37[•],38,39,40^{••},41,42] (for additional reviews of research on the genetic basis of political behaviors and attitudes, see Refs. [45–49]). In this article, we examine the state of the literature on the genetic basis of political ideology. We begin by describing the findings that have emerged from studies using the classic twin design and also from more sophisticated approaches. Next, we examine the state of research on genetic influences on ideology over the life cycle and mechanisms that might link genes and ideology. We end by providing an overview of the preliminary genetic association studies (and criticisms of those studies) that have been conducted so far.

Twin studies

The starting point for understanding the genetic basis of ideology is the classical twin design (CTD). The basic idea behind this approach is to compare monozygotic (MZ) twins, who are genetically identical, to dizygotic (DZ) twins, who share half of their genes. Generally, if MZ twins show more similarity on a given trait compared to DZ twins, researchers would take this as evidence that the trait is under genetic influence. In accordance with the CTD, it is possible to estimate the *heritability* of a trait, which is defined as the amount of variation in the trait that can be attributed to genetic variation. It is important to keep in mind that heritability estimates refer to a population rather than individuals. For example, if a study reported a heritability estimate of 0.45 for a particular trait, the correct interpretation would be that 45% of the individual differences in that trait is attributable to genetic variation. In other words, this estimate does not mean that for a specific individual, 45% of the trait is due to their genes and the other 55% is due to their environment.

In the study that sparked interest in the genetics of ideology among political scientists, Alford, Funk, and Hibbing reported a heritability estimate of roughly 40%

for ideology [6**]. Follow-up studies, which have used a wide range of samples and measures and have used data collected across different countries, support this result [7**,8,9*,10–12]. In addition, more fundamental dispositions toward social rules, order, and conduct that inform attitudes about issues of the day [13*] have also been shown to be heritable [14]. Interestingly, this highly influential work was actually predated by several studies by Lindon Eaves, Hans Eysenck, and Nicholas Martin in the 1970s and 80s showing that genes play a role in shaping ideology [15–17].

Although the classical twin design provides a way of learning about the genetic and environmental underpinnings of orientations like ideology, it is important to point out that the CTD relies on several assumptions required to identify the effect of genetic and environmental factors, such as the absence of assortative mating and the so-called equal environments assumption (EEA). Also, a limitation of restricting the analysis to MZ and DZ twins is that the effect of additive and non-additive genetic as well as environmental factors cannot all be estimated in the same model.

As a result, follow-up work on the genetic basis of ideology has used more sophisticated designs utilizing information from parents to test for assortative mating and non-twin siblings to estimate additive and non-additive genetic factors [18,19,20*,21**]. These models also enable a better understanding of the role of environment shared by children and parents as well as among twin siblings compared to that of non-twin siblings. Generally, the results from research using additional family members confirm the previous finding that individual differences in political ideology can be explained, at least in part, by genetic factors. Interestingly, researchers who use these approaches often report that genes account for an even greater proportion of the variance in ideology than what is reported in studies using the CTD [21**]. Thus, results from studies using the CTD may actually underestimate the extent to which ideology is heritable.

The assumption of the CTD as well as more sophisticated designs that typically is the source of strong criticism [22,23] is the EEA (equal environments assumption). In order to conclude that difference in similarity between MZ and DZ twin pairs for a particular trait is due to genetic factors, it is necessary to assume that the shared environmental influences on the trait studied are the same for both MZ and DZ twins. If this is not the case, the effect of shared environmental and genetic factors is confounded. While this assumption cannot be directly tested in the CTD (or models using additional family members), studies utilizing measures of self-reported environmental similarities among twins have failed to find evidence that a violation of the EEA leads to inflated heritability estimates of ideology [24,25].

Ideology over the life cycle

In addition to the use of additional family members and more sophisticated models, scholars interested in the biological basis of ideology have examined how genetic influences on ideology change over the life cycle and how experiences during the life course can interact with genetic factors to influence ideology [19,26**]. To date, there have only been a few studies in this area, likely due to the fact that fairly complex datasets are necessary in order to answer questions about ideology over time (e.g., longitudinal surveys with data on twins). The existing studies provide an interesting picture of the development of ideology, and indicate that this is a fruitful area for future research. For example, scholars have found that genetic influences on ideology are typically absent before people reach young adulthood. During childhood and adolescence, ideology seems to be driven mostly by unique and shared environmental influences (an example of the latter being family socialization), but when individuals reach early adulthood (and leave home), genetic influences on political attitudes become as prominent as environmental influences and end up persisting throughout most of adulthood [26**].

Mechanisms linking genes and ideology

Interesting research is also developing on the possible psychological mechanisms that might connect genes to political ideology. Although the research outlined above provides solid evidence that there is a genetic basis to ideology, genes do not directly influence ideology. Thus, it makes sense to examine how genes have an indirect influence on ideology. Indeed, Jost has suggested that “the heritability of basic cognitive, motivational, and personality orientations could account for the heritability of political attitudes” [55]. To date, numerous studies have examined whether genetic influences on ideology work through psychological traits or dispositions that have been demonstrated by social scientists to be related to ideology, such as the Big Five personality traits [2–5], cognitive ability [27], cognitive style [2], and religiosity [28]. Given that many psychological traits are heritable, it makes sense to examine whether they are possible mechanisms that account for some of the heritable variation in political ideology. A number of recent studies have found that there is indeed genetic overlap between political orientation and psychological traits, including cognitive ability [9*], social fear [29], the Big Five personality traits [12,16], need for cognition and need for cognitive closure [30*], need to evaluate [31], religiosity [32,33], social dominance orientation [34], and right-wing authoritarianism [35].

It is necessary to point out, though, that there is debate about what the genetic overlap between psychological traits and ideology means. For instance, the relationship could be causal in nature. Genes may influence psychological traits that in turn influence ideology. On the other

hand, the reverse could be true. Genes could influence attitudes that in turn influence psychological traits. Additionally, genetic overlap between ideology and psychological traits could indicate reciprocal causation, where psychological traits influence ideology but ideology also influences psychological traits. Lastly, it is possible that the same set of genes influences political ideology and psychological traits independently—a relationship known as pleiotropy. Numerous recent studies focusing on personality traits and ideology have reported that the relationship between personality and political ideology is correlational (and not causal) and is driven by common genetic influences [36,37,38,39]. Interestingly, though, there is some evidence that cognitive ability, which is not generally seen as a personality trait, mediates part of the genetic influence on political orientations [9]. Additional research is needed in order to develop a better understanding of the pathways that connect genes to political ideology.

Genetic association studies

It is also important to note that researchers interested in the genetic basis of ideology have attempted to conduct genetic linkage [40] and association studies [7,41,42]. The basic idea here is to search the genome for genetic variants that are significantly correlated with ideology in the hope of elucidating the pathways linking genes and ideology. While a large body of evidence has accumulated from twin studies suggesting that genetic factors explain a substantial fraction of the variation in ideology, no study to this point has provided definitive evidence of a specific genetic marker being related to ideology. This should not come as too much of a surprise. It is highly unlikely that a single gene or even a small group of genes will directly influence a complex trait like political ideology. Instead, it is much more likely that thousands of genetic variants scattered across the genome each exert very small effects in an indirect manner [42]. Therefore, extremely large samples are necessary to detect such small effects [43]. It is necessary to point out that there has been debate about the utility of such studies. Although the debate has primarily centered on studies on the genetic basis of political participation, it is relevant to studies on ideology as well since scholars have done similar studies (i.e., candidate gene studies) in the context of ideology. While some scholars have argued that genetic association studies are beset by difficulties [50,51], other researchers believe that they are valuable for understanding the genetic basis of political traits [52,53]. In recent years, scholars have put forward ideas on how gene association studies should be interpreted by scholars and handled by academic journals, which will hopefully help improve the literature in this area [52,53].

Given the types of datasets and sample sizes that are necessary to conduct such an analysis, the search for specific genetic variants associated with ideology will

be extremely challenging. However, alternate approaches may prove fruitful. Rather than test whether individual genes are associated with ideology, researchers have instead begun to construct and analyze individual-level indices called genome-wide polygenic scores that aggregate the effect of genes associated with a particular trait [44]. This approach overcomes issues of statistical power while at the same time illuminating potential pathways through which genes influence ideology. For example, polygenic scores for personality traits can be utilized to test whether the genes associated with personality also influence political orientations. Overall, research in this area is in its infancy and scholars will need to do a great deal of additional work to better understand the genetic etiology of ideology.

Conclusions

Political ideology influences a wide range of variables, including how people perceive and react to others in society (i.e., ingroup versus outgroup), view political events, and vote in elections. Thus, it is not surprising that researchers across different disciplines have been interested in understanding the causes and consequences of ideology. Interest in political ideology has only heightened in recent years given the increase in elite and mass ideological polarization. Importantly, over that past fifteen years or so, political scientists and psychologists have started to take seriously the idea that ideology might be influenced by genes—that it is not entirely explained by environmental factors like parental socialization or demographic variables. Indeed, there is now a solid body of evidence—using different samples (collected across different countries), different measures of ideology, and different methodologies—indicating that ideology is partially heritable. Given this finding, the natural follow-up question is “*how* are genes connected to ideology?” Researchers are currently working to better understand the specific mechanisms that link genes and political orientations. At this point, we have some insights about the pathways that connect genes and ideology, but there is a lot left to learn (For example, one recent study using twin data from Sweden found evidence that cognitive ability mediates part of the genetic influence on ideology [9], but it will be important to replicate this study using different samples and contexts). There are a number of areas for future research on the genetic basis of ideology. Although scholars have long debated whether human behavior and attitudes are driven by nature or nurture, it appears that scholars are now convinced that both sets of factors influence people. Thus, researchers interested in ideology would be well served by focusing on the biological *and* environmental underpinnings of ideology. In fact, work that considers *both* factors and the *interplay* between biology and environmental factors probably offers the greatest potential for developing a realistic picture of how ideology is formed and maintained (or changed) over time. We encourage researchers to utilize

different research designs (i.e., adoption studies) and longitudinal studies on genetically informed samples to separate genes from environment. Another area of research, as Jost has suggested, is to continue to examine whether additional cognitive, motivational, and personality measures are linked to political attitudes. Indeed, scholars have only examined a handful of basic predispositions that could be related to ideology. We note, however, that it will not be possible to establish a definitive causal pathway from genes to ideology given that it is difficult or impossible to experimentally manipulate these potentially mediating factors. One final interesting research area will be in the area of epigenetics. Epigenetics focuses on processes that alter gene activity (i.e., switching genes on or off) without changing the DNA sequence. Although researchers in genetics are learning more and more about epigenetic processes, there has been virtually no work applying epigenetics to politics. Understanding whether and how epigenetic mechanisms are related to political orientations would help to further illuminate the links between genes and ideology. As Smith *et al.* note, “the kinds of phenomena that social scientists study (voting behavior, ideological variations, etc.) are complex and continuous, what geneticists refer to as quantitative traits. For most phenotypes (observable characteristics) that interest social scientists, a large number of different genes are likely to interact with the environment and with other genes and epigenetic markers to shape the behavior of interest” [13*].

Overall, despite the challenges associated with studying genetic influences on ideology (e.g., locating datasets with the necessary information and large sample sizes), now is an incredibly exciting time for political scientists, psychologists, sociologists, and economists to be studying the underpinnings of ideology—while some robust empirical findings have emerged in the literature, existing studies yield more questions than they do answers.

Conflict of interest statement

Nothing declared.

References and recommended reading

Papers of particular interest, published within the period of review, have been highlighted as:

- of special interest
 - of outstanding interest
1. Conover P, Feldman S: **The origins and meaning of liberal/conservative self-identifications.** *Am J Polit Sci* 1981, **25**:617-645.
 2. Jost JT, Glaser J, Gershowski A, Sulloway F: **Political conservatism as motivated social cognition.** *Psychol Bull* 2003, **129**:339-375.
 3. Gerber A, Huber G, Doherty D, Dowling C, Ha S: **Personality and political attitudes: relationships across issue domains and political contexts.** *Am Polit Sci Rev* 2010, **104**:111-133.
 4. Mondak J: *Personality and the Foundations of Political Behavior.* Cambridge University Press; 2010.
 5. Mondak J, Halperin K: **A framework for the study of personality and political behaviour.** *Br J Polit Sci* 2008, **38**:335-362.
 6. Alford J, Funk C, Hibbing J: **Are political orientations genetically transmitted?** *Am Polit Sci Rev* 2005, **99**:153-167
This is a seminal paper on the genetics of political orientations. It stimulated interest in the genetics of political behavior among political scientists. Using the classic twin design, Alford *et al.* showed that genetics could play an important role in shaping attitudes and ideologies. Much of the research that has emerged in the past 15 years builds on the ideas presented in this paper.
 7. Hatemi Peter K, Medland Sarah E, Klemmensen Robert, Oskarsson Sven, Littvay Levente, Dawes Christopher T, Verhulst Brad, McDermott Rose, Nørgaard Asbjørn Sonne, Klofstad Casey A *et al.*: **Genetic influences on political ideologies: twin analyses of 19 measures of political ideologies from five democracies and genome-wide findings from three populations.** *Behav Genet* 2014, **44**:282-294
This paper examines the role of genes in shaping ideology using datasets from five different countries (with a total of over 12 000 twin pairs). Thus, it represents one of the largest-scale analyses to date. Most previous studies have relied on one or two samples. The authors find support for the idea that genes influence ideology. They also conduct a genome-wide association study. They do not uncover any polymorphisms that reach genome-wide significance but note that incredibly large sample sizes will be necessary in future research in this area.
 8. Bell Edward, Schermer Julie Aitken, Vernon Philip A: **The origins of political attitudes and behaviours: an analysis using twins.** *Can J Polit Sci* 2009, **42**:855-879.
 9. Oskarsson Sven, Cesarini D, Dawes C, Fowler J, Johannesson M, Magnusson P, Teorell J: **Linking genes and political orientations: testing the cognitive ability as mediator hypothesis.** *Polit Psychol* 2015, **36**:649-665
This paper examines the possibility that psychological traits mediate the influence of genes on political ideology. In short, it explores the possible mechanisms linking genes and attitudes. The authors analyze twin data from Sweden and find evidence that cognitive ability mediates part of the genetic influence on ideology. Many scholars have suggested that genes are unlikely to directly influence ideology. This paper supports the idea that psychological traits are likely mediators.
 10. Oniszczenko Włodzimierz, Jakubowska Urszula: **Genetic determinants and personality correlates of sociopolitical attitudes in a polish sample.** *Twin Res Hum Genet* 2005, **8**:47-52.
 11. Bell Edward, Kandler Christian, Riemann Rainer: **Genetic and environmental influences on sociopolitical attitudes: addressing some gaps in the new paradigm.** *Polit Life Sci* 2018, **37**:236-249.
 12. Kandler Christian, Bell Edward, Shikishima Chizuru, Yamagata Shinji: **Genetic foundations of attitude formation: the case of left-right political orientation.** In *Emerging Trends in the Social and Behavioral Sciences: Interdisciplinary Directions.* Edited by Scott RA, Kosslyn SM. Wiley; 2015.
 13. Smith KB, Oxley DR, Hibbing MV, Alford JR, Hibbing JR: **Linking genetics and political attitudes: reconceptualizing political ideology.** *Polit Psychol* 2011, **32**:369-397
This paper examines the possible pathways linking genes and ideology. The basic idea is that heritability of specific issue attitudes could be the result of the heritability of general orientations toward bedrock principles (e.g., preferences about the flexibility of social rules). This paper provides a theoretical framework for thinking about how genes and attitudes might be connected and a number of empirical tests of predictions from the framework.
 14. Funk Carolyn L, Smith Kevin B, Alford John R, Hibbing Matthew V, Eaton Nicholas R, Krueger Robert F, Eaves Lindon J, Hibbing John R: **Genetic and environmental transmission of political orientations.** *Polit Psychol* 2013, **34**:805-819.
 15. Eaves Lindon, Eysenck Hans: **Genetics and the development of social attitudes.** *Nature* 1974, **249**:288-289.
 16. Eaves Lindon, Eysenck Hans, Martin Nicholas: *Genes, Culture, and Personality: An Empirical Approach.* Academic Press; 1989.
 17. Martin N, Eaves L, Heath A, Jardine R, Feingold L, Eysenck H: **Transmission of social attitudes.** *Proc Natl Acad Sci U S A* 1986, **83**:4364-4368.

18. Eaves L, Heath A, Martin N, Maes H, Neale M, Kendler K, Kirk K, Corey L: **Comparing the biological and cultural inheritance of personality and social attitudes in the Virginia 30,000 study of twins and their relatives.** *Twin Res* 1999, **2**:62-80.
19. Hufer Anke, Kornadt Anna, Kandler Christian, Riemann Rainer: **Genetic and environmental variation in political orientation in adolescence and early adulthood: a nuclear twin family analysis.** *J Pers Soc Psychol* 2020, **118**:762-776.
20. Kandler C, Bleidorn W, Reimann R: **Left or right? Sources of political orientation: the roles of genetic factors, cultural transmission, assortative mating, and personality.** *J Pers Soc Psychol* 2012, **102**:633-645
- This paper uses an extended twin family design to examine genetic influences on ideology. Kandler *et al.* have data on monozygotic and dizygotic twin pairs, unmatched twins, spouses of twins, and parents of twins. Thus, they are able to address some of the potential concerns with the twin design, such as assortive mating. Overall, this paper shows that political attitudes are genetically but not environmentally transmitted from parents to offspring and that a substantial proportion of this genetic variance can be accounted for by genetic variance in personality traits.
21. Hatemi P, Hibbing J, Medland S, Keller M, Alford J, Smith K, Martin N, Eaves L: **Not by twins alone: using extended family design to investigate genetic influence on political beliefs.** *Am J Polit Sci* 2010, **54**:798-814
- This paper uses the extended family design to examine the influence of genes on ideology. The authors have data on monozygotic and dizygotic twin pairs, nontwin siblings, spouses, and parents. This approach allows the researchers to overcome some of the criticisms of the classic twin design, which is widely used in research on the genetic underpinnings of ideology. Overall, Hatemi *et al.* find evidence that genes influence ideology. Importantly, they find that estimates from twin studies may actually underestimate the influence of genes on ideology.
22. Beckwith J, Morris CA: **Twin studies of political behavior: untenable assumptions?** *Perspect Polit* 2008, **6**:785-791.
23. Charney E: **Genes and ideologies.** *Perspect Polit* 2008, **6**:299-319.
24. Smith Kevin, Alford John R, Hatemi Peter K, Eaves Lindon J, Funk Carolyn, Hibbing John R: **Biology, ideology, and epistemology: how do we know political attitudes are inherited and why should we care?** *Am J Polit Sci* 2012, **56**:17-33.
25. Littvay L: **Do heritability estimates of political phenotypes suffer from an equal environment assumption violation? Evidence from an empirical study.** *Twin Res Hum Genet* 2012, **15**:6-14.
26. Hatemi P, Funk C, Medland S, Maes H, Silberg J, Martin N, Eaves L: **Genetic and environmental transmission of political attitudes over the life time.** *J Polit* 2009, **71**:1141-1156
- This paper examines the role of different influences on ideology at different points over the life cycle. The authors find that genetic influences on ideology are typically absent before people reach young adulthood. During childhood and adolescence, ideology seems to be driven mostly by unique and shared environmental influences, but when individuals reach early adulthood (and leave home), genetic influences on political attitudes become as prominent as environmental influences and persist.
27. Deary IJ, Batty GD, Gale CR: **Bright children become enlightened adults.** *Psychol Sci* 2008, **19**:1-6.
28. Smidt CE, Kellstedt LA, Guth JL: **The role of religion in American politics: explanatory theories and associated analytical and measurement issues.** *The Oxford Handbook of Religion and American Politics*. 2009:3-42.
29. Hatemi PK, McDermott R, Eaves LJ, Kendler KS, Neale MC: **Fear as a disposition and an emotional state.** *Am J Polit Sci* 2013, **57**:279-293.
30. Ksiazkiewicz Aleksander, Ludeke S, Krueger R: **The role of cognitive style in the link between genes and political ideology.** *Polit Psychol* 2016, **37**:761-776
- This paper examines the role of two psychological dispositions, need for closure and need for cognition, in shaping ideology. The authors find that the need for cognition and the need for cognitive closure are heritable and are linked to political ideology primarily, perhaps solely, because of shared genetic influences. Cognitive style may represent a possible pathway linking genes to ideology.
31. Ksiazkiewicz Aleksander, Krueger Robert: **The role of genes and environments in linking the need to evaluate with political ideology and political extremity.** *Soc Justice Res* 2017, **30**:381-407.
32. Aleksander K, Friesen A: In press. **The higher power of religiosity over personality on political ideology.** *Polit Behav*. <https://doi.org/10.1007/s11109-019-09566-5>.
33. Friesen Amanda, Ksiazkiewicz Aleksander: **Do political attitudes and religiosity share a genetic path?** *Polit Behav* 2015, **37**:791-818.
34. Kleppesø TH, Czajkowski NO, Vassend O, Røysamb E, Eftedal NH, Sheehy-Skeffington J, Kunst JR, Thomsen L: **Correlations between social dominance orientation and political attitudes reflect common genetic underpinnings.** *Proc Natl Acad Sci U S A* 2019, **116**:17741-17746.
35. Lewis GJ, Bates TC: **Common heritable effects underpin concerns over norm maintenance and in-group favoritism: evidence from genetic analyses of right-wing authoritarianism and traditionalism.** *J Pers* 2014, **82**:297-309.
36. Hatemi Peter K, Verhulst Brad: **Political attitudes develop independently of personality traits.** *PLoS One* 2015, **10**:e0118106.
37. Verhulst B, Eaves L, Hatemi P: **Correlation not causation: the relationship between personality traits.** *Am J Polit Sci* 2012, **56**:34-51
- This paper challenges the idea that the relationship between personality and ideology is causal in nature, which many previous studies have argued. The authors provide evidence that personality traits do not cause people to develop political attitudes. Instead, the correlation between the two appears to be a function of a common underlying genetic factor.
38. Verhulst B, Hatemi P, Eaves L: **Disentangling the importance of psychological pre-dispositions and social constructions in the organization of American political ideology.** *Polit Psychol* 2012, **33**:375-393.
39. Verhulst B, Hatemi P, Martin N: **The nature of the relationship between personality and political attitudes.** *Pers Individ Differ* 2010, **49**:306-331.
40. Hatemi P, Eaves L, Maher B, Webb B, Heath A, Medland S, Smyth D, Beeby H, Gordon S, Montgomery G *et al.*: **A genome-wide analysis of liberal and conservative political attitudes.** *J Polit* 2011, **73**:1-15
- This paper presents the first genome-wide analysis of ideology. The basic idea is to conduct a genome-wide linkage, a method for narrowing down the regions where there is likely to reside a gene or genes relevant to the phenotype of interest. The authors identified several significant linkage peaks, but additional replication studies will be necessary.
41. Settle Jaime E, Dawes Christopher T, Chrskatis Nicholas A, Fowler James H: **Friend-ships moderate an association between a dopamine gene variant and political ideology.** *J Polit* 2010, **72**:1189-1198.
42. Benjamin DL, Cesarini D, Matthijs JHM, Dawes CT, Koellinger PD, Magunsson PKE, Chabris CF, Conley D, Laibson D, Johannesson M, Visscher PM: **The genetic architecture of economic and political preferences.** *Proc Natl Acad Sci U S A* 2012, **109**:8026-8031.
43. Lee JJ, Wedow R, Okbay A, Kong E, Maghziyan O, Zacher M, Nguyen-Viet TA, Bowers P, Sidorenko J, Linnér RK, Fontana MA: **Gene discovery and polygenic prediction from a genome-wide association study of educational attainment in 1.1 million individuals.** *Nat Genet* 2018, **50**:1112.
44. Plomin R, von Stumm S: **The new genetics of intelligence.** *Nat Rev Genet* 2018, **19**:148.
45. Alford JR, Hibbing JR: **The new empirical biopolitics.** *Annu Rev Polit Sci* 2008, **11**:183-203.
46. Hatemi Peter K, Eaves Lindon, McDermott Rose: **It's the end of ideology as we know it.** *J Theor Polit* 2012, **24**:345-369.
47. Hatemi Peter, McDermott Rose: **The genetics of politics: discovery, challenges, and progress.** *Trends Genet* 2012, **28**:525-533.
48. Hatemi PK, McDermott R: **Give me attitudes.** *Ann Rev Polit Sci* 2016, **19**:331-350.

49. Ksiazkiewicz A, Friesen A: **6. Genes and politics**. *Handbook of Biology and Politics*. 2017. p. 85.
50. Charney Evan, English William: **Candidate genes and political behavior**. *Am Polit Sci Rev* 2012, **106**:1-34.
51. Charney Evan, English William: **Genopolitics and the science of genetics**. *Am Polit Sci Rev* 2013, **107**:382-395.
52. Fowler James, Dawes Christopher: **In defense of genopolitics**. *Am Polit Sci Rev* 2013, **107**:363-375.
53. Deppe Kristen, Stoltenberg Scott, Smith Kevin, Hibbing John: **Candidate genes and voter turnout: further evidence on the role of 5-HTTLPR**. *Am Polit Sci Rev* 2013, **107**:375-381.
54. Jost John T, Federico Christopher M, Napier Jaime L: **Political ideology: its structure, functions and elective affinities**. *Ann Rev Psychol* 2009, **60**:307-337.
55. Jost John: **The end of ideology**. *Am Psychol* 2006, **61**:651-670.