

The Genetics of Political Behavior: Claims and Refutations

By Jay Joseph, Psy.D.

Berkeley, CA

www.jayjoseph.net

jayjoseph22@gmail.com

**Manuscript submitted for publication in the
American Political Science Review, May 2009**

PLEASE DO NOT REPRODUCE OR QUOTE AT LENGTH
WITHOUT PERMISSION BY THE AUTHOR

KEYWORDS: Politics, genetics, twin study, molecular genetics, voting, behavioral genetics

Abstract

Political scientists Alford, Funk, and Hibbing published a 2005 twin study in this journal, where they concluded that genetic factors play an important role in shaping political attitudes and ideologies. Subsequent researchers claimed to have identified genes associated with political behavior at the molecular level. Here, I join previous critics in arguing that Alford and colleagues' research method, known as the twin method, rests on the clearly false theoretical assumption that reared-together monozygotic and dizygotic twins experience equal environments. I conclude that the results of Alford and colleagues' twin study can be explained completely by non-genetic factors. In addition, I argue that recent gene discovery claims are likely false positive findings in much the same way as this has occurred in psychology and psychiatry. I elaborate on the flaws in twin studies, and analyze the evidence put forward in support of the equal environment assumption (EEA) of the twin method.

Politics, Genetics, and the Twin Method

I feel the need to comment on the recent claims by political scientists Alford, Funk, and Hibbing (hereafter, AFH) and others that differences in political orientations and behavior have an important genetic basis.¹ Intuitively we might reject such an idea out of hand, yet the past few years have seen claims that the genes/political behavior link is based on objective scientific evidence. This has led to the creation of the nascent field of "genopolitics."² It is my understanding that political scientists take quantitative empirical methodology very seriously. Thus, one can only welcome a detailed scrutiny of the assumptions of the twin method in this field. Such scrutiny has been largely absent in psychiatry and psychology, where journals regularly publish research using the twin method, with little or no critical analysis. Conversely, genetic theories and claims have sparked a debate in political science on the validity of twin research, a debate largely absent in other fields.³

What concerns us here is the possible role of genetic influences on individual differences in political attitudes and behavior, not the undisputed fact that human beings are the product of both their genes and their environments. Hannagan and Hatemi stated the obvious when they wrote, mistakenly implying that critics of genetic research disagree, "the scientific community recognizes that genes are very much a part of what it means to be human."⁴ We might as well say that the scientific community recognizes that Barack Obama won the 2008 United States presidential election. Human behavioral genetic researchers, however, are concerned with trait

¹ See Alford et al. 2005, 2008a, 2008b; Fowler and Dawes 2008; Fowler et al. 2008; Hatemi et al. 2007; Hatemi et al. 2008; Hatemi et al. 2009; Medland and Hatemi 2009.

² See <http://en.wikipedia.org/wiki/Genopolitics>.

³ For criticism of twin research in political science see Beckwith and Morris 2008; Charney 2008a, 2008b; Suhay et al. 2007. For responses to these critics, see Alford et al. 2008a, 2008b; Hatemi et al. 2008.

⁴ Hannagan and Hatemi 2008, 332.

variation in the population, and usually conclude that heredity plays an important role in explaining this variation.

In their 2005 APSR twin study,⁵ AFH concluded that "genetics plays an important role in shaping political attitudes and ideologies . . ." ⁶ They reached this conclusion on the basis of finding a significantly higher correlation of MZ (monozygotic, identical) versus same-sex DZ (dizygotic, fraternal) twin pairs on Wilson-Patterson Attitude Inventory scores. They used the "classical twin method" (hereafter the "twin method"; political science twin researchers sometimes refer to the twin method as the "classic twin design," or "CTD"). Specifically, the twin method compares the trait resemblance of reared-together MZ twin pairs, who share a 100% genetic similarity, versus the resemblance of reared-together same-sex DZ twin pairs, who average a 50% genetic similarity. Based on the fact that MZ pairs share a greater genetic resemblance than DZ pairs, twin researchers believe that genetic factors are responsible for a finding of significantly greater behavioral resemblance among MZ versus same-sex DZ twin pairs. A critical theoretical assumption of the twin method, which allows researchers to conclude in favor of genetics, states that the childhood and adult environments of both types of twins are comparable. This is known as the equal environment assumption (or "EEA").

As both twin researchers and their critics recognize, the validity of the EEA is central.

Indeed, in their twin study publication AFH wrote,

This assertion that the effect of genetics is measurably distinct for MZ and DZ twins, while the effect of the environment is either equivalent or at least randomly distributed around equivalence [EEA], is crucial to everything that follows from twin research.⁷ [italics added]

⁵ Alford et al., 2005.

⁶ Ibid., 153.

⁷ Ibid., 155.

AHF proceeded to cite evidence that they believed upheld the validity of the equal environment assumption. While critics Beckwith and Morris agreed that “the EEA is essential for conclusions drawn from twin studies concerning human behavioral traits,”⁸ they concluded “that the EEA has not been well tested nor validated,”⁹ thus casting doubt on AFH’s original conclusions in favor of genetics. Political scientists Evan Charney, and Elizabeth Suhay and colleagues, have also questioned the validity of the equal environment assumption and the twin method.¹⁰ My purpose here is (1) to elaborate further on the untenable basis of the EEA, (2) to show that the twin method is no more able to disentangle potential genetic and environmental factors than is a family study, and (3) to suggest that it is very unlikely that “genes for” political behavior will ever be found.

Twin researchers and most of their critics agree that MZ twin pairs resemble each other more (i.e., correlate higher) than same-sex DZ pairs for most behavioral and psychological traits. The key question, however, is the determination of what factor or factors explain this finding. Behavior geneticists argue that genetic factors provide the best explanation,¹¹ whereas critics frequently argue that environmental factors play a large or exclusive role.

On the basis of the ubiquitous finding that MZ pairs resemble each other more than DZ pairs for behavioral traits, it should have come as no surprise to either genetic researchers, or to proponents of a purely social theory of political behavior, that AFH found MZ pairs to resemble each other more than DZ pairs for political attitudes as well. Political scientists influenced by behavioral genetics argue that this finding provides solid evidence that genetic factors play an

⁸ Beckwith and Morris 2008, 788.

⁹ *Ibid.*, 788.

¹⁰ Charney 2008a, 2008b; Suhay et al. 2007.

¹¹ e.g., Bouchard and McGue, 2003; Plomin et al. 2008; Rutter 2006.

important role.¹² Thus, political behavior joins a long list of other intuitively non-genetic behaviors now claimed for genetics on the basis of twin research. Among these are included anorexia,¹³ breakfast eating patterns,¹⁴ frequency of orgasm in women,¹⁵ loneliness,¹⁶ perfectionism,¹⁷ and religiousness.¹⁸

There are two main conclusions that we can reach on the basis of such research:

- 1) **Twin Researchers' Conclusion:** The greater resemblance of MZ vs. same-sex DZ twin pairs provides solid evidence that a sizable portion the population variance of these and other traits can be explained by genetic factors, **or**
- 2) **Twin Method Critics' Conclusion:** The twin method is a faulty instrument for assessing the role of genetics, given the likelihood that MZ vs. same-sex DZ comparisons measure environmental rather than genetic influences. Therefore, all previous interpretations of the twin method's results in support of genetics are wrong.

Here, I argue that Conclusion #2 is the correct one, and that it is unlikely that the twin method measures anything more than the greater treatment, environmental similarity, and emotional bond experienced by MZ vs. DZ twin pairs.

The Two Main Definitions of the Equal Environment Assumption

As most people intuitively understand, MZ twin pairs experience much more similar environments than do DZ pairs. This has been recognized not only by some early twin researchers and commentators,¹⁹ but by leading contemporary behavior geneticists as well. Some examples from the latter group are as follows:

¹² See for example Carmen 2007; Fowler and Schreiber 2008.

¹³ Bulik et al. 2006; Wade et al. 2000.

¹⁴ Keski-Rahkonen et al. 2004.

¹⁵ Dawood et al. 2005.

¹⁶ Boomsma et al. 2005.

¹⁷ Tozzi et al. 2004.

¹⁸ Koenig et al. 2005.

¹⁹ See Joseph 2004, Chapter 2.

- Sandra Scarr and Louise Carter Saltzman in 1979: “The evidence of greater environmental similarity for MZ than DZ twins is overwhelming.”²⁰
- David Rowe in 1994: “The question is not whether MZ twins receive more similar treatments (they do, and to claim otherwise would be foolish), but whether these treatments influence a particular trait.”²¹
- Stephan Faraone and colleagues in 1999: “Several studies have found that the social environments of MZ twins are more similar than those of DZ twins. For example, habits, activities, personal preferences, parental treatment, and self-image tend to be more similar between MZ twins. Moreover, MZ twins are more likely to be dressed alike and are more likely to be confused for one another in childhood.”²²
- Thomas Bouchard, Jr. and Matt McGue in 2003: “MZ twins are more likely than DZ twins to share friends and parental treatment in adolescence.”²³
- Kenneth Kendler and Carol Prescott in 2006: “Consistent with other studies, we found evidence that some aspects of the environment of members of MZ pairs are, on average, more similar than those of members of DZ pairs.”²⁴

The EEA has been defined in two main ways since the inception of the twin method in the 1920s. The first is the traditional definition, which was the only definition used until the mid-1960s, and states simply that MZ and same-sex DZ twin pairs experience roughly equal childhood and adult environments. Most twin researchers now recognize that this definition of the EEA is false.²⁵ Thus, in the 1960s twin researchers changed the definition of the EEA to the currently used trait-relevant definition.²⁶ For example, leading behavioral genetic twin researcher Kenneth Kendler and his colleagues have defined the EEA as follows:

The traditional twin method, as well as more recent biometrical models for twin analysis, are predicated on the equal-environment assumption (EEA)—that monozygotic (MZ) and

²⁰ Scarr and Carter-Saltzman 1979, 528.

²¹ Rowe 1994, 45.

²² Faraone et al. 1999, 38.

²³ Bouchard and McGue 2003, 9.

²⁴ Kendler and Prescott 2006, 124

²⁵ For example, see Kendler 1983; Rowe 1994.

²⁶ Some researchers continue to use the traditional EEA definition. For example, bipolar disorder genetic researcher Samuel Barondes (1998, 81) wrote, “assuming that the shared environments of sets of identical twins and sets of fraternal twins are roughly equal (which appears to be the case), comparing their degree of similarity gives the indication of the relative contributions of nature and nurture.”

dizygotic (DZ) twins are equally correlated for their exposure to environmental influences that are of etiologic relevance to the trait under study [italics added].²⁷

After subtly redefining the equal environment assumption by adding the ad hoc trait-relevant condition, twin researchers then implied or stated that critics bear the responsibility of identifying trait-relevant environmental factors for which MZ and DZ twin pairs differ.²⁸

However, as psychologist Scott Lilienfeld and his colleagues noted, "a basic tenet of science is that the burden of proof always falls squarely on the claimant, not the critic . . . Consequently, it is up to the proponents of these techniques to demonstrate that they work, not up to the critics of these techniques to demonstrate the converse."²⁹

Twin researchers in political science also use this "trait relevant" definition of the equal environment assumption.³⁰ Like previous twin researchers, they focus narrowly on factors such as dressing alike, or having common playmates as children, while downplaying factors relating to the greater psychological and emotional bond of MZ pairs, and their greater propensity to experience "ego fusion" and mutual association when compared with DZ pairs.³¹

Twin Studies and Family Studies

Before performing twin studies, behavior geneticists frequently use family studies to assess whether a trait is familial. Family studies attempt to determine whether the biological relatives of persons manifesting a given trait exhibit the trait more often than do members of the

²⁷ Kendler et al. 1993, 21.

²⁸ An example of twin researchers reversing the burden of proof from themselves onto critics is seen in AFH's response to Evan Charney's (2008A) critique of their work. After acknowledging that MZ pairs experience more similar environments to some extent, they argued that the "central question" is whether these factors influence political beliefs, and that "no evidence has yet been presented that it does" (AFH 2008A, 322). Other twin researchers attempting to place the burden of proof onto critics include Faraone and Biederman 2000; Lyons et al. 1991.

²⁹ Lilienfeld et al. 2003, 3

³⁰ e. g., Hannagan and Hatemi 2008. According to Medland and Hatemi (2009, 8), "the central questions of the equal environment assumption (EEA) are whether these differences [between MZs and DZs] influence the specific trait under analysis and if these environmental differences are manifestations of the genetic similarity of MZ twins."

³¹ Jackson 1960; Kringlen 1967.

general population or a control group. Although the results often show that a trait is familial, this does not mean that it is genetic. Most researchers in the behavioral sciences agree that family studies are unable to disentangle the potential roles of genetic and environmental factors.³² As behavior geneticist Robert Plomin and his colleagues recognized, "Many behaviors 'run in families,' but family resemblance can be due to either nature or nurture."³³

Thus behavioral geneticists recognize that, because family members share a common environment as well as common genes, a trait "running in the family" can be completely explained on genetic or environmental grounds. In other words they recognize, correctly, that potential genetic and environmental influences cannot be disentangled in a family study. I am unaware of any behavior geneticist researcher arguing, for example, that a family study finding that the behavior of voting for the Democratic Party runs in families suggests that this behavior has a genetic basis (or is "heritable").

Behavior geneticists, however, imply or argue that there is a qualitative difference between family studies and twin studies. Although most recognize that MZs experience more similar environments than DZs, they maintain that the twin method is not confounded by environmental factors and therefore provides unequivocal evidence in favor of genetics.

This is a puzzling and contradictory position. If differing environments automatically invalidate genetic interpretations of family study data, then the differing environments of MZ vs. DZ twin pairs must automatically invalidate genetic interpretations of twin method data as well.

Family members experience a more similar environment and a greater psychological association with other family members than do randomly selected members of the general population. In the same way, MZ twin pairs experience a more similar environment and a greater

³² For example, see Bouchard and McGue 2003; Faraone et al. 1999; Plomin et al. 2008.

³³ Plomin et al. 2008, 70.

psychological association than DZ pairs. However, although the experimental (index) and control groups in both family studies and twin studies experience far different environments, behavior geneticists and popularizers of their work approach family studies and twin studies as if they were completely different phenomena.

From the standpoint of environmental confounds, however, family studies and the twin method have precisely the same problem. This means that the twin method is merely a variation on the family study design, and is no more able than a family study to disentangle possible genetic and environmental influences on a trait.

Testing the Validity of the Equal Environment Assumption

Although most proponents of genetic theories in political science recognize that MZ twins do indeed experience more similar environments than DZ pairs,³⁴ they place great emphasis on research that has supposedly tested, and in most cases upheld, the validity of the EEA. Ironically, the authors of most "EEA-test" studies confirmed that MZ pairs experience much more similar environmental than DZ pairs.³⁵ However, twin researchers such as Kenneth Kendler³⁶ and others testing the EEA uphold the validity of the twin method on the basis of the following reasoning:³⁷

- The observation by twin method critics, that MZ pairs experience more similar environments than DZ pairs, is correct.
- Although MZ pairs experience more similar environments, this does not seriously bias the results of twin studies. The twin method remains valid because the greater environmental similarity of MZ pairs is the result, not the cause, of their greater genetic similarity.³⁸

³⁴ Alford et al. 2005; Alford et al. 2008a; Hatemi et al. 2008; Medland and Hatemi 2009.

³⁵ For example, Borkeu et al. 2002; Kaprio et al. 1990; Kendler and Gardner, 1998; LaBuda et al. 1997; Lytton 1977; Morris-Yates et al. 1990; Scarr 1968; Scarr and Carter-Saltzman 1979.

³⁶ Kendler 1983.

³⁷ Adapted from Joseph 2004, 86-87.

³⁸ Kendler 1983.

- Critics of the twin method bear the burden of proof for showing that MZ and DZ twin pair environments differ on environmental factors etiologically relevant to the trait under study.
- On the basis of the "trait-relevant" definition of the equal environment assumption, and the belief that MZ twins create more similar environments for themselves on the basis of their greater genetic similarity, the twin method remains a viable instrument for the detection of genetic influences on psychological trait differences, behavioral variation, and psychiatric disorders.

Beckwith and Morris point out that investigators carrying out EEA-test studies, who are themselves usually twin researchers, frequently conclude in favor of the EEA despite ample evidence from their own studies suggesting otherwise.³⁹ EEA-test researchers' bias is understandable, and it is as unlikely that these twin researchers will conclude that their own research method is invalid as it is that a study performed by Chevron executives will conclude that the oil companies are soaking the public and racking up windfall profits. Although bias in research is normal and understandable, its existence does indicate that critical analysis of research and data should become the default mode in human genetic research.⁴⁰

One of the few research teams to test the EEA whose members lacked professional or philosophical allegiances to behavior genetics and twin research was that of Alan Horwitz and his colleagues. Horwitz et al. analyzed data from 414 twin pairs (230 MZ, 187 DZ) and assessed the relationship between several environmental variables. They concluded that "measures of the social environment sometimes reduce or eliminate apparent genetic affects," suggesting that "past twin studies could overstate the effect of genetic influences because some similarities in behavior among monozygotic compared to dizygotic twins stem from social influences."⁴¹

³⁹ Beckwith and Morris 2008.

⁴⁰ Joseph and Baldwin 2000; Joseph in press.

⁴¹ Horwitz et al. 2003, 111.

Indeed, most schizophrenia twin researchers believed that MZ-DZ concordance rate⁴² differences were caused in part by non-genetic factors.⁴³

The EEA-test literature, then, is primarily a body of research carried out by twin researchers focusing narrowly on areas that they claim support the EEA and the twin method. In doing so, they choose to de-emphasize the fact that their tests usually show that MZ pairs experience much more similar environments than DZs.

Twin researchers also frequently overlook empirical findings clearly inconsistent with the validity of the EEA. One of many such examples we find in the 85-year history of the twin method is that, when studied, same-sex DZ pairs (DZSS) usually correlate higher than opposite-sex DZ pairs (DZOS) for psychiatric disorders and behavioral traits. For example, the pooled DZSS concordance rate across all schizophrenia twin studies is 11.3% (59/523), but is only 4.7% (20/422) for DZOS pairs.⁴⁴ Because both types of twins share the same genetic—but not environmental or interpersonal—relationship with each other, on genetic grounds there should be no correlational differences between these two types of twin pairs for traits failing to show sex differences in the general population.⁴⁵ But in fact, there usually is.

Looking at the brief history of twin studies in political science, we find similar results: DZSS pairs frequently correlate significantly higher than DZOS pairs on politically-related behaviors.⁴⁶ In Hatemi and colleagues’ 2007 Australian twin study of voting behavior, the authors found “some substantial differences in the correlations of opposite sex [DZ] pairs

⁴² Concordance rates are used extensively in psychiatric twin research. Concordance refers a finding that both members of a twin pair are diagnosed with the same disorder.

⁴³ See Joseph 2004, 171-75.

⁴⁴ Joseph 2004.

⁴⁵ This point was made by Don Jackson in his classic (1960) critique of schizophrenia genetic research.

⁴⁶ See Hatemi et al. 2007, Table 3; Hatemi et al. 2008, Table 3. AFH 2005, and Fowler et al. 2008 did not report opposite-sex DZ correlations.

compared to those for the same sex DZ pairs.”⁴⁷ The problem this presents for the twin method is that higher DZSS vs. DZOS correlations are difficult to explain on genetic grounds (I am not aware of any genetic researcher attempting to do so since the inception of the twin method in the 1920s), but are consistent with the views of critics who argue that the twin method measures nothing more than differing levels of environmental influence and mutual association among various types of twin pairs. Thus, as psychiatrist Don Jackson argued long ago, environmental interpretations of twin method findings predict that, according to the degree of environmental similarity among siblings and twins, we would expect greater behavioral resemblance, without concern for genetic relationship.⁴⁸

Do twins “create their own environments”? A major argument that EEA-test twin researchers put forward in defense of the assumption is that MZ pairs “create” more similar environments for themselves than do DZ pairs because they are more similar genetically. In 1983, Kendler upheld the validity of the twin method mainly on the basis of this position: “Although the similarity in environment might make MZ twins more similar, the similarity in behavior of MZ twins might create for themselves more similar environments.”⁴⁹

However, to invalidate the EEA and the twin method it is only necessary to show that MZ pairs experience more similar environments. For example, suppose for genetic reasons that MZ pairs are more likely than DZ pairs to enjoy spending time at the beach together. Although researchers might find higher skin cancer correlations among MZ versus DZ pairs, this does not mean that skin cancer is a genetically-based disease. This is similar to Charney’s example of the genetic trait of skin color leading to slavery as an indication of the “absolutely fallacious nature

⁴⁷ Hatemi et al. 2007, p. 442.

⁴⁸ Jackson 1960.

⁴⁹ Kendler 1983, 1416, italics in original.

of the assumption that the effects of behavior which is a response to a ‘genetic trait’ should itself be counted as genetic.” As Charney noted:

Are we to assume then, that the effects upon blacks of their enslavement by European whites were genetic, because slavery was “caused” or “elicited” or “created” by the genetic trait of black skin color?⁵⁰

Moreover, the “twins create their own environment” argument is based on circular reasoning in that twin researchers’ contention that twins’ behavior, temperament, and personality are due to heredity is based implicitly on the results of previous twin studies. Thus, EEA-test researchers and others circularly rely on conclusions reached on the basis of previous twin method data to validate current twin method data. Twin researchers have thus placed themselves and the twin method in a no-lose situation as they argue that the EEA is valid (a) if MZ and DZ pairs experience equal environments, **or** (b) if MZ and DZ pairs experience far different environments. As the critical psychiatrist R. D. Laing wrote long ago in response to a similar argument made by schizophrenia twin researcher Franz J. Kallmann, “With this two-headed penny it is not clear how Kallmann can lose.”⁵¹

The Martin et al. social attitudes twin study. AFH rely heavily on the 1986 Martin et al. twin study of social attitudes in support of their contention that co-twin contact, which they recognize is “higher for MZ than for DZ twins,” does “not predict the extent of [twins’] political similarity.”⁵² But in fact, the larger picture of Martin and colleagues’ results strongly suggests that greater contact does lead to greater correlation for social attitudes.

Predictably, Martin and colleagues found that MZ twin pairs correlate significantly higher than DZ pairs for various social attitudes. Although, as AFH point out, these investigators reported little correlation between the “frequency of contact” and “absolute intrapair difference

⁵⁰ Charney 2008b, 337.

⁵¹ Laing 1981, 143.

⁵² Alford et al. 2008b, 794.

in conservatism,”⁵³ the larger picture of their results is completely explainable on environmental grounds. The logic I present below, though plausible, is dismissed by behavior geneticists both in and out of political science:

- 1) Environmental factors play a role in shaping social attitudes (twin method critics, Martin et al., AFH, and most behavior geneticists would agree with this statement).
- 2) MZ twin pairs as a population experience more similar environments, and have more “frequency of contact,” compared with DZ twin pairs as a population (twin method critics, AFH and most behavior geneticists would agree with this statement).
- 3) MZ twin pairs resemble each other more (correlate higher) than DZ pairs for most social attitudes (some twin method critics, AFH, Martin et al., and most behavior geneticists see this as a replicated scientific finding).
- 4) **CONCLUSION:** A plausible interpretation of the entire Martin et al. study is that it proves nothing about genetics, but does suggest that environmental similarity, and frequency of contact, lead to greater twin pair resemblance for social attitudes.

Taking this a step further, one could argue that the entire body of twin method data (which dates back to the 1920s) provides no evidence in support of genetics, but does suggest strongly that the more similar treatments, environments, and mutual association experienced by MZ vs. DZ twin pairs is the cause of MZ pairs’ greater resemblance for behavioral and psychological trait variation, and greater resemblance for psychiatric disorders.

Thus AFH and the EEA-test researchers, similar to the old story of the blind men and the elephant, emphasize the correlations they believe support the EEA, while overlooking numerous other correlations that point to the falseness of the EEA.

In the same way, given that twin studies are hopelessly confounded by environmental factors (just as family studies are hopelessly confounded by environmental factors), the results of

⁵³ Martin et al. 1986, 4367.

Alford and colleagues' 2005 APSR twin study of political attitudes are completely explainable on environmental grounds. As David Rosenthal, a leading psychiatric genetic researcher of the 1960s and 1970s, concluded toward the end of his career, both family studies and twin studies are "confounded," and "one can draw conclusions about them only at considerable risk."⁵⁴

The "reverse zygosity" studies. AFH and other twin researchers⁵⁵ cite the results of the "reverse-zygosity" EEA-test studies in support of the twin method. This method assesses twins who misidentify, or whose parents misidentify, their zygosity status (whether a pair is MZ or DZ). Researchers then compare the resemblance of these misidentified pairs to correctly identified pairs in order to test the effects of "true" versus "perceived" zygosity. Although AFH claimed that "the degree of correspondence between MZ twins surpasses DZ twins even in the large subpopulation of twins thought by their parents to be MZ twins,"⁵⁶ an examination of the data shows that some of the comparisons fall in the direction predicted by environmental theories.⁵⁷

Behavior geneticist Sandra Scarr, who is the most well known researcher of reverse zygosity among twins, ended her frequently cited study as follows:

The critical assumption of equal environmental variance for MZ and DZ twins is tenable. Although MZ twins generally experience more similar environments, this fact seems to result from their genetic similarities and not to be a cause of exaggerated phenotypic resemblance.⁵⁸

Thus, Scarr's entire argument rested on the claim that the twin method is valid because MZ pairs create more similar environments for themselves on the basis of their greater genetic similarity. We have seen, however, this "twins create their own environment" argument lends no

⁵⁴ Rosenthal 1979, 25.

⁵⁵ AHF 2005, 2008A; Fowler et al. 2008.

⁵⁶ AHF 2005, 155.

⁵⁷ Joseph 2006, chapter 9. This chapter is devoted entirely to a critical analysis of the EEA test literature.

⁵⁸ Ibid., 541.

support to the EEA. Thus, we see that another pillar of AFH’s defense of the twin method lies on shaky ground indeed.

I would further propose that the very idea that the EEA can be “tested” is faulty. We can evaluate the twin method’s validity only by looking at the larger picture of how MZ and DZ twin pairs exist in, and interact with, the social and familial environments in which they live—in precisely the same way that behavioral geneticists and others currently evaluate family studies. Behavioral geneticists do not require critics to identify the “trait relevant” features that lead to behavioral resemblance in family studies, nor do they argue that the results of family studies point to genetics because family members “create their own environments,” nor do they perform “family study test” research. It is high time that they apply these standards to the twin method as well.

Thus, the widely recognized greater environmental similarity of MZ versus DZ twins invalidates the twin method on its face, meaning that the twin method is confounded by environmental factors regardless of what EEA-test researchers claim. What they actually must demonstrate, without qualification, is that MZ and same-sex DZ twins pairs experience roughly equal environments. The validity of twin method can be determined only by assessing whether—not why—MZ twins experience more similar environments than same-sex DZs.⁵⁹

Twins Reared-Apart Studies

According to AFH, “the most powerful refutation” of criticism of the twin method “comes in recent studies utilizing MZ and DZ twin raised apart. These studies uniformly validate MZ and DZ differences found in earlier studies of twins raised together.”⁶⁰ Other political

⁵⁹ See Joseph 2004, 2006.

⁶⁰ Alford et al. 2005, 155.

science twin researchers have also cited twins reared-apart (know as “TRA”) studies in defense of the EEA and the twin method, such as Fowler and colleagues writing, “studies of twins raised together have been validated by studies of twin reared apart.”⁶¹ The most well known investigation, the Minnesota Study of Twin Reared Apart (known as MISTRA), was carried out by Thomas J. Bouchard, Jr. and colleagues in the 1980s and 90s.⁶²

Twins reared-apart studies compare the psychological trait resemblance (e.g., personality, IQ) of purportedly reared-apart MZ pairs (“MZAs”) to that of reared-together MZs (“MZTs”). Although some studies have included reared-apart DZ pairs (“DZAs”), claims in favor of genetics are usually made on the basis of MZA-MZT comparisons. TRA (twins reared-apart) researchers usually conclude that, because MZA correlations for psychological traits are far greater than zero, and are comparable to MZT correlations, their study supports a role for important genetic factors.

Critics, however, have pointed to several key methodological problems with TRA studies.⁶³ These include (1) the dubious “separation” of twins, who frequently grew up together and had contact over much of their lives; (2) similarity bias in the methods of MZA identification and recruitment; (3) the questionable status of “intelligence” and “personality” as valid and quantifiable constructs; (4) the failure of the MISTRA researchers to publish or share raw data and life history information for the twins under study, and (5) the impact that the researchers’ bias in favor of genetic interpretations may have had on their results and conclusions.

While these and other issues are important, the main problem with TRA studies such as Bouchard’s MISTRA is that the investigators used the wrong control group (MZTs). By using

⁶¹ Fowler et al. 2008, 235.

⁶² Bouchard et al. 1990.

⁶³ TRA study critics include Farber 1981; Joseph 2001, 2004; Kamin 1974; Kamin and Goldberger 2002; Lewontin et al. 1984; Taylor 1980.

MZTs as controls, they failed to control for several critical environmental factors shared by both MZAs and MZT pairs.⁶⁴ Environmental influences shared by both MZAs and MZTs include, but are not limited to:

- They are exactly the same age (birth cohort)
- They are always the same sex⁶⁵
- They are almost always the same ethnicity
- Their appearance is strikingly similar (which will elicit more similar treatment from the social environment)
- They usually are raised in the same socioeconomic class
- They usually are raised in the same culture
- They shared the same prenatal environment
- Most studied pairs spent a certain amount of time together in the same family environment, were aware of each other's existence when studied, and often had regular contact over long periods of time.⁶⁶

We should therefore expect, on purely environmental grounds, that MZAs reared-apart from birth (and very few were⁶⁷) would correlate well above zero for psychological and behavioral traits.

A major reason is that MZA correlations are heavily influenced by cohort effects, which account for similarities in people's behaviors and preferences that arise from the characteristics of the historical periods and cultural milieu in which they experience stages of life at the same time. In other words, we would expect two genetically-unrelated adults of the same gender, who are born at the same time, to resemble each other more for psychological traits, behaviors, tastes, political behavior and attitudes, etc. than would two randomly selected members of the population, spanning the entire adult age range. Thus, for reasons having nothing to do with

⁶⁴ See Joseph 2004; Rose 1982.

⁶⁵ The Minnesota TRA studies adjusted correlations to take into account age and sex effects (McGue and Bouchard 1984), but these adjustments were inadequate, and at best only accounted for only two environmental similarities shared by MZAs.

⁶⁶ Farber 1981; Kamin 1974.

⁶⁷ Farber 1981.

genetics, we should expect to find a much higher “video game playing behavior” correlation in the United States among pairs of randomly selected 15-year-old boys than we would expect to find among randomly selected pairs drawn from the entire 15-100-year-old male and female population of the United States. This example illustrates one of the central fallacies of twins reared-apart studies.

As evidence of the effects of common age alone, a 1981 study looked at the relationship between age and personality among genetically-unrelated people (non-twins).⁶⁸ The researchers found an average correlation between age, and personality scale scores on the California Psychological Inventory (CPI), of .28 across all 18 scales, with 10 scales showing a correlation of .35 or higher.⁶⁹ If these findings reflect age effects in the general population, the influence of common age, which represents only one of many environmental variables shared by MZAs (see above), accounts for more than half of the reported MZA personality correlations.

In order to control for the influence of cohort effects, a scientifically valid MZA study must compare the resemblance of MZAs reared-apart from birth and unknown to each other, versus a control group consisting not of MZTs, but rather of genetically-unrelated pairs of strangers who (1) are the same age, (2) are the same sex, (3) share the same ethnicity and culture, (4) share a similar socioeconomic status, and (5) are similar in appearance and attractiveness. Moreover, both the MZA and genetically-unrelated (GU) pairs should have no contact with each other until after they are evaluated and tested. After concluding such a study, we might find that the GU and MZA correlations are similar, which would suggest that MZA correlations are the result of non-genetic influences. I am unaware of any attempt to compare MZA and GU groups

⁶⁸ Martin et al. 1981.

⁶⁹ The California Psychological Inventory claims to measure aspects of normal personality. Bouchard et al. used the CPI to assess personality in the MISTRA studies.

as I have described above, and for this and other reasons we can draw no valid conclusions in support of genetics on the basis of twins reared-apart (TRA) studies published to date.

Although Alford, Funk, and Hibbing (AFH) implied that the MISTRA researchers’ main comparison was between MZAs and DZAs,⁷⁰ we have seen that the main comparison in TRA research is between MZAs and MZTs.⁷¹ The MISTRA, however, was the first TRA study to collect a sizable sample of DZAs. Due to their identical genetic makeup, of course, from the genetic standpoint MZAs must correlate significantly higher than DZAs. However, the MISTRA results, though selectively published, failed to demonstrate that same-sex DZAs correlate much differently than MZAs on personality measures and IQ tests.⁷²

Finally, we could conduct a thought experiment on political behavior and social attitude correlations among reared-apart MZ twin pairs who, while genetically identical, grow up in truly uncorrelated environments in different eras.⁷³ Suppose one male MZA twin is placed at birth in an aristocratic Japanese family in 1802. The other male MZA twin is placed at birth in a poor peasant family living in the highlands of El Salvador in 1965. Unlike previous TRA studies, in which the investigators calculate correlations among partially reared-apart twins⁷⁴ sharing many cultural influences, in our thought experiment we eliminate cultural influences such as family (which most MZAs share to some extent), mutual association and influence (which most MZAs also share to some extent), nation, region, ethnic, religion, economic class, and birth cohort (of course, they would still be the same sex).⁷⁵ I conclude this thought experiment by posing the

⁷⁰ AFH 2005, 155.

⁷¹ For example, see the Bouchard et al.1990 study published in Science.

⁷² See Joseph 2004, 130-33; Kamin and Goldberger 2002.

⁷³ Many behavior geneticists argue, quite mistakenly, that the mere fact that MZAs are raised in different homes means that they grew up in “uncorrelated environments.”

⁷⁴ As pointed out by Farber 1981.

⁷⁵ The environmental influences we would not be able to eliminate in this thought experiment are common sex, and common prenatal environment.

following question: Would we expect a study of genetically identical pairs of this type to find sizable correlations for political behavior and social attitudes?

Genes for Political Behavior?

In 2008 AFH attempted to bolster their argument further by claiming that the “preliminary results” of efforts to identify genes associated with political behavior at the molecular level, using genome-wide scans and allelic association tests, “are promising.”⁷⁶ However, we have seen similar subsequently non-replicated claims in psychiatry and psychology since at least the early 1980s. As I write this in mid-2009, the fact remains that, although there have been literally thousands of false positive claims (see below), gene finding efforts in these fields have failed to discover any genes shown by consistent replication of association, and by evidence that the association is causal, to underlie psychiatric disorders (e.g., schizophrenia,⁷⁷ bipolar disorder,⁷⁸ autism,⁷⁹ attention-deficit/hyperactivity disorder⁸⁰), or variation in psychological traits (e.g., IQ, personality).⁸¹

In the words of a leading group of psychiatric geneticists, writing in 2008, “It is no secret that our field has published thousands of candidate gene association studies but few replicated findings.”⁸² To locate these “thousands” of false positive findings, political scientists and others can simply scan the past 20 or so years of online abstracts for journals such as Molecular Psychiatry, The American Journal of Psychiatry, Archives of General Psychiatry, The American Journal of Human Genetics, American Journal of Medical Genetics (Part B), Psychiatric

⁷⁶ Alford et al. 2008b, 795.

⁷⁷ Need et al. 2009.

⁷⁸ Craddock and Sklar 2009.

⁷⁹ Burmeister et al. 2008.

⁸⁰ Faraone, Doyle et al. 2008.

⁸¹ For example, see the psychiatric genetic publication of Smoller et al. 2008. See also the 2008 edition of the authoritative behavior genetics textbook by Robert Plomin and colleagues, where the authors also recognized the failure to identify presumed genes in most areas of psychology and psychiatry. See also Joseph in press.

⁸² Faraone, Sklar et al. 2008, 1.

Genetics,⁸³ and yes, Behavior Genetics (a 2006 edition featured an article describing the discovery of a gene for “loneliness”⁸⁴). As Kendler conceded in 2005, “The strong, clear, and direct causal relationship implied by the concept of ‘a gene for ...’ does not exist for psychiatric disorders. Although we may wish it to be true, we do not have and are not likely to ever discover ‘genes for’ psychiatric illness.”⁸⁵

Turning to the search for the genes believed underlie general cognitive ability (IQ), in 2008 behavior geneticist Robert Plomin and colleagues recognized that, after the initial failures of the mid-1990s, “Dozens of studies have subsequently explored other candidate gene associations with g [general cognitive ability] but none have shown consistent results.”⁸⁶ Efforts to identify genes for personality have experienced a similar fate. According to Plomin et al., “replication of [personality] associations has been difficult.”⁸⁷

Writing as if a generation of false positive (yet highly publicized) “gene discoveries” did not happen, AFH claimed that “Scholars . . . have uncovered genes involved with reading disorders, depression, autism, risk-taking, and attention deficit hyperactivity disorder.”⁸⁸ And a pair of political science genetic researchers made similar claims with regard to autism, depression, and “social” traits.⁸⁹ Again, despite countless subsequently unsubstantiated gene finding claims in these areas, no verified discoveries have been made for psychiatric disorders or variation in psychological traits.

In their 2008 molecular genetic study, Fowler and Dawes found that individuals with a particular genetic variation “are significantly more likely to have voted in the 2004 presidential

⁸³ A better name for the journal Psychiatric Genetics, which is published by The International Society of Psychiatric Genetics, would be “Journal of False Positives.”

⁸⁴ Boomsma et al. 2006.

⁸⁵ Kendler 2005, 1250.

⁸⁶ Plomin et al. 2008, 170.

⁸⁷ *Ibid.*, 263.

⁸⁸ Alford et al. 2008a, 324.

⁸⁹ Medland and Hatemi 2009.

election." They continued, "These are the first results ever to link specific genes to political behavior."⁹⁰ However, virtually all such "results" in molecular genetic behavioral research turn out to be false positives (in addition to the fact that an "association" or "link" does not equal "cause"). This means that the claims put forward by AFH, Fowler and Dawes, and others are misleading and even irresponsible given the inevitable reports in the media trumpeting yet another non-existent "gene discovery." The journalists filing such reports usually fail to mention the fact that subsequent replication attempts invariably fail to substantiate such findings.

It is clear that molecular genetic research in the behavioral sciences is massively plagued by false positive results, and is due to some type of systematic error that has been repeated year-after-year, and decade-after-decade.

Thus, there is every reason to believe that molecular genetic researchers in political science have painted themselves into the very same corner as the behavioral genetic and psychiatric genetic researchers before them. They have landed in this corner due to their mistaken belief that the twin method produces unequivocal evidence that genetic factors contribute to the observed variation in political behavior and attitudes. This means that gene finding efforts in political science, despite recent claims, almost certainly will fail to bear fruit.

Conclusion

Current theories promoting genetic influences on differences in political behavior are based (1) on the results of studies using the twin method, and (2) on claims that genes associated with political behavior have been discovered at the molecular level. I have chosen to overlook

⁹⁰ Fowler and Dawes 2008, 579.

many other methodological problem areas in twin research⁹¹ in order to focus on the Achilles Heel of the twin method, which is the clearly false theoretical assumption that MZ and DZ twin pairs experience equal environments. There are many more claims, arguments, and methodological errors by AFH and others that due to space considerations I am not able to address in this article.

I agree with Evan Charney when he wrote that the twin method in general, and AHF’s 2005 study in particular, is “based upon a faulty paradigm,”⁹² with Beckwith and Morris who concluded that the AFH twin study “is of dubious scientific value,”⁹³ and with Elizabeth Suhay and colleagues, who wrote, “heritability claims based on twin studies generally cannot be trusted due to the confounding influence of the greater environmental similarity of MZ twins.”⁹⁴

Because the twin method is no more able than a family study to disentangle genetic and environmental influences, twin studies of political behavior provide no scientifically acceptable evidence in support of genetic factors. Moreover, recent gene finding claims use the same methodology that has led to 30 years of false-positive findings for behavioral traits and psychiatric disorders, and there is every reason to believe that these claims will also suffer the same fate.

AFH wrote that “concerns with twin studies have been raised and rebutted before,”⁹⁵ and Hatemi and colleagues wrote, “the present [EEA] debate simply recapitulates that which was

⁹¹ Other problem areas in twin studies in psychiatry and psychology (adapted from Joseph 2004) include (1) the acceptance of unsupported theoretical assumptions; (2) the lack of an adequate and consistent definition of the trait or disorder under study; (3) the questionable reliability and validity of the trait or disorder under study; (4) the use of non-blinded diagnoses (5) the use of diagnoses that were made on the basis of inadequate information; (6) the use of unreliable methods of zygosity determination (whether a pair is MZ or DZ); (7) that hospital psychiatrists might have given MZ twins similar diagnoses because they were influenced their knowledge of the twins’ common genetic heritage; (8) the unnecessary use of age-correction formulas; (9) the use of non-representative sample populations; (10) small sample sizes; (11) the lack of an adequate description of the methods; (12) investigator bias in favor of genetic conclusions.

⁹² Charney 2008a, 311.

⁹³ Beckwith and Morris 2008, 785.

⁹⁴ Suhay et al. 2007, 16.

⁹⁵ AFH 2008b, 793

exhausted in psychology and psychiatry more than 20 years ago."⁹⁶ In fact, twin researchers have never been able to refute the critics. Instead, they have overlooked abundant evidence against the validity of the equal environment assumption while constructing dubious ad hoc hypotheses in order to salvage the twin method. The twin method survives today not because the critics have been successfully "rebutted," but rather for precisely the same reason that critical behavior geneticist Douglass Wahlsten gave for the endurance of heritability analysis, which he viewed as "the outcome of a power struggle, not the resolution of a debate among scientists."⁹⁷

Beckwith and Morris concluded by urging "political scientists to take a more critical look at the studies that supposedly provide the foundation for this field."⁹⁸ At the outset of this article I welcomed political scientists' detailed scrutiny of the assumptions of the twin method, and noted that such scrutiny has been largely absent in psychiatry and psychology. It may be that behavior genetics has finally ventured into a field that will examine its claims very closely, and that the twin method will not survive this examination.

⁹⁶ Hatemi et al. 2008, 3.

⁹⁷ Wahlsten 1994, 254.

⁹⁸ Beckwith and Morris 2008, 788.

REFERENCES

- Alford, J. R., C. L. Funk, and J. R. Hibbing. 2005. Are political orientations genetically transmitted? American Political Science Review 99: 153-67.
- Alford, J. R., C. L. Funk, and J. R. Hibbing. 2008a. Beyond liberals and conservatives to political genotypes and phenotypes. Perspectives on Politics 6: 321-28.
- Alford, J. R., C. L. Funk, and J. R. Hibbing. 2008b. Twin studies, molecular genetics, politics, and tolerance: A response to Beckwith and Morris. Perspectives on Politics 6: 793-97.
- Barondes, S. H. 1998. Mood Genes: Hunting for Origins of Mania and Depression. New York: Oxford University Press.
- Beckwith, J., and C. A. Morris. 2008. Twin Studies of Political Behavior: Untenable Assumptions? Perspectives on Politics 6: 785-91.
- Boomsma, D. I., J. T. Cacioppo, P. E. Slagboom, and D. Posthuma. 2006. Genetic linkage and association analysis for loneliness in Dutch twin and sibling pairs points to a region on chromosome 12q23-24. Behavior Genetics 36: 137-46.
- Boomsma, D. I., G. Willemsen, C. V. Dolan, L. C. Hawkey, and J. T. Cacioppo. 2005. Genetic and environmental contributions to loneliness in adults: The Netherlands Twin Register Study. Behavior Genetics 35: 745-52.
- Borkenau, P., R. Riemann, A. Angleitner, and F. M. Spinath. 2002. Similarity of childhood experiences and personality resemblance in monozygotic and dizygotic twins: A test of the equal environments assumption. Personality and Individual Differences 33: 261-69.
- Bouchard, T. J., Jr., D. T. Lykken, M. McGue, N. L. Segal, and A. Tellegen. 1990. Sources of human psychological differences: The Minnesota Study of Twins Reared Apart. Science 250: 223-28.
- Bouchard, T. J., Jr., and M. McGue. 2003. Genetic and environmental influences on human psychological differences. Journal of Neurobiology 54: 4-45.
- Bulik, C. M., P. F. Sullivan, F. Tozzi, H. Furberg, P. Lichtenstein, and N. L. Pedersen. 2006. Prevalence, heritability, and prospective risk factors for anorexia nervosa. Archives of General Psychiatry 63: 305-12.
- Burmeister M., M. G. McInnis, and S. Zöllner. 2008. Psychiatric genetics: progress amid controversy. Nature Reviews Genetics 9: 527-40.
- Carmen, I. H. 2007. Genetic configurations of political phenomena: New theories, new methods. Annals of the American Academy of Political and Social Science 614: 34-55.

- Charney, E. 2008a. Genes and Ideologies. Perspectives on Politics 6: 292-319.
- Charney, E. 2008b. Politics, genetics, and "greedy reductionism." Perspectives on Politics 6: 337-43.
- Craddock, N., and P. Sklar. 2009. Genetics of bipolar disorder: Successful start to a long journey. Trends in Genetics 25: 99-105.
- Dawood, K., K. M. Kirk, J. M. Bailey, P. W. Andrews, and N. G. Martin. 2005. Genetic and environmental influences on the frequency of orgasm in women. Twin Research and Human Genetics 8: 27-33.
- Faraone, S. V., and J. Biederman. 2000. Nature, nurture, and attention deficit hyperactivity disorder. Developmental Review 20: 568-81.
- Faraone, S. V., A. E. Doyle, J. Lasky-Su, P. B. Sklar, E. D'Angelo, J. Gonzalez-Heydrich, C. Kratochvil, E. Mick, K. Klein, A. J. Rezac, and J. Biederman. 2008. Linkage analysis of attention deficit hyperactivity disorder. American Journal of Medical Genetics Part B (Neuropsychiatric Genetics), 147B: 1387-91.
- Faraone, S. V., J. W. Smoller, C. N. Pato, P. Sullivan, and M. T. Tsuang. 2008. The new neuropsychiatric genetics. American Journal of Medical Genetics Part B (Neuropsychiatric Genetics) 147B: 1-2.
- Faraone, S. V., M. T. Tsuang, and D. W. Tsuang. 1999. Genetics of Mental Disorders. New York: The Guilford Press.
- Farber, S. L. 1981. Identical Twins Reared Apart: A Reanalysis. New York: Basic Books.
- Fowler, J. H., L. A. Baker, and C. T. Dawes. 2008. Genetic variation in political participation. American Political Science Review 102: 233-48.
- Fowler, J. H., and C. T. Dawes. 2008. Two genes predict voter turnout. Journal of Politics 70: 579-94.
- Fowler, J. H. and D. Schreiber. 2008. Biology, politics, and the emerging science of human nature. Science 322: 912-14.
- Hannagan, R. J., and P. K. Hatemi. 2008. The threat of genes: A comment on Evan Charney's "Genes and Ideologies." Perspectives on Politics 6: 329-34.
- Hatemi, P. K., J. R. Alford, J. R. Hibbing, N. G. Martin, and L. J. Eaves. 2008. Is there a 'party' in your genes? Political Research Quarterly (Advance online publication, published 12/18/2008).

Hatemi, P. K., S. E. Medland, and L. J. Eaves. 2009. Do genes contribute to the "gender gap"? Journal of Politics 71: 262-76.

Hatemi, P. K., S. E. Medland, K. I. Morley, A. C. Heath, and N. G. Martin. 2007. The genetics of voting: An Australian twin study. Behavior Genetics 37: 435-48.

Horwitz, A. V., T. M. Videon, M. E. Schmitz, and D. Davis. 2003. Rethinking twins and environments: Possible social sources for assumed genetic influences in twin research. Journal of Health and Social Behavior 44: 111-29.

Jackson, D. D. 1960. A critique of the literature on the genetics of schizophrenia. In The Etiology of Schizophrenia, ed. D. Jackson (37-87). New York: Basic Books.

Joseph, J. 1998. The equal environment assumption of the classical twin method: A critical analysis. Journal of Mind and Behavior 19: 325-58.

Joseph, J. 2001. Separated twins and the genetics of personality differences: A critique. American Journal of Psychology 11: 1-30.

Joseph, J. 2002. Twin studies in psychiatry and psychology: Science or pseudoscience? Psychiatric Quarterly 73: 71-82.

Joseph, J. 2004. The Gene Illusion: Genetic Research in Psychiatry and Psychology Under the Microscope. New York: Algora. (Revised Algora Edition; 2003 United Kingdom edition by PCCS Books)

Joseph, J. 2006. The Missing Gene: Psychiatry, Heredity, and the Fruitless Search for Genes. New York: Algora.

Joseph, J. in press. Genetic research in psychiatry and psychology: A critical overview. In Handbook of Developmental Science, Behavior, and Genetics, ed. K. Hood, C. Tucker Halpern, G. Greenberg, and R. Lerner. Malden, MA: Wiley-Blackwell.

Joseph, J., and S. Baldwin. 2000. Four editorial proposals to improve social sciences research and publication. International Journal of Risk and Safety in Medicine 13: 117-27.

Kamin, L. J. 1974. The Science and Politics of I.Q. Potomac, MD: Lawrence Erlbaum Associates.

Kamin, L. J., and A. S. Goldberger, A. S. 2002. Twin studies in behavioral research: A skeptical view. Theoretical Population Biology 61: 83-95.

Kaprio, J., M. Koskenvuo and R. J. Rose. 1990. Change in cohabitation and intrapair similarity of monozygotic (MZ) cotwins for alcohol use, extraversion, and neuroticism. Behavior Genetics 20: 265-76.

Kendler, K. S. 1983. Overview: A current perspective on twin studies of schizophrenia. American Journal of Psychiatry 140: 1413-25.

Kendler, K. S. 2005. "A gene for ...": The nature of gene actions in psychiatric disorders. American Journal of Psychiatry 162: 1243-52.

Kendler, K. S., M. C. Neale, R. C. Kessler, A. C. Heath, and L. J. Eaves. 1993. A test of the equal-environment assumption in twin studies of psychiatric illness. Behavior Genetics 23: 21-27.

Kendler, K. S., and C. O. Gardner. 1998. Twin studies of adult psychiatric and substance dependent disorders: Are they biased by differences in the environmental experiences of monozygotic and dizygotic twins in childhood and adolescence? Psychological Medicine 28: 625-33.

Kendler, K. S., and C. A. Prescott. 2006. Genes, Environment, and Psychopathology. New York: Guilford.

Keski-Rahkonen, A., R. J. Viken, J. Kaprio, A. Rissanen, and R. J. Rose. 2004. Genetic and environmental factors in breakfast eating patterns. Behavior Genetics 34: 503-14.

Koenig, L. B., M. McGue, R. F. Krueger, and T. J. Bouchard, Jr. 2005. Genetic and environmental influences on religiousness: Findings for retrospective and current religiousness ratings. Journal of Personality 73: 471-88.

Kringlen, E. 1967. Heredity and Environment in the Functional Psychoses: An Epidemiological-Clinical Study. Oslo: Universitetsforlaget.

LaBuda, M. C., D. S. Svikis, and R. V. Pickens. 1997. Twin closeness and co-twin risk for substance use disorders: Assessing the impact of the equal environment assumption. Psychiatry Research 70: 155-64.

Laing, R. D. 1981. A critique of Kallmann's and Slater's genetic theory of schizophrenia. Dialogue with R. D. Laing ed. R. Evans (pp. 97-156). New York: Praeger.

Lewontin, R. C., S. Rose, and L. J. Kamin. 1984. Not in Our Genes. New York: Pantheon.

Lilienfeld, S. O., S. J. Lynn, and L. M. Lohr. 2003. Science and pseudoscience in clinical psychology: Initial thoughts, reflections, and considerations. Science and Pseudoscience in Clinical Psychology, ed. S. Lilienfeld, S. Lynn, and J. Lohr (1-14). New York: Guilford.

Lyons, M. J., K. S. Kendler, A. Provet, and M. T. Tsuang. 1991. The genetics of schizophrenia. Genetic Issues in Psychosocial Epidemiology, ed. M. Tsuang, K. Kendler, and M. Lyons (119-52). New Brunswick, NJ: Rutgers University Press.

Lytton, H. (1977). Do parents create, or respond to, differences in twins? Developmental Psychology 13: 456-59.

Martin, J. D., G. E. Blair, W. D. Dannenmaier, P. C. Jones, and M. Asako. 1981. Relationship of scores on the California Psychological Inventory to age. Psychological Reports 49: 151-54.

Martin, N. G., L. J. Eaves, A. C. Heath, R. Jardine, L. M. Feingold, and H. J. Eysenck. 1986. Transmission of social attitudes. Proceedings of the National Academy of Science 83: 4364-68.

McGue, M., and T. J. Bouchard, Jr. 1984. Adjustment of twin data for the effects of age and sex. Behavior Genetics 14: 325-43.

Medland, S. E., and P. K. Hatemi. 2009. Political science, biometric theory, and twin studies: A methodological introduction. Political Analysis 17: 191-214.

Morris-Yates, A., G. Andrews, P. Howie, and S. Henderson. 1990. Twins: A test of the equal environments assumption. Acta Psychiatrica Scandinavica 81: 322-26.

Need, A. C., D. Ge, et al. 2009. A Genome-Wide Investigation of SNPs and CNVs in Schizophrenia. PLoS Genetics 5 (Advance online publication, published online 2/6/2009).

Plomin, R., J. C. DeFries, G. E. McClearn, and P. McGuffin. 2008. Behavioral Genetics (4th ed.). New York: Worth Publishers.

Rose, R. J. (1982). Separated twins: Data and their limits. Science 215: 959-60.

Rosenthal, D. 1979. Genetic factors in behavioural disorders. Psychiatry, Genetics and Pathography: A Tribute to Eliot Slater, ed. M. Roth and V. Cowie (22-33). London: Oxford University Press.

Rowe, D. C. 1994. The Limits of Family Influence: Genes, Experience, and Behavior. New York: Guilford.

Rutter, M. 2006. Genes and Behavior: Nature-Nurture Interplay Explained. Malden, MA: Blackwell.

Scarr, S. 1968. Environmental bias in twin studies. Eugenics Quarterly 15: 34-40.

Scarr, S., and L. Carter-Saltzman. 1979. Twin method: Defense of a critical assumption. Behavior Genetics 9: 527-42.

Smoller, J. W., B. R. Sheidley and M. T. Tsuang, ed. 2008. Psychiatric Genetics: Applications in Clinical Practice. Washington, DC: American Psychiatric Publishing.

Suhay, E., N. Kalmoe, and C. McDermott. 2007. Why twin studies are problematic for the study of political ideology: Rethinking "Are Political Orientations Genetically Transmitted?" Presented at the International Society of Political Psychology.

Taylor, H. F. 1980. The IQ Game: A Methodological Inquiry Into the Heredity-Environment Controversy. New Brunswick, NJ: Rutgers University Press.

Tozzi, F., S. H. Aggen, B. N. Neale, C. B. Anderson, S. E. Mazzeo, M. C. Neale, and C. M. Bulik. 2004. The structure of perfectionism: A twin study. Behavior Genetics 34: 483-94.

Wade, T., C. M. Bulik, M. Neale, and K. S. Kendler. 2000. Anorexia nervosa and major depression: Shared genetic and environmental risk factors. American Journal of Psychiatry 157: 469-71.

Wahlsten, D. 1994. The intelligence of heritability. Canadian Psychology 35: 244-59.