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The Use of the Classical Twin Method in the Social and Behavioral Sciences: The Fallacy Continues

Jay Joseph

Private Practice, Oakland, California

The classical twin method assesses differences in behavioral trait resemblance between reared-together monozygotic and same-sex dizygotic twin pairs. Twin method proponents argue that the greater behavioral trait resemblance of the former supports an important role for genetic factors in causing the trait. Many critics, on the other hand, argue that non-genetic factors plausibly explain these results. The twin method has been used for decades in psychology, psychiatry, and medicine, and more recently in social science fields such as political science and economics. In 2012, a team of researchers in political science using behavioral genetic methods performed a study based on twin data in an attempt to test the critics' position, and concluded in favor of the validity of the twin method and its underlying monozygotic–dizygotic "equal environment assumption." The author argues that this conclusion is not supported, because the investigators (1) framed their study in a way that guaranteed validation of the twin method, (2) put forward untenable redefinitions of the equal environment assumption, (3) used inadequate methods to assess twin environmental similarity and political ideology, (4) reached several conclusions that argue against the twin method's validity, (5) overlooked previous evidence showing that monozygotic twin pairs experience strong levels of identify confusion and attachment, (6) mistakenly counted environmental effects on twins' behavioral resemblance as genetic effects, and (7) conflated the potential yet differing roles of biological and genetic influences on twin resemblance. The author concludes that the study failed to support the equal environment assumption, and that genetic interpretations of twin method data in political science and the behavioral science fields should be rejected outright.

Keywords: behavioral genetics, equal environment assumption, political science, twin study

Researchers in psychology and psychiatry have used the "classical twin method" since the 1920s to assess whether genetic factors underlie psychological traits such as IQ and personality, and major psychiatric disorders such as schizophrenia and bipolar disorder. Because reared-together MZ (monozygotic,

Correspondence concerning this article should be addressed to Jay Joseph, Psy.D., P.O. Box 5653, Berkeley, California 94705–5653. Email: jayjoseph22@gmail.com

identical) pairs share 100% of their segregating genes, whereas reared-together DZ (dizygotic, fraternal) share on average only 50%, twin researchers have argued that the usual finding that MZ pairs resemble each other more for behavioral traits and disorders than do same-sex DZ twin pairs is caused by the former's greater genetic resemblance, thereby indicating that the trait or disorder has an important genetic component. From the very beginning (Siemens, 1924), the basic underlying assumption of the twin method has been that reared-together MZ and DZ twin pairs experience similar environments. This critical theoretical assumption (Scarr and Carter–Saltzman, 1979) is called the "equal environment assumption," or "EEA."

At the same time, most critics of the twin method have argued that MZ pairs experience much more similar environments than DZ pairs, and that this greater environmental similarity confounds genetic interpretations of twin method data.[1] As it turned out, by the 1960s most critics and many twin researchers alike agreed that research had shown what common sense already dictated: that MZ twin pairs experience more similar environments, are treated more alike, and are socialized to be more alike than are DZ pairs (Joseph, 2004). Indeed, as twin researchers Scarr and Carter–Saltzman (1979) concluded, "the evidence of greater environmental similarity for MZ than DZ twins is overwhelming" (p. 528). According to a 1978 account by behavioral genetic twin researcher John Loehlin, in his 1976 study he "found, as nearly everybody else has found who has investigated the point, that identical twins are indeed treated more alike — they are dressed alike more often, are more often together at school, play together more, and so forth" (Loehlin, 1978, p. 72). Others have pointed to MZs' greater psychological closeness, identity confusion, and "ego fusion" when compared with DZ pairs (Dalgard and Kringlen, 1976; Husén, 1959; Jackson, 1960; Joseph, 2004; Koch, 1966; Kringlen, 1967; Shields, 1954). In the words of twin researcher Ricardo Ainslie (1997), "twins often encounter ambiguity and confusion with respect to their sense of identity" (p. 2).

The "Fallacy" of the Twin Method

For most critics, it was by now crystal clear that the twin method was based on the "fallacy" that MZ and DZ environments were equal (Bleuler, 1978, p. 432; Penrose, 1973, p. 90; Stocks, 1930, p. 104). Several leading twin researchers and psychologists studying behavior and personality in the postwar era were themselves unsure of the validity of the equal environment assumption. For example, according to schizophrenia twin researcher Pekka Tienari,

[1]My own first attempt to articulate this position appeared in this journal in 1998 (Joseph, 1998).

> It is doubtful . . . whether the difference in concordance rate between identical and fraternal groups of twins can, as such, be ascribed to hereditary factors. In all likelihood, the environment, too, is more similar in the case of identical than in the case of fraternal twins . . . . Furthermore, it is obvious that the intensity of the mutual relationship of identical twins is considerably greater than that of siblings in general and, also, of fraternal twins . . . . It is apparent that differences in concordance rates between groups of identical and fraternal twins, as well as between female and male twin pairs, are partly attributable to environmental (psychological) factors. (Tienari, 1963, pp.119–121)

In his twin study of personality, Irving Gottesman (1963) recognized that although the twin method "assumes that the within-pair environmental variance is the same for the two types of twins," the equal environment assumption "is not necessarily true for the personality traits as measured by the tests, but one can proceed only on the assumption that such variance is not too different for the two types of twins" (p. 8). Given the difference in variance, Gottesman could have decided not to proceed, or could have chosen a more modest title than the one he eventually chose: "Heritability of Personality: A Demonstration."[2]

Mid-1960s researchers in the fields of behavioral genetics, psychiatric genetics, and medical genetics were presented with a major problem, since their theories and claims in favor of the importance of heredity, and at times advocacy of eugenic policies (Joseph, 2004), were based primarily on twin method data (and family study data). Yet, the evidence strongly suggested that the equal environment assumption — as it had been defined until then — was false. This indicated that conclusions in favor of genetics based on twin studies (as well as family studies) were confounded by environmental factors, suggesting that the twin method should have been discarded as an instrument for the detection of genetic influence.

We will see, however, that despite several devastating and never-refuted critiques of the twin method (most notably, Jackson, 1960), twin researchers were successful in preserving the twin method mainly on the basis of (1) using circular arguments; (2) changing the definition of the equal environment assumption; and/or (3) denying, ignoring, or downplaying the evidence that MZ and DZ environments are different (Joseph, 2004, 2010a, 2012; Lewontin, Rose, and Kamin, 1984; Pam, Kemker, Ross, and Golden, 1996).

Thus, in the twenty-first century the "fallacy" of the twin method and its untenable equal environment assumption live on as twin studies, and their authors' conclusions that they prove something about genetic influences on behavioral traits, continue to be published in leading journals and textbooks in psychology, psychiatry, and other fields, with little critical analysis. More recently,

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[2]Around the same time, founding behavioral genetic researcher Gerald McClearn expressed doubts similar to Gottesman's (1963) about the validity of the equal environment assumption, yet the chapter in which he expressed these doubts was entitled "The Inheritance of Behavior" (McClearn, 1964).

researchers in the fields of political science and economics have used twin method data to argue in favor of an important role for genetic factors in their respective fields (e.g., Alford, Funk, and Hibbing, 2005; Cesarini, Johannesson, Wallace, and Lichtenstein, 2009), and have created the subfields of "genopolitics" and "genoeconomics."

Here I focus on an attempt by Kevin Smith and a group of leading political scientists, which include John Alford, Peter Hatemi, Carolyn Funk, John Hibbing, and veteran behavioral genetic twin researcher Lindon Eaves (Smith, Alford, Hatemi, Eaves, Funk, and Hibbing, 2012) to uphold the validity of the equal environment assumption and the twin method in the face of challenges both from within their field (Charney, 2008a, 2008b; Suhay, Kalmoe, and McDermott, 2007), and outside of their field (Beckwith and Morris, 2008; Joseph, 2010b). Indeed, Alford, Funk, and Hibbing (2005) had previously written, correctly, that the equal environment assumption "is crucial to everything that follows from twin research" (p. 155).

The analysis I present here is relevant to twin research in psychology, psychiatry, and the social and behavioral sciences in general. All studies I discuss and analyze are based on samples of twin pairs reared-together in the same family, which form the basis of twin method investigations.[3]

Two Arguments in Defense of the Twin Method and the Equal Environment Assumption

Argument A

Since the 1960s, twin researchers have defended the validity of the twin method on the basis of two main arguments, sometimes invoking both arguments at the same time.[4] What I will call here *Argument A* states that although MZ environments are more similar than DZ environments, the twin method retains its validity because MZ pairs "create" or "elicit" more similar environments for themselves because they are more similar genetically. Elsewhere I have called

[3]I do not discuss "twins reared-apart" studies here, mainly because Smith and colleagues (2012) did not cite them in support of the twin method. Other political science twin study publications have cited these studies in support of the twin method (e.g., Alford et al., 2005), and elsewhere I have discussed the many potentially invalidating problems found in reared-apart twin studies (see Joseph, 2004, 2010a, 2010b; see also Kamin, 1974).

[4]At times, genetic researchers and their supporters ignore the equal environment issue altogether (thereby tacitly accepting twin method assumptions), or simply deny that MZ and DZ environments are different. As an example of the latter position, in his book *Mood Genes*, psychiatric genetic researcher Samuel Barondes 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 an indication of the relative contributions of nature and nurture" (Barondes, 1998, p. 81).

this the "twins create their own environment theory" (Joseph, 1998). Five examples of the Argument A defense of the equal environment assumption (EEA) read as follows:

> It has been argued that the environmental difference of monozygotic twins is reduced because they tend to seek similar environments; however, in so far as they do this because of their genetic similarity rather than just to copy one another, their behaviour is a reflection of their genotype and must be regarded as influencing their genetic rather than their environmental variance. (Bulmer, 1970, p. 144)

> A series of ingenious studies . . . have all pointed to the conclusion that, for the most part, the more similar treatment of MZs is not the cause of their greater phenotypic similarity but, rather, a consequence of their genetic identity and the more similar responses this elicits from the environment. (Martin, Boomsma, and Machin, 1997, p. 390)

> A subtle, but important, issue is that identical twins might have more similar experiences than fraternal twins because identical twins are more similar genetically. Such differences between identical and fraternal twins in experience are not a violation of the equal environments assumption because the differences are not caused environmentally. (Plomin, DeFries, McClearn, and McGuffin, 2008, p. 79)

> Critics of the classic twin design cite a number of alleged failures of the equal environment assumption. A common theme of these criticisms is that MZ twins receive more similar treatment . . . . It is important to emphasize that even if MZ twins are treated more similarly, this does not in and of itself constitute a violation of the assumption; greater similarity in environment may be caused by the greater similarity in genotypes. (Cesarini et al., 2009, p. 621)

> It is important to note that if MZ twins are treated more alike than DZ twins, it is most likely associated with their genetically based behavioral similarities. (Segal and Johnson, 2009, p. 82)

In addition, the following passage appeared in a 2010 twin study published in a political science journal:

> If MZ twins are treated more similarly because they are biologically more alike, this can hardly be considered a violation of the EEA. For the reason that MZ environments are more similar than DZ environments (if indeed they are) is *because of the initial difference in genetic predispositions.* (Sturgis et al., 2010, p. 222, emphasis in original)

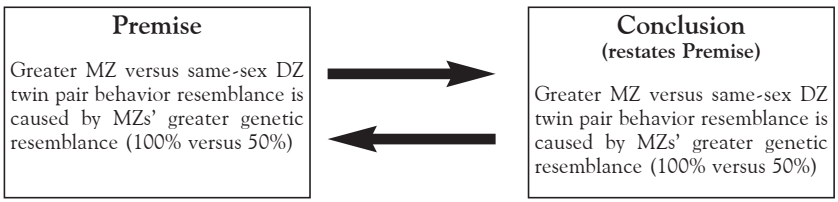
Many other leading behavioral genetic researchers have defended the validity of the twin method on the basis of Argument A (for example, Flint, Greenspan, and Kendler, 2010; Kendler, 1983; Loehlin and Nichols, 1976; Rose, 1991; Rutter, 2006; Scarr and Carter–Saltzman, 1979; Vandenberg, 1966).

Although twin researchers have used Argument A consistently since the 1960s (for more examples, see Joseph, 2012), I have shown elsewhere that this is a circular argument, because twin researchers' conclusion that MZ–DZ differences are explained by genetics is based on assuming the very same thing (Joseph, 2010a,

2012). In other words, as seen in Figure 1, twin researchers using Argument A simultaneously and circularly assume and conclude that the greater behavioral trait resemblance of MZ versus DZ twin pairs is caused by the former's greater genetic similarity, and their position that genetic factors explain the greater behavioral resemblance of MZ twin pairs is both a *premise and a conclusion* of twin studies.

Circular reasoning has been defined as "empty reasoning in which the conclusion rests on an assumption whose validity is dependent on the conclusion" (Reber, 1985, p. 123). A circular argument consists of "using as evidence a fact which is authenticated by the very conclusion it supports," which "gives us two unknowns so busy chasing each other's tails that neither has time to attach itself to reality" (Pirie, 2006, p. 27). As seen in Figure 1, the Argument A premise and conclusion are the same — that MZs' greater genetic resemblance causes their greater behavioral resemblance — and they are too busy "chasing each other's tails" to provide any evidence in favor of genetics.

According to the psychologist Lance Rips, in circular arguments, "the arguer illicitly uses the conclusion itself . . . as a crucial piece of support, instead of justifying the conclusion on the basis of agreed-upon facts and reasonable inferences." He concluded, "A convincing argument for conclusion c can't rest on the prior assumption that c [is correct], so something has gone seriously wrong with such an argument" (Rips, 2002, p. 767). In their attempts to answer



Example

"The similar phenotypes in monozygotic twins are caused by their genetic similarity. The similar phenotypes of these twins are then responsible for creating their similar social environment."

—Psychiatric genetic twin researcher Kenneth Kendler (1983, p. 1414) arguing in defense of the equal environment assumption and the twin method

Figure 1: Circular reasoning used consistently since the 1960s in support of the twin method. Twin researchers' Argument A. Figure modified from Jay Joseph (2012), "The 'Missing Heritability' of Psychiatric Disorders: Elusive Genes or Non-Existent Genes?" *Applied Developmental Science, 16*(2), p. 71. © 2012 Taylor & Francis Group, New York.

the critics' objections, in Figure 1 we see that twin researchers invoke Argument A as they refer to the premise in support of the conclusion, and then refer back to the conclusion in support of the premise, in a continuously circular loop of faulty reasoning.

An additional problem with Argument A is that, even if true, MZ pairs could still resemble each other more than DZ pairs for psychiatric disorders and medical conditions for purely environmental reasons. For example, MZ twin pairs with equal genetic predispositions for enjoying tennis would probably correlate higher than DZ pairs for tennis elbow, but this condition would not be caused by any genes for tennis elbow. A final problem with Argument A is that it portrays twins as behaving according to an inherited environment-creating blueprint, but portrays *parents* as easily able to change their behavior and treatment in response to their twins' behavior — in effect being flexible enough to allow their twins to "create their own environments." However, according to the logic of Argument A, parents' "environment-creating" behavior and personalities should be far more unchangeable than their children's because, in addition to their presumed genetic predispositions, adults have experienced decades of behavior-molding peer, family, religious, and other socialization influences. Thus, the Argument A defense of the equal environment assumption is based on a "seriously wrong" error in reasoning, in addition to other problems, and we must therefore reject it as a valid argument in support of the twin method.

Argument B

Like supporters of Argument A, proponents of what I will call *Argument B* (the "trait-relevant" qualification) recognize that MZs experience more similar environments than DZs, but argue that, in order to invalidate the equal environment assumption, it must be shown that MZ and DZ environments differ in respects that are relevant to the trait in question. This is known as the "equal trait-relevant environment assumption" (Carey and DiLalla, 1994), and is seen in the following definition of the equal environment assumption by a group of leading psychiatric twin researchers:

> 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 dizygotic (DZ) twins are equally correlated for their exposure to environmental influences *that are of etiologic relevance to the trait under study*. (Kendler, Neale, Kessler, Heath, and Eaves, 1993, p. 21, emphasis added)

And according to behavioral genetic investigators Thomas Bouchard and Matt McGue, two key researchers in the Minnesota Study of Twins Reared Apart (MISTRA):

> Behavioral geneticists call this assumption the "equal environmental similarity assumption," a term that is somewhat misleading in that the issue is not whether [reared together] MZ twins experience more environmental similarity than DZ twins, but rather whether they are more likely to share trait-relevant features of their environments. (2003, p. 9)

In political science, researchers sometimes define the assumption on the basis of Argument B. According to Hatemi and McDermott,

> The [twin method] approach relies on several assumptions. The most contested, yet dependable, is that the familial environment influences the examined trait to the same degree for MZ and DZ twins. (2012, p. 528)

And Medland and Hatemi (2009) wrote that, while "there is little argument that MZ twins are treated more similarly than DZ twins in certain aspects," one of the "central questions of the equal environment assumption (EEA)" is "whether these differences influence the specific trait under analysis" (pp. 198–199).

To the best of my knowledge, Argument B was first put forward in the mid-1960s, without explanation or theoretical justification, by twin researchers Gottesman and Shields. These investigators wrote that, in schizophrenia twin studies, the equal environment assumption would be wrong if "the environments of MZ twins are systematically more alike than those of DZ twins in features which can be *shown* to be of etiological relevance in schizophrenia" (Gottesman and Shields, 1966, pp. 4–5, emphasis in original). In defining the assumption using this new trait-relevant formulation, Gottesman and Shields appeared to place the burden of proof on critics to "show" that the environments differ in trait-relevant aspects.

Although other twin researchers frequently (yet wrongly) place the burden of proof on critics for demonstrating that MZ pairs experience more similar trait-relevant environments than DZ pairs (e.g., Alford, Funk, and Hibbing, 2008; Bouchard, 1993; DeFries and Plomin, 1978; Faraone and Biederman, 2000; Lyons, Kendler, Provet, and Tsuang, 1991), at other times, such as the Smith et al. study I will review shortly, twin researchers attempt to test the equal environment assumption for environmental bias (for critical reviews of the equal environment test literature, see Felson, 2009; Joseph, 2006; Pam et al., 1996; Richardson and Norgate, 2005).

As seen in Kendler and colleagues' Argument B definition above, the MZ–DZ equal environment assumption also underlies more complex biometrical analyses based on twin data, which attempt to partition genetic (A), "shared environment" (C), and "unshared environment" (E) contributions to trait variation in a population (the "ACE Model"; see Medland and Hatemi, 2009). It is therefore important to emphasize that regardless of the apparent complexity of the statistical formulations, path diagrams, twin family designs, "Cholesky decompositions," and covariance matrices that researchers put forward, the "dazzling statistical

pyrotechnics" (Lerner, 1995, p. 148) they often present depend — in the final analysis — on the validity of the MZ–DZ equal environment assumption. The assumption is the potential Achilles heel of the twin method, as well as of all statistical calculations and models based on twin method MZ–DZ comparisons.

Argument A Potentially Renders Argument B Irrelevant

An example of an Argument B environmental factor relevant to a trait or disorder is the relationship between exposure to trauma and post-traumatic stress disorder (PTSD). Because trauma exposure is (by definition) an environmental factor known to contribute to the development of post-traumatic stress disorder, a finding that MZ pairs are more similarly exposed to trauma than DZ pairs means that MZs experience more similar "trait-relevant" environments than DZs. Many twin researchers using Argument B would conclude that the equal environment assumption is violated in this case.

Interestingly, the Argument A position that twins create their own environments because they are more similar genetically potentially renders Argument B irrelevant because, even if critics or researchers show that MZ pairs experience more similar "trait-relevant" environments than DZ pairs, twin researchers could still argue in favor of the validity of the twin method and the equal environment assumption on the basis of MZ pairs having "created" or "elicited" more similar "trait-relevant" environments for themselves.

For example, in a twin study of posttraumatic stress disorder (PTSD) among combat veterans, William True and his colleagues (1993) found that MZ pairs did indeed experience more similar posttraumatic stress disorder trait-relevant combat experiences than did the DZ pairs (combat experience correlations were MZ r = .34, DZ r = .17; p. 258).[5] However, these twin researchers concluded that "inheritance makes a substantial contribution to PTSD symptoms" based on their Argument A claim that "inherited factors . . . increase the likelihood of exposure to traumatic events and responding to exposure by developing PTSD" (True et al., 1993, p. 263). The researchers therefore chose to conclude that their results supported a genetic basis for posttraumatic stress disorder, despite the finding that their MZ pairs experienced more similar trait-relevant combat experiences than experienced by the DZ pairs.

Another group of twin researchers explicitly stated that, even if trait-relevant environmental influences are found, the "twins create their own environment" argument would trump this finding and validate the twin method:

> It has been shown that MZ twins in childhood more often share playmates, share the same room, and dress more alike than same-sex DZ twins . . . . However, this does not

[5]I thank Roar Fosse for bringing this study to my attention.

> necessarily imply that the EEA is violated. First, the greater environmental similarity in MZ than DZ twins does not have to be related to a greater phenotypic similarity. Second, even if a greater environmental similarity is related to a greater phenotypic similarity, this association could be mediated by a greater genetic similarity in MZ than DZ twins. (Derks, Dolan, and Boomsma, 2006, p. 403, emphasis in original)

Like most twin researchers, Derks et al. recognized that MZ and DZ environments are different. In the language of the present review, they then wrote that even if Argument B does not hold, researchers could still fall back on Argument A and validate the twin method, because the trait-relevant environmental "association could be mediated by a greater genetic similarity in MZ than DZ twins." For this and other reasons, the validity of the equal environment assumption — and therefore of the twin method itself because it is based on the validity of the assumption — rests mainly on the acceptance or rejection of the "twins create their own environment" Argument A.

Family Studies and the Twin Method

It is noteworthy that twin researchers and behavioral geneticists do not make the "trait-relevant" or "create their own environment" arguments when discussing potential environmental confounds in *family studies*, despite the fact that both family studies and the twin method compare groups experiencing very different environments. That is, most behavioral genetic researchers recognize that family members share much more similar family and physical environments than shared by randomly selected members of the population, and recognize that MZ pairs share much more similar environments than shared by DZ pairs. However, they approach the unequal environments in each type of study very differently. Table 1 shows the differing ways that most leading behavioral geneticists approach and interpret family study data, versus the ways they approach and interpret data produced by twin method MZ–DZ comparisons.

In Table 1 we see that most behavioral genetic researchers recognize that the comparison groups in both family studies and twin studies experience different environments. In the case of family studies, they make no qualifications about how they should interpret data derived from these differing environments — the simple recognition that the environments are different is enough to invalidate genetic inferences based on family studies. Leading behavioral genetic researchers such as Robert Plomin and colleagues then unambiguously conclude, "family studies by themselves cannot disentangle genetic and environmental influences" (Plomin et al., 2008, p. 151).

However, with the twin method and *its* differing environments, behavioral geneticists usually invoke Argument A and/or Argument B and conclude the opposite — that the twin method is one of the "workhorses of human behavioral genetics that help to disentangle genetic and environmental sources of familial

Table 1

Differing Behavioral Genetic Interpretations of Research Findings: Family Studies versus Twin Studies

Type of Study	Environments of Comparison Groups	Qualifications Invoked by Behavioral Geneticists	Conclusions Reached by Most Behavioral Geneticists
FAMILY STUDIES	**Different:** Family members experience much more similar environments than those experienced by members of the general population	**None** (No claim that family members create or elicit more similar environments for themselves because they are more similar genetically; no requirement that family members must be shown to experience more similar *trait-relevant* environments than those experienced by members of the general population; no denial that families share a common environment as well as common genes)	**Unable** to disentangle potential environmental and genetic factors Therefore, a family study by itself provides no conclusive evidence in support of genetics **"Many behaviors 'run in families,' but family resemblance can be due to either nature or nurture."** (Plomin et al., 2008, p. 70)
THE TWIN METHOD	**Different:** Reared-together MZ twin pairs experience much more similar environments than those experienced by reared-together same-sex DZ pairs	1) **Argument A:** MZ pairs create or elicit more similar environments for themselves because they are more similar genetically, and/or 2) **Argument B:** it must be shown that MZ twin pairs experience more similar trait-relevant environments than those experienced by DZ pairs (behavioral geneticists usually conclude that this has not been shown), or 3) **Ignoring or denying:** failure to address the issue of MZ and DZ environments (thereby tacitly accepting twin method assumptions), or occasional claims that the environments are not different	**Able** to disentangle potential genetic and environmental factors Therefore, the twin method by itself provides conclusive evidence in support of genetics **"The twin method is a valuable tool for screening behavioral dimensions and disorders for genetic influence."** (Plomin et al., 2008, p. 80)

resemblance" (Plomin et al., 2008, p. 38). Thus, whereas behavioral genetic researchers rightly see family studies as *unable* to disentangle potential genetic and environmental influences, they see the twin method as *able* to disentangle these influences. In doing so, however, these researchers arbitrarily choose to apply a standard to family studies that they choose not to apply to the twin method, and then arrive at entirely different conclusions about each key research method.

The error lies in the contrasting behavioral genetic evaluations of family studies and the twin method. As some critics have argued, there should be no such contrast because these two research methods are equally unable to disentangle the potential influences of genes and environment. Thus, because the comparison groups in both types of studies experience very different environments, both must be assessed in the same way.

A 2012 Defense of the Equal Environment Assumption in Political Science

Beginning with a twin study of political attitudes and ideology published in 2005 (Alford et al., 2005), the political science field has seen a major growth of genetic research.[6] The investigators' conclusions have been highlighted in the popular press and in leading scientific journals (e.g., Buchan, 2012). At the same time, we have seen that critics both within and without of political science have argued that the equal environment assumption is not supported by the evidence. In addition, political scientist Evan Charney (2012) has shown that many previously accepted biological and genetic assumptions underlying twin research may not be true. Indeed, these findings "are necessitating a rethinking of every one of the assumptions of the classical twin study methodology" (Charney and English, 2012, p. 1).

Molecular genetic researchers in political science also claim to have located specific genes that influence political behavior (Fowler and Dawes, 2009; Hatemi et al., 2011). Like similar subsequently non-replicated claims in psychiatry and psychology over the past four decades, however, these findings are unlikely to be replicated (Charney and English, 2012; Joseph, 2010b, 2011, 2012; Plomin, 2013; Wahlsten, 2012). Indeed, in 2012 a team of leading molecular genetic researchers in the social sciences noted the failures to replicate, and, while continuing to believe that genes for political and economic behaviors and attitudes exist, concluded that they need possibly unattainably large samples: "It is likely that extremely large — perhaps impractically large — samples will be required" (Benjamin et al., 2012, p. 8030). In another publication, political scientists Hatemi and McDermott recognized that, for political traits, "replication of

[6]In political science, the twin method is frequently called the "CTD," or "classic twin design."

genome-wide, candidate gene and gene-environment interaction studies is almost nonexistent" (2012, p. 530).

The failure at the molecular genetic level to identify any genes that underlie political traits means that the argument in support of genetic theories in political science is based mainly on inferences drawn from twin data. Given the arguments of the critics and the understandable reluctance of many social scientists to accept the position that important genetic influences underlie political ideology and behavioral traits in general, Kevin Smith and his colleagues (see Smith et al., 2012) published a study whose results, they argued, supported the validity of the equal environment assumption and the twin method in political science and indicated, at least to some degree, that "political attitudes are inherited" (p. 17). The investigators seemed puzzled that despite the "consistency" of twin study results, "their [twin studies'] validity has been consistently challenged on a number of key issues" (p. 18). What many critics argue, however, is that twin researchers have *consistently misinterpreted* the results of twin studies in favor of genetics.

Smith and colleagues wrote that the critics' "central argument" is that studies using the twin method "inflate heritability estimates and do not accurately account for environmental-based sources of variance in political attitudes due to several specific shortcomings in the model" (p. 19). In fact, some critics have entirely rejected the validity of heritability estimates in the social and behavioral sciences (e.g., Lewontin, 1987; Moore, 2001; Rose, 1997), and also argue that (in addition to other sources of bias) in most cases MZ–DZ comparisons measure nothing more than the environmental factors that make MZ pairs resemble each other more than DZs for the psychological trait or psychiatric condition in question (see Joseph, 2004, 2010a).

Smith et al. wrote that criticism of the twin method is "made on the basis of secondary analysis of published research, not on the basis of empirical examination of CTD [twin method] assumptions on political variables" (p. 19). Although this is largely true, the researchers, like many other twin researchers past and present, imply that because critics usually do not study twins directly, researchers' conclusions carry more weight than those of the critics. However, the obvious and understandable bias of twin researchers in favor of the validity of twin research suggests that the opposite could also be true — that because most critics have no professional, collegial, or emotional stake in supporting the validity of twin research, from this distance they are able to provide a more realistic appraisal of this research, including especially its most important underlying theoretical assumptions.

An Approach That Guaranteed the Validity of the Twin Method

In the abstract of their publication, whose stated purpose was to assess the validity of environmental explanations of MZ–DZ behavioral trait differences,

Smith and colleagues (2012) wrote that even if the critics are "wholly correct" that the causes of MZ–DZ differences are "exclusively environmental," this finding would "provide reasons for political science to pay more rather than less attention to the biological basis of attitudes and behaviors" (p. 17). Thus, the investigators assured themselves and their readers that the validity of the twin method would be upheld by setting up a "heads I win, tails you lose" scenario whereby, regardless of what they found, the twin method and biological explanations of political behavior would retain their importance.[7] It is illogical, however, to state that political scientists should "pay more attention" to biological influences on political attitudes and behaviors if explanations for MZ–DZ differences are "wholly environmental."

In their concluding remarks, Smith and colleagues wrote that they had examined the arguments of the critics (actually, only the 2007 critique of Suhay et al.) and "found them wanting" (p. 30). They wrote that even if the arguments of critics were "empirically valid, the evidence from those studies, combined with molecular, physiological, neurological, and other studies provides good reason for political science to take biology (not just genes) seriously as a basis for explaining attitudes and behaviors" (p. 30). However, the validity of the twin method must stand or fall on its own merits, and cannot be validated in the context of claiming that it is part of a supposed converging set of evidence in support of biology and genetics (Joseph, 2006).

We have seen that, if the position of some critics that MZ–DZ differences are caused solely by environmental factors is "wholly correct," it is illogical for Smith et al. to argue that MZ–DZ comparisons supply evidence in support of biology and genetics. Quite the opposite is true: if these critics are correct, we can safely assume that twin studies of human behavioral traits measure nothing other than environmental influences (and potential research bias). It is certainly true that biology plays a role in everything human beings do, but Smith et al. invoked this obvious fact in support of the importance of biological and genetic approaches to the study of human variation in political behavior and attitudes. Self-evidently, one could invoke this argument in support of a genetic and biological approach to *any* aspect of the human condition. The researchers utilized this argument in the process of mistakenly conflating genetic causation and biological causation (see below) as they attempted to shore up the massive theoretical leaking ship that is the twin method.

[7]This also occurred in a 1998 behavioral genetic adoption study (Plomin, Corley, Caspi, Fulker, and DeFries, 1998), where the researchers found a .01 personality test correlation between birthparents and their 240 adopted-away biological offspring, yet concluded that their results supported an important genetic basis for personality (Joseph, 2013).

Smith and Colleagues Respond to the Critics

As we will see, one method Smith and colleagues (2012) used to uphold the validity of the twin method and the equal environment assumption was the transformation of environmental influences that cause MZ pairs to resemble each other more than DZ pairs into genetic influences. In the process, their conclusions about the validity of the twin method and the arguments of critics varied considerably. At some points they concluded that they "find little support" (p. 17) for the arguments of the critics, that they found these arguments "wanting" (p. 30), and that "political attitudes are inherited" (p. 17). At other times Smith et al. conceded that the critics are correct on certain points, and that their own "DZ findings may lend credence to criticisms that heritability estimates . . . from CTD [twin method] studies should be taken with a grain of salt" (p. 23).

Smith et al. concluded,

> Our analyses . . . strongly support the inference that nothing in the EEA critique credibly supports a claim that genetic influence on political temperament is nonzero or nontrivial. Additionally, our analyses find nothing to suggest that heritability estimates from CTD [twin method] studies on political traits are misleading or unduly biased. At a minimum, the undisputed patterns of ideological similarity between MZ and DZ twins do not seem to be fully explained by the mechanisms proposed by EEA critics. Our analyses provide little reason to expect points 1 and 2 [that MZ pairs have more similar experiences, and experience greater mutual influence], individually or in combination, to provide a wholly environmental explanation for observed MZ–DZ differences in ideological similarity. (2012, p. 30)[8]

Thus, Smith and colleagues' defense of the equal environment assumption boiled down to their conclusion that the twin method is not *entirely* confounded by environmental factors. However, the assumption can only be true if genetic factors explain virtually *all* of the observed greater resemblance of MZ versus DZ twin pairs for the behavioral trait in question. Smith and colleagues' recognition that at least part of this greater resemblance is caused by non-genetic factors leads to the conclusion that many critics have reached for decades — that, like family studies, the twin method is unable to disentangle the potential influences of genes and environment. Smith and colleagues' conclusion that "ideological similarity between MZ and DZ twins do not seem to be fully explained by the mechanisms proposed by EEA critics" is hardly a ringing endorsement of the twin method. In fact, it could serve as the epitaph of the twin method.

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[8]In this quotation, Smith et al. wrote that critics argue that genetic influence on political temperament is "nonzero or nontrivial," when from the context they appear to have meant "zero or trivial." I thank M.C. Jones for bringing this to my attention.

Smith et al. (p. 23) argued that their results "clearly indicate" that the greater environmental similarity of MZ pairs "cannot account for all MZ–DZ differences." However, to accept the validity of the equal environment assumption we must assume that environmental factors explain virtually *none* of the difference. Thus, some critics of the twin method agree that genetic interpretations of twin method data should "be taken with a grain of salt," while others demand the outright rejection of genetic interpretations of twin method data.

The investigators also confused the requirement of the twin method that environmental factors have little or no influence on the behavioral trait resemblance of MZ versus DZ twin pairs, with whether environmental factors influence the trait itself. Variation in behavioral *traits* (political ideology, I.Q., schizophrenia, personality, economic behavior, and so on) could theoretically be caused by both genetic and environmental factors, but the *research method* used to establish the genetic component must be largely free from environmental contamination. Clearly, as Smith and colleagues recognized, the twin method is contaminated by environmental influences. They argued only that the twin method is not *completely* contaminated by these influences.

Defining the Equal Environment Assumption

During the first 45 years of the twin method (roughly 1924 to 1969), most twin researchers defined the equal environment assumption — without qualification — as the assumption that MZ and DZ pairs experience roughly equal environments. Some examples of twin researchers' non-qualified definitions of the assumption during this period are presented below (the term "nature" refers to genetic (inherited) influences; "nurture" refers to environmental influences):

> "It has been assumed that the mean nurture difference . . . is the same for identical and fraternal twins" (Holzinger, 1929, p. 244).

> The twin method "Assum[es] that environmental differences are the same for both identical and fraternal twins" (Newman, Freeman, and Holzinger, 1937, p. 21).

> "The [twin] formulas usually involve the assumption that the nurture influences are approximately equal for fraternal and identical twins" (Carter, 1940, p. 246).

> "The 'twin method' developed in Germany . . . and much used here in the last two decades for the study of heredity and environment . . . . [rests] on the assumption that the environment is as similar for a pair of fraternals as for a pair of identicals" (Woodworth, 1941, p. 9).

> One assumption of the twin method is "that nurture influences are the same for both types of twins" (Eysenck and Prell, 1951, p. 461).

> "In the comparison of MZ with DZ twins the assumption is made that the individual members of a twin-pair enjoy comparable or equivalent environments" (Neel and Schull, 1954, p. 280).

> The twin method assumes "That the 'average nurture difference' is the same for the two types of twins" (Jones, 1955, p. 102).

> "Research workers, who have endeavored to determine the 'shares' of nature and nurture in observed trait variations, have assumed the *environmental variance* to be the same for MZs and DZs in groups of twins that were reared together" (Husén, 1959. pp. 17–18, emphasis in original).

> "An underlying assumption [of the twin method] has been that the environments of the members of the identical pairs are not, on the average, more similar than those of the members of the fraternal pairs" (Tienari, 1963, p. 10).

> The twin method assumes that "The within-pair environmental variance is the same for the two types of twins" (Gottesman, 1963, p. 8).

> "The traditional use of the twin method entails the assumption that the environmental factors are, on an average, just as alike, or just as unlike, for monozygotic as for dizygotic twins" (Juel–Nielsen, 1965/1980, pp. 25–26).

> "In studies of twins, the higher intra-pair similarity for MZ as contrasted with DZ twins is frequently attributed to hereditary influence. This conclusion is based, in part, on the assumption that the environment is common to both types of twins" (Smith, 1965, p. 45).

> "The basic underlying assumption for the classical twin method is, of course, that environmental conditions of monozygotic twins do not differ from those of dizygotic twins" (Kringlen, 1967, p. 20).

Upon discovering that MZ and DZ environments are very different, some commentators were prepared to reject the twin method on this basis alone. For example, the psychologist Robert S. Woodworth concluded in his 1941 review, "Having convinced ourselves (in considering the 'twin method') that the environment differs more for fraternal than for identical twins, we cannot derive much information from a comparison of the results from the two classes of twins" (Woodworth, 1941, p. 21). And Neel and Schull, in their 1954 textbook *Human Heredity*, concluded that because it is "rarely . . . the case" that MZ and DZ environments are comparable, "twins have contributed little which may be extrapolated to other genetic situations" (p. 280).

In striking contrast to the earlier researchers, Smith and colleagues defined the equal environment assumption as follows:

> Importantly, the assumption is *not that MZs and DZs have equal environmental experiences*. It is well known, for example, that MZs are more likely to be dressed alike, share the same bedroom, and have the same friends . . . . Rather, the EEA assumes that these more similar environmental experiences do not lead to a greater co-twin similarity on the specific trait being studied. (2012, p. 19, emphasis in original)

Using the same Argument B "trait-relevant" definition used by other twin researchers since the 1960s, Smith and colleagues emphasized, paradoxically, that for them the equal environment assumption *does not* assume that the environments are equal. Thus, like others before them they redefined the equal environment assumption very differently from how it had been defined for the first 45 years of twin research, without any discussion of the historical or theoretical context in which they and their predecessors performed this redefinition. Many critics, in contrast, agree with the first two generations of twin researchers that the equal environment assumption assumes what it is supposed to assume — that without qualification, MZ and DZ twin pairs "have equal environmental experiences."

Smith et al. chose to focus on Suhay and colleagues' (2007) critique of twin research in political science (and by implication, other areas of social science). They addressed four major points put forward by Suhay and colleagues. *Point 1* states that MZ pairs have more similar experiences than DZ pairs; *Point 2* is that MZs experience a greater mutual influence than DZs; *Point 3* is that MZ pairs are treated more similarly than DZ pairs; *Point 4* is that MZ pairs share more similar prenatal (intrauterine) environments than DZ pairs. Let us now examine how Smith et al. responded to the four major points raised in Suhay and colleagues' (2007) critique.

Points # 1 and # 2: MZ Pairs Have More Similar Experiences, and Influence Each Other More, Than DZ pairs

Smith and colleagues saw Points 1 and 2 (similar experience and mutual influence) as being related to "similarities in the social environment and as such are consistent with traditional social science explanations for political attitudes and behaviors" (p. 29). In contrast, they saw Points 3 and 4 (similar treatment and prenatal environment) as "focus[ing] on biological environments" (p. 29). I will address this questionable latter claim in a subsequent section.

In their attempt to test some critics' argument that MZ–DZ behavioral trait correlation differences are caused by environmental factors, Smith and colleagues analyzed data obtained from 596 adult twin pairs (born between 1947 and 1956; 356 MZ, 240 DZ) based on the University of Minnesota Twin Registry. Afterwards, they decided to "replicate" their analysis on the basis of 30-year-old additional data they obtained from the Virginia 30K twin sample (p. 23). They argued that the data showed "little support" for the critics' contention that "exclusively environmental" factors explain MZ–DZ differences for traits such as political ideology (Smith et al., 2012, p. 17).

As an example of a political trait, Smith and colleagues chose "ideology" as assessed by the Wilson–Patterson Index. The Index purports to measure political conservatism, and consists simply of labels or catch-phrases of supposedly controversial issues (e.g., "socialism," "mixed marriage," "bible truth," "pyjama parties,"

"jazz," "women drivers," "learning Latin," "chaperones," and "striptease shows"; Wilson and Patterson, 1968, p. 266), to which respondents answer "yes," "no," or "?" (uncertain). The original Wilson–Patterson Index contained 50 such catch-phrases (Wilson and Patterson, 1968) and used this three-point response scale, but in the Minnesota sample the researchers used an updated and modified version containing 28 items and a seven-point response scale (the Virginia 30K sample used the three-point scale). The face validity of the Index is highly questionable (Charney, 2008a), and Smith and colleagues provided no evidence or citations in support of the validity of either the original or revised version.[9] Moreover, genetic researchers in political science tend to see "liberalism" and "conservatism" as the only political positions one can hold, when in fact the range is, historically and presently, much wider. The American researchers in particular appear to have committed the "fallacy of taking the local and particular for the universal" (Charney, 2008a, p. 309).

The researchers provided a table of MZ and DZ Minnesota Wilson–Patterson correlations (p. 22) as a product of varying levels of environmental similarity, as assessed by twins' answers to questions such as how often you "See your twin," "Talk to your twin on the telephone," "Communicate with twin via text/email," "Attended same classes at school," "Dressed alike when growing up," "Shared the same bedroom at home," and "Had the same friends growing up" (Smith et al., 2012, p. 22). Smith and colleagues recognized that "these items do not exhaust all potential categories of similar experience and mutual influence," but they saw them as being "comprehensive enough to provide a robust empirical test of the [critics'] key claims" (p. 21). As we will see, limiting the analysis to questions of this type fails to capture a major component of MZ twins' greater environmental similarity.

Smith and colleagues' table (p. 22) is noteworthy in that, for several environmental similarity categories, the authors arbitrarily combined differing responses into one score. To the question of whether twins were dressed alike when growing up, the only correlations listed in the table were the combined response categories "always/usually" and "sometimes/rarely/never." There is not a big distinction between "usually" and "sometimes." For the "Shared the same bedroom at home?"

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[9]Even some psychometrically oriented researchers who support claims of important genetic influences on social attitudes had issues with the Wilson–Patterson Index. According to Minnesota twin researcher Thomas Bouchard and his colleagues, writing about the Wilson–Patterson Conservatism Scale, its "'catch phrase' format strikes many psychologists as inadequate and of doubtful validity. We concurred with this judgment, but because of the scale's brevity and the strong genetic influence on the Conservatism score derived from this instrument reported by Martin et al. (1986), we incorporated it into the MISTRA assessment" (Bouchard et al., 2004, p. 97). Thus, despite its "doubtful validity, " Bouchard and colleagues decided to use the Index in their twin study because of its "brevity," and because a previous group of twin researchers (Martin et al., 1986), based on their acceptance of the validity of both the Index and the equal environment assumption, concluded in favor of strong genetic influences on Conservatism.

question, the possible responses were "always," "usually," "sometimes," "rarely," and "never." However, the researchers decided to combine these five possible responses into only two categories: "always," and "usually/sometimes/rarely/never." Once again, there is not a great distinction between responses such as "usually" and "always." The reported and *non*-reported responses and correlations for two of the environmental similarity questions are seen in Table 2.

Perhaps a much different picture of the relationship between twin environmental similarity and Wilson–Patterson correlations would have emerged had

Table 2

Reported and Non-Reported Correlations Between Wilson–Patterson Index Ideology Scores and Environmental Similarity: Two Questions

	Combined Response Correlations (AS REPORTED)			
	MZ	N	DZ	N
"Shared the same bedroom at home?"				
Always	.67	262	.48	141
Usually/sometimes/rarely/never	.71	42	.17	41
"Had the same friends growing up?"				
Always/usually	.67	255	.46	101
Sometimes/rarely/never	.46	32	.17	72
	Non-Combined Response Correlations (NOT REPORTED)			
	MZ		DZ	
"Shared the same bedroom at home?"				
Usually	?		?	
Sometimes	?		?	
Rarely	?		?	
Never	?		?	
"Had the same friends growing up?"				
Always	?		?	
Usually	?		?	
Sometimes	?		?	
Rarely	?		?	
Never	?		?	

Reported correlations from Smith et al., 2012, p. 22. Correlations rounded to second decimal place; zero to the left of decimal point removed. MZ = reared-together monozygotic twin pairs; DZ = reared-together same-sex dizygotic twin pairs. N = number of twin pairs.

the researchers decided to show the correlations for each of the possible responses seen in Table 2 (see Kamin, 1981, for examples of how earlier twin researchers also combined responses). Additionally, in categories such as how often twins see each other ("See your twin?"), twins could choose from only two possible (potentially similar) answers, "Once a month or more," or "Several times a year or less." Smith and colleagues derived mean scores from twins' ordinal scale responses to the environmental similarity questions (p. 21), which constitutes a widespread yet questionable statistical practice because, with ordinal data, differences between responses are not equivalent, as they are with interval data (Bradley and Schaefer, 1998).

Although Smith et al. noted "relatively stable MZ correlations" (p. 22), in part because of the restricted and combined environmental similarity categories they used, they found "In contrast, DZ ideological similarities display extreme variation depending on levels of adult contact/similarity in childhood experiences" (p. 23). Nevertheless, Smith and colleagues continued to weakly uphold the validity of the twin method because, "overall, these results strongly suggest that MZ–DZ ideological similarities are not based solely in environmental similarities" (p. 23). This contrasts with their previously quoted definition of the equal environment assumption, where they wrote, "the EEA assumes that these more similar environmental experiences do not lead to a greater co-twin similarity on the specific trait being studied" (p. 19). Clearly, as the researchers themselves recognized, environmental similarity *does* lead to greater co-twin similarity for political traits.

Identity confusion and attachment. Some earlier critics of the twin method argued that the types of environmental similarity measures used by Smith et al. and others are limited, and while they assess some aspects of this similarity, they fail to adequately assess the nature of the attachment, conscious attempts to be alike, identity confusion, and ego fusion of MZ twin pairs. Family systems pioneer Don Jackson described "the intertwining of [MZ] twin identities, in the ego fusion that in one sense doubles the ego (because the other is felt as part of the self) and in another sense halves it (because the self is felt as part of the other)" [Jackson, 1960, p. 66]. According to the psychoanalytically oriented twin researcher Dorothy Burlingham, "Identical twins when they grow up often fail to develop into separate human entities" (quoted in Jackson, 1960, p. 66).

Looking at earlier twin studies whose authors attempted to assess twins' emotional closeness and attachment, Shields (1954) found that 47% of his MZ pairs experienced a "degree of attachment" that was "very close," whereas only 15% of the DZs experienced a very close degree of attachment (p. 234). Husén (1959) calculated an "index of attachment" for twins and found "a considerable mean difference" between MZ and DZ pairs (p. 143). Husén concluded that MZ pairs "are much more prone to emphasize the desire to be alike, to be together, to share the same interests, and to have a feeling of loyalty" (p. 142). Kringlen

(1967, p. 115) performed a "global evaluation of twin closeness" and found that 65% of MZ pairs had an "extremely strong level of closeness," which was true for only 17% of the DZ pairs. And in a 1966 twin study, Helen Koch found that "Identical [MZ] co-twins tended to be closer to each other than fraternals [DZs] . . ." (Koch, 1966, p. 132).

Some findings by earlier twin researchers that relate to twins' emotional attachment and identity issues are seen in Table 3. The results are taken from all twin

Table 3

Environmental Dissimilarity Among MZ and Same-Sex DZ Twin Pairs: Levels of Identity Confusion and Attachment

Study	Characteristic of Twin Relationship	MZ	DZ
von Bracken, 1934	"Closely attached"	87%	21%
Wilson, 1934	"Never separated from twin"	44%	27%
Mowrer, 1954	"Other twin as member of family that understands me best"	61%	24%
Mowrer, 1954	"Should be closer to my twin than other siblings"	70%	44%
Shields, 1954	"Very close degree of attachment"	47%	15%
Husén, 1959	"Very keen on always being together"	50%	25%
Cederlöf et al., 1961*	"As like [sic] as two peas"	54%	0%
Koch, 1966	"Sees likeness between himself and twin"	78%	54%
Nichols and Bilbro, 1966*	"Mistaken for each other by parents (as children)"	27%	0%
Kringlen, 1967	"Identity confusion in childhood"	90%	10%
Kringlen, 1967	"Mistaken for each other by parents and/or sibs"	21%	0%
Kringlen, 1967	"Considered alike as two drops of water"	76%	0%
Kringlen, 1967	"Inseparable as children to an extreme degree"	73%	19%
Kringlen, 1967	"Inseparable as adults to an extreme degree"	18%	0%
Kringlen, 1967	"Brought up 'as a unit'"	72%	19%
Kringlen, 1967	"Global evaluation of twin closeness"	65%	17%
Cohen et al., 1973*	"Confused for each other by mother of father"	78%	10%
Cohen et al., 1973*	"Sometimes confused by other people in family"	94%	15%
Cohen et al., 1973*	"Hard for strangers to tell them apart"	99%	16%
Cohen et al., 1975*	"Confused for each other by mother or father"	79%	1%
Cohen et al., 1975*	"Sometimes confused by other people in family"	93%	1%

studies I am aware of that provided percentage figures (or enough information to calculate percentages) based on twins' responses to questions relating to attachment and identity issues. I have excluded more common questions posed by modern twin researchers (including Smith et al., 2012), such as whether twins shared the same bedroom, attended school together, dressed alike, played together, etc. Some of the results in Table 3 were obtained by twin researchers using or developing questionnaires attempting to more easily and economically

Table 3 (Continued)

Study	Characteristic of Twin Relationship	MZ	DZ
Cohen et al., 1975*	"Hard for strangers to tell them apart"	99%	8%
Dalgard and Kringlen, 1976	"Extreme or strong interdependence in childhood"	86%	36%
Dalgard and Kringlen, 1976	"Brought up as a unit"	92%	75%
Dalgard and Kringlen, 1976	"Extreme or strong closeness in childhood"	86%	36%
Kasriel and Eaves, 1976*	"Confused for each other in childhood"	98%	6%
Torgersen, 1979*	"As alike as two peas in a pod"	83%	1%
Torgersen, 1979*	"Twins mixed up for each other as children"	71%	2%
Morris–Yates et al., 1990	"Parental treatment of twins as two individuals"	55%	83%

Sources (same-sex twin pair samples sizes; country): Cederlöf et al., 1961, p. 344 (MZ = 81, DZ = 100; Sweden); Cohen et al., 1973, p. 467 (MZ = 94, DZ = 61; United States); Cohen et al., 1975, p. 1374 (MZ = 181, DZ = 84; United States); Dalgard and Kringlen, 1976, p. 224 (MZ = 49, DZ = 89; Norway); Husén, 1959, p. 141 (MZ = 26, DZ = 24; Sweden); Kasriel and Eaves, 1976, p. 265 (MZ = 94, DZ = 84; United Kingdom); Koch, 1966, p. 233 (MZ = 70, DZ = 72; United States); Kringlen, 1967, p. 115 (MZ = 75, DZ = 42; Norway); Morris–Yates et al., 1990, p. 323 (MZ = 186, DZ = 157; Australia); Mowrer, 1954, pp. 469–470 (based on "612 twins," status not stated; United States); Nichols and Bilbro, 1966, p. 270 (MZ = 82, DZ = 41; United States); Shields, 1954, p. 234 (MZ = 36, DZ = 26; United Kingdom); Torgersen, 1979, p. 228 (MZ = 98, DZ = 117; Norway); von Bracken, 1934, p. 299 (MZ = 23, DZ = 19; Germany); Wilson, 1934, p. 334 (MZ = 70, DZ = 55; United States).

MZ = monozygotic twin pairs; DZ = same-sex dizygotic twin pairs. Includes studies whose authors provided percentage figures for environmental similarity, or enough information to calculate percentages. Excluded are studies whose authors provided only correlations or mean scores, or correlations between twins' environmental similarity and the trait under study. Excludes questions such as whether twins shared the same bedroom, attended school together, dressed alike, played together, etc. The Cohen et al. 1973 and 1975 studies were based on different twin samples.

*Studies obtaining information in the context of using or developing questionnaires designed to distinguish between MZ and DZ pairs.

distinguish MZ from DZ pairs for future twin studies.[10] Although there are various methodological issues in these studies, the trend is clear that MZ twin pairs experience much greater levels of identity confusion and attachment than DZ pairs, which we would expect to contribute to their greater resemblance for behavioral (including political) traits.

The findings in Table 3, which plausibly explain at least a portion of MZ–DZ behavioral correlation differences, are rarely cited by contemporary twin researchers and their supporters. They were not mentioned or directly assessed in Smith and colleagues' (2012) study, nor in any other publication by genetic researchers in political science that I am aware of. Of the researchers using or developing questionnaires, only the Cohen group commented on the irony of needing to demonstrate the great dissimilarity of MZ and DZ childhood environments as a method to reliably distinguish between MZ and DZ twin pairs. As we have seen, the twin method assumes that these environments are *not* dissimilar. According to the researchers, "The impact of such repeated confusion on individual twinships, or the effect of these differences between MZ and DZ twins is not known with certainty. However, such information must cast doubt upon the assumption of environmental equivalence" (Dibble, Cohen, and Grawe, 1978, pp. 246–248). In other words, in the process of developing a questionnaire designed to help future twin researchers reliably distinguish between MZ and DZ pairs, the researchers noticed that their data, which showed greatly unequal MZ–DZ childhood environments, cast doubt on the validity of the twin method itself.

Attempting to uphold the validity of twin research in political science, Medland and Hatemi (2009) wrote, "it is difficult to conceive of a population where parents of MZ twins would purposely or unconsciously socialize their children [more than DZ twins] to support the same political party" (p. 199). However, it is *not* difficult to conceive of a population in which MZs' greater attempts to be like each other, in addition to their much greater levels of closeness, loyalty, attachment, and identity confusion (as seen in Table 3), would cause them to hold similar political views, and support the same candidates and parties, much more often than DZ pairs.

From Argument B . . . to Argument A. In direct contrast to the way the equal environment assumption was defined in its first five decades of existence, we have seen that Smith and colleagues initially defined the assumption in its Argument B form, meaning that environments need only be equal as they influence the development of the trait in question. They upheld the validity of the assumption by concluding that the acknowledged greater environmental

[10]In twin research, the procedure used to distinguish MZ and DZ pairs is known as "zygosity determination."

similarity of MZ versus DZ pairs does not have a major trait-relevant impact on the former's greater resemblance for political ideology.

However, aside from the questionable methods they used to reach this conclusion, the Argument B defense of the equal environment assumption must generalize, in the behavioral and political trait context, to the untenable position that the social environment has little influence on *anyone's* behavior — whether twins or single-born individuals. If researchers conclude that the social environment does not have much influence on individual MZ twin's political ideology, they should conclude that this holds true for non-twins as well. For Smith and colleagues' Argument B conclusion in support of the equal environment assumption to hold, therefore, they should also conclude that environmental factors have little influence on political ideology and human behavior in general, and that social environments for all human beings (at least in the political context) are largely trait-*ir*relevant (Joseph, 2006).

We have seen that the Argument A "twins create their own environment" position is based on a circular argument whereby the statement that the greater behavioral resemblance of MZ versus DZ pairs is caused by genetic factors is both a conclusion *and a premise* of the twin method (see Figure 1). Nevertheless, Smith and colleagues employed this argument in their analysis, writing that "it is . . . possible that ideological similarity leads to environmental similarity" (p. 28):

> In other words, if liberals prefer the company of liberals over conservatives, and vice versa, twins who are more alike ideologically may be more likely to maintain a high level of contact with their co-twin. If, *as twin studies suggest*, there is a genetic predisposition toward ideology, this in turn raises the possibility that there is a genetic component underlying the environmental variation reported by twins. This latter view already has considerable empirical support. (Smith et al., 2012, p. 28, emphasis added)

This passage captures over 50 years of twin researchers' Argument A defense of the twin method in the social and behavioral sciences. Smith and colleagues argued that "there is a genetic component underlying the environmental variation reported by twins," which they supported with the circular claim that "twin studies suggest" that this is the case. The purpose of their study was to test some critics' argument that environmental factors completely explain MZ–DZ behavior correlation differences, but in the process they *assumed* the validity of genetic interpretations of previous twin studies in order to currently *conclude* in favor of such interpretations.

Reasoning of this type led Smith and colleagues to claim, mistakenly, that the correlation between DZ pairs' trait-relevant environmental similarity and their resemblance for political ideology is a *genetic* effect: "Environmental similarities seem to influence similarities in political temperament, but this influence is mediated by genes" (Smith et al., 2012, p. 23). Thus, like the post-traumatic stress disorder twin researchers we visited earlier, Smith and colleagues ultimately

concluded in favor of genetics and the validity of the twin method more on the basis of Argument A than on Argument B. Using the same faulty reasoning that we saw explicitly laid out by Derks et al. (2006), Smith and colleagues, after recognizing that their Argument B equal environment assumption definition was not supported by some aspects of their (albeit flawed and limited) data, chose to uphold the validity of the assumption by invoking the Argument A position that the trait-relevant environmental influences that "seem to influence similarities in political temperament" are negated, because the influences of these "environmental similarities" are "mediated by genes." The circularity of this argument is seen in Figure 2.

The researchers' defense of the twin method, at least as they attempted to explain their DZ results, ultimately rested on the Argument A conclusion *and premise* that "as twin studies suggest, there is a genetic predisposition toward ideology." Their error in reasoning, seen in Figure 2, is that when assessing the meaning of twin method data, one cannot simultaneously assume and conclude that "there is a genetic predisposition toward ideology." In using such faulty reasoning, the researchers committed the fallacy of calling on an unproven premise and an unproven conclusion to cross-validate each other.

Conclusion. We have seen that both the data and the arguments Smith and colleagues (2012) presented in support of the equal environment assumption do little to counter Points 1 and 2 as summarized by Suhay and colleagues (2007). Thus, as many critics have argued, it is likely that the more similar experiences and greater mutual influence of MZ compared with DZ twin pairs, in addition to their greater levels of identity confusion and attachment, play a major role in explaining the greater political and behavioral trait resemblance of MZ versus DZ pairs.

The quoted statement is both a premise and a conclusion of the study. The conclusion supports the premise; the premise supports the conclusion, and so on.

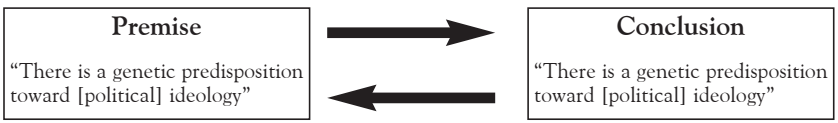

Figure 2: Circular reasoning used in Smith and colleagues' defense of the equal environment assumption in political science twin studies. Quotations from Smith et al., 2012, p. 28. Figure modified from Jay Joseph (2012), "The 'Missing Heritability' of Psychiatric Disorders: Elusive Genes or Non-Existent Genes?" *Applied Developmental Science, 16*(2), p. 71. © 2012 Taylor & Francis Group, New York.

Point #3: Is More Similar Treatment (Based on Similar Appearance) a Genetic Effect?

Smith and colleagues went on to address the critics' argument that MZ pairs are treated more alike than DZ pairs in many respects. We have seen that most twin researchers have recognized for decades that MZ pairs are treated more alike than are DZ pairs, and we saw in Table 3 that MZ pairs experience much greater levels of identity confusion and attachment than DZ pairs. As Husén concluded, "it is mainly the desire to be dissimilar and to compete with each other, etc., that differentiates the DZ-pairs from the MZ-pairs" (Husén, 1959, p. 145). Since the 1960s, we have seen that twin researchers have responded to the "overwhelming" evidence that MZs receive more similar treatment than DZs mainly by arguing, in direct contrast to how they interpret family study data, (a) that MZ pairs create more similar environments for themselves because they are more similar genetically, and/or (b) that it must be shown that MZ twin pairs experience more similar trait-relevant environments than those experienced by DZ pairs (see Table 1).

Although social beliefs in western countries dictate that MZ pairs should be treated more alike than DZs (Rosenthal, 1970), and although most twin researchers in political science recognize that MZs are treated more alike than DZs in many respects by parents and others (e.g., Hatemi et al., 2010; Medland and Hatemi, 2009), Smith and colleagues chose to focus only on the more similar treatment elicited by MZs' more similar *physical appearance*, conceding that "there is some basis for such an expectation" (p. 29). However, they mistakenly counted this as a *genetic* effect, arguing that "whatever variation in ideological similarity [that] can be attributed to physical appearance has an indisputably genetic basis. Even critics of twin studies concede that MZ twin pairs look more alike than DZ pairs because of their close genetic relationship" (p. 29). This position, in fact, is very disputable. The claim that treatment similarity based on physical appearance counts as a genetic effect must be therefore examined more closely.

Charney (2008b) has pointed to the "fallacious nature" of counting treatment effects based on appearance as genetic effects. He noted that people with the inherited trait of black skin color were forced into slavery, and asked, "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?" (Charney, 2008b, p. 337, emphasis in original). Based on the logic of Smith and colleagues' position, the status of being a slave should be seen as an "indisputably" strongly genetic trait, because virtually all variation in the population of the Confederacy for the status of being a "slave" or a "non-slave" was attributed to the inherited trait of dark skin color.

Another example is Neurofibromatosis Type I, a true genetic disorder caused by a malfunctioning gene on chromosome 17, that can cause severe facial dis-

figurement. It is possible, even likely, that an unfortunate pair of monozygotic twins with this condition would both suffer from depression and severe social anxiety. Still, it would be very mistaken to view their depression and anxiety as being caused by genetic factors simply because Neurofibromatosis Type I is a genetic disorder. In fact, the etiology of Neurofibromatosis Type I in this example has no bearing on whether we view the twins' depression and anxiety as being caused by genetic factors, since their conditions are clearly caused by years of mistreatment and negative reactions they received, both as children and as adults, from people in their schools and neighborhoods, in shopping centers and movie theaters, and so on. The emotional disorders of these twins are not caused by any genes for depression or anxiety, but rather by the treatment they receive from other people throughout their lives.

A further point is Smith and colleagues' (2012) claim that "pharmacological manipulation of social interactions consistently suggest that biology plays a crucial role in shaping social, economic, and political attitudes and behavior." They saw this as supporting the position that "biological systems built by genes seem to play an important role in mediating political attitudes" (p. 18). They could make such a claim only in the context of one of the themes of their article, which is the invalid conflation of biological causation and genetic causation. The possible influence of a prescribed medication, or even a martini or a narcotic, on how people behave in social situations does nothing to support the genetic argument, other than point out the undeniable fact that the ingestion of certain chemicals can influence people's behavior.

Smith and colleagues wondered "whether physical appearance systematically creates an environment that socializes individuals into a particular set of political attitudes" (p. 29). They were right to question this, but to the extent that it might be occurring, they mistakenly counted this as a genetic effect.

Point # 4: Do Prenatal (Intrauterine) Environmental Differences Count as Genetic?

Continuing the theme of counting that what are in fact environmental influences on twin pair resemblance as genetic influences, and of conflating potential biological and genetic influences on traits and disorders, Smith et al. addressed Suhay and colleagues' (2007) argument that MZ twins' more similar prenatal (intrauterine) environment might further confound MZ–DZ political trait comparisons. One reason that most critics of the twin method have steered clear of this argument is that it implies endorsement of the idea that non-genetic biological brain malfunctions contribute to variation in abnormal behavior and psychiatric disorders (critics of genetic theories in political science who avoided the intrauterine environment include Beckwith and Morris, 2008; Charney 2008a, 2008b; Joseph, 2010b). Nevertheless, Smith and colleagues seized on

the Suhay et al. argument and claimed that the latter's comments on the more similar intrauterine environment of MZ pairs "brings critics of twin studies into agreement with proponents on a key issue, namely the importance of biological precursors of adult ideology that are present at birth" (p. 30). In addition to mistakenly implying (here and elsewhere in their study) that Suhay and colleagues' (2007) analysis represents the views of all "critics" of twin research, this is a fundamentally flawed position.

Biological and genetic influences are not the same thing, and in many cases biological causes are *environmental* causes. Although it is true that every genetic influence must have a corresponding biological substrate, the reverse is not true: many biological influences are not genetic or inherited. As Gottesman and Hanson (2005) pointed out, "Everything that is genetic is biological, but not all things biological are genetic" (p. 265). The measles virus is one of countless such examples. Death caused by rattlesnake venom is another. The authors of a hypothetical twin study of death by rattlesnake venom, who find much higher MZ vs. DZ concordance (because MZ pairs spend more time together than DZ pairs and have more similar interests), could not conclude in favor of an important genetic influence on death resulting from a rattlesnake bite.

Another example would be a twin study of birth defects. In such a study, all twin pairs would be born to mothers who had been prescribed the drug Thalidomide in the 1950s and 1960s, which was subsequently shown to cause birth defects in children born to these mothers. As Smith and colleagues recognized (p. 29), in the intrauterine setting, MZ pairs share a more similar placental and chorionic environment than experienced by DZs (Bulmer,1970). This means that MZ pairs would be more similarly exposed to Thalidomide and other potential toxins prenatally than would DZ pairs.

Suppose a group of twin researchers finds that the MZ correlation for Thalidomide-related birth defects is 60%, but only 15% for the DZ pairs. This finding would be the result of a biological agent (Thalidomide) affecting MZs more than DZs, since the former share a more similar intrauterine environment. The differing correlations would be explained by biological factors, but *not* by genetic factors. Thus, any conclusion in favor of genetics and a 90% heritability estimate for birth defects would clearly be mistaken (though welcomed and cited by the manufacturers of Thalidomide), since higher MZ concordance would be the result of non-genetic biological factors. Based on Smith and colleagues' faulty reasoning that such factors count as genetic factors, they would likely conclude in favor of an important role for genetic influences on birth defects because the study demonstrated the importance of "biological precursors" of birth defects "that are present at birth."

Let us further imagine a study of pregnant mothers of twins who had ingested an imaginary drug called "Politomide," a chemical agent that impacted the brains of twin fetuses in a way that subsequently caused adult MZ pairs to resemble

each other more for political ideology than adult DZ pairs. According to Smith and colleagues' logic, a finding that intrauterine "Politomide" exposure influenced adult political ideology would lend support to the idea that the twin method is a valid instrument for the detection of *genetic* influences. In this example, however, a non-inherited biological influence contributes to MZ–DZ differences in political ideology, and any conclusions in support of genetic influences on political ideology would be mistaken.

So even in the unlikely event that biological agents shared to a greater degree by MZ versus DZ pairs in the intrauterine environment contribute to the former's greater resemblance for political ideology as adults, this would do nothing to support the theoretical basis of the twin method. On the contrary — this finding would constitute yet another environmental influence confounding genetic interpretations of twin method data.

The Twin Method Versus the Real World: Which Provides the Better "Natural Experiment"?

Behavioral genetic researchers and political scientists using behavioral genetic methods frequently refer to the twin method as a "naturally occurring experiment centered on twins" (Smith et al., 2012, p. 18), and as an "experiment of nature" (Plomin et al., 2008, p. 38). At the same time, they frequently overlook, downplay, or ignore research from outside their field demonstrating the importance of environmental factors. As the child psychiatrist Michael Rutter observed, "It is quite striking that behavioral genetics reviews usually totally ignore the findings on environmental influences. It is almost as if research by non-geneticists is irrelevant" (2006, pp. 11–12). They also tend to overlook numerous real world "natural experiments" that argue against their major theories.

The evolutionary biologist Richard Lewontin observed in 1987 that both genetically oriented researchers, and their environmentalist critics, wish "to determine how much change is possible so that we may act rationally in social programs." Lewontin then wondered why behavioral genetic researchers "keep studying heritability, which simple logic tells us cannot give the answer to this problem." As to why these researchers usually do not "ask the questions about changeability directly," he believed that it is "because the answer would come out in the wrong direction" (Lewontin, 1987, p. 32). Behavioral genetic methods assess environmental factors indirectly in the process of performing studies attempting to assess the role of genetic factors. The "shared" and "non-shared" environmental components they calculate are simply the remaining portions of the population variance after heritability estimates are calculated. Real world examples and studies directly assessing the importance of the environment, which from the genetic perspective frequently "come out of the wrong direction," are as Rutter pointed out often ignored by behavioral genetic researchers.

Smith and colleagues (2012) wrote, "In many respects" the findings from political science twin studies "contradict decades of empirical work in political science treating individual differences in attitudes as environmentally determined and the environmental experiences shared by family members as particularly effective agents of political socialization" (pp. 17–18). Even if we frame the issue only on the basis of research attempting to assess genetic or socialization influences on individual differences in political traits, the question nonetheless comes down to "decades of empirical work" showing the importance of environmental influences, versus decades of (as I have attempted to show) *unsuccessful* attempts to validate the equal environment assumption of the twin method.

Like others before them, Smith and colleagues (2012) failed to recognize and consider the larger historical, social, and political experiences that argue against their thesis. As one of many possible examples, for non-genetic reasons we would expect a Wilson–Patterson type "government provided health care" item to show marked differences between people of British ancestry living on either side of the United States–Canada border. As another example, Germany was heavily anti-Nazi in the late 1920s, and heavily pro-Nazi just a few years later. Conversely, researchers could have administered the Wilson–Patterson "socialism" question to Germans on either side of the Berlin Wall in 1965, and no one would have expected similar scores on both sides of the Wall. Similarly, we could have posed the Wilson–Patterson "apartheid" question to Blacks and Whites in South Africa in 1980, and currently pose the "bible truth" question to Coptic Christians and Muslims in Egypt, and we should expect to see very different patterns of answers in each set of two populations.

The same point can be made currently in relation to the genetically homogeneous populations of "socialist" North Korea ("Democratic People's Republic of Korea") and "capitalist" South Korea ("Republic of Korea"). If a research team finds that Koreans on both sides of the demilitarized zone that divides the two countries give similar levels of "yes" or "no" responses (confidentially) to the Wilson–Patterson "socialism" question, this finding would lend far more support to genetic theories in political science than any inferences one could draw on the basis of Minnesota and Virginia twin register data. However, the expected large score difference between responses in the North and South would provide additional evidence against such theories.[11]

Smith and colleagues (2012) believed that "the validity of challenges to twin studies should be addressed as empirical issues rather than debating points" (p. 30). Examples such as these, however, are empirical "natural experiments" suggesting that non-genetic factors strongly influence political attitudes and behavior, regard-

[11]Despite the influences of family and political socialization, education, and propaganda, Wilson–Patterson "socialism" scores in North Korea and South Korea could be affected by disillusionment with the economic and political realities in both countries. Naturally, this would still be related to environmental as opposed to genetic influences.

less of correlations researchers derive from narrow ahistorical analyses of (environmentally confounded) twin data. These analyses, which include four decades of "equal environment assumption test" studies (see Joseph, 2006; Medland and Hatemi, 2009), not only fail to address the social, historical, and political events that argue against their authors' conclusions, but also fail to adequately address the historical findings, controversies, biases, definition changes, and political aspects of twin research itself (Joseph, 2004; Joseph and Wetzel, 2013; Kamin, 1974; Lewontin et al., 1984; Teo and Ball, 2009).

The empirical evidence from the history of political movements and political change, indeed from all human history, argues strongly against current "genopolitical" theories based on twin research. According to Charney (2008a), the acceptance of genetic theories in political science "would require nothing less than a revision of our understanding of all of human history, much — if not most — of political science, sociology, anthropology, and psychology, as well as, perhaps, our understanding of what it means to be human" (p. 300). At the same time, we have seen that empirical data from twin research *fails* to provide scientifically acceptable evidence in support of a genetic basis for political traits. Far more can be learned from history textbooks about the genetic basis of political attitudes and behavior — or the lack of such a basis — than from any behavioral genetic study one could mention.

Summary and Conclusions

Recent attempts by twin researchers in political science to uphold the validity of the twin method and its all-important "equal environment assumption" do not hold up to critical examination. From the outset of their publication, Smith and colleagues framed the issue in a way that guaranteed validation of the twin method. Additional errors arguing against Smith and colleagues' conclusions include that they:

1. Put forward the untenable Arguments A and B in support of the equal environment assumption in the face of overwhelming evidence that MZ and same-sex DZ environments are not equal.
2. Used inadequate methods to assess twin environmental similarity and political ideology.
3. Reached several conclusions that argue against the validity of the equal environment assumption.
4. Mistakenly counted environmental effects on twins' behavioral resemblance as genetic effects.
5. Did not account for levels of identity confusion and attachment experienced to a much greater degree by MZ than DZ twin pairs.

6. Mistakenly conflated the potential, yet differing, roles of biological and genetic effects on twin resemblance.
7. Overlooked or downplayed current and historical political events, situations, and research that argue against their thesis.

Earlier, I pointed to the ongoing failure of molecular genetic researchers to discover genes underlying political behaviors and traits, with all results thus far either negative or unreplicated (Benjamin et al., 2012; Charney and English, 2012; Hatemi and McDermott, 2012). Similar negative gene finding results have occurred for psychological traits such as I.Q. and personality (Chabris et al., 2012; Deary, 2012; Plomin, 2013), psychiatric disorders such as schizophrenia (Collins et al., 2012), and other observed variation in human behavior (Wahlsten, 2012). Molecular genetic researchers continue to cite the results of twin research to justify the continuation of their work, but a more plausible explanation for the negative results obtained thus far is that 90 years of misinterpreting twin method results in favor of genetics has led to decades of fruitless gene searches in psychiatry, psychology, and the social sciences (Joseph, in press; Joseph and Ratner, 2013; Latham and Wilson, 2010).

Smith and colleagues thus join a long list of twin researchers who, based on their acceptance of the equal environmental assumption fallacy, mistakenly concluded in favor of important genetic influences on traits and behaviors intuitively understood as being caused by non-genetic factors. These twin studies include those looking at breakfast eating patterns (Keski–Rahkonen, Viken, Kaprio, Rissanen and Rose, 2004), cell phone use (Miller, Zhu, Wright, Hansell, and Martin, 2012), ethnocentrism (Orey and Park, 2012), finger-sucking and nail-biting in childhood (Ooki, 2005), female sexual dysfuntion (Burri, Greven, Leupin, Spector, and Rahman, 2012), frequency of orgasm in women (Dawood, Kirk, Bailey, Andrews, and Martin, 2005), happiness (Bartels and Boomsma, 2009), loneliness (Boomsma, Willemsen, Dolan, Hawkley, and Cacioppo, 2005), physical activity in young adults (Mustelin et al., 2012), problematic masturbatory behavior in children (Långström, Grann, and Lichtenstein, 2002), sedentary behavior during adolescence (van der Aa et al., 2012), tea and coffee drinking preferences (Luciano, Kirk, Heath, and Martin, 2005), and voter turnout (Loewen and Dawes, 2012). In addition to the unsupported claim that twin research has shown these behaviors and traits to have an important genetic basis, research of this type encourages reductionistic focus on biological and genetic factors — and away from social and environmental factors — as the main way society should think about and approach human behavioral differences (Lewontin, 1991; Rose, 1997).

The two main competing hypotheses for explaining the usual finding that MZs correlate higher than same-sex DZs for behavioral traits are: (1) based on

the *acceptance* of the equal environment assumption, important genetic influences underlie variation in most human behavioral traits; or (2) based on the *rejection* of the equal environment assumption, MZ–DZ correlation differences are caused exclusively by non-genetic influences. On the basis of the more plausible "Hypothesis 2" position, previously reported twin method MZ–DZ comparisons point to nothing more than the importance of *non-*genetic influences on human behavioral trait variation.

Medland and Hatemi wrote in 2009 that "there is no evidence" that the more similar environments experienced by MZ twin pairs are "influencing MZ co twin correlations for political preferences" (p. 199). Three years later, Smith et al. (2012) reached a similar conclusion. However, viewing twin data from the Hypothesis 2 perspective suggests that this "evidence" is *precisely what the finding of greater MZ versus DZ resemblance for political traits has uncovered*.

Critics have argued for decades that the twin method is unable to disentangle the potential roles of genetic and environmental influences, and genetic researchers in political science have been no more able than their predecessors in psychology and psychiatry to provide convincing arguments otherwise. Acceptance of the Hypothesis 2 position that the twin method is unable to disentangle genetic and environmental influences does not mean that twin studies "overestimate heritability," or that the equal environment assumption should be tested "trait-by-trait," but rather indicates that the twin method should be evaluated in exactly the same way as most behavioral geneticists currently evaluate family studies (seen in Table 1). This means that *genetic interpretations of twin method data in political science, psychology, psychiatry, and other social and behavioral sciences must be rejected outright*. Thus, twin studies have provided no reason to re-evaluate previous theories stressing the dominant behavior-shaping influences of factors such as family, culture, the media, birth cohort effects, social policy decisions, religion, oppression, learned gender and class roles, and education.

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