

# Twin Studies of Political Behavior: Untenable Assumptions?

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Using the “classical twin method,” political scientists John Alford, Carolyn Funk, and John Hibbing conclude that political ideologies are significantly influenced by genetics, an assertion that has garnered considerable media attention. Researchers have long used human twins in attempts to assess the degree of genetic influence on various behavioral traits. Today, this methodology has been largely replaced in favor of contemporary molecular genetic techniques, and thus heritability studies have seen a diminishing role in behavioral genetic research of the twenty-first century. One important reason the twin method has been superseded is that it depends upon several questionable assumptions, the most significant of which is known as the equal environments assumption. Alford, Funk, and Hibbing argue that this crucial assumption, and thus their conclusion, holds up under empirical scrutiny. They point to several studies in support of this assumption. Here, we review the evidence presented and conclude that these attempts to test the equal environments assumption are weak, suffering significant methodological and inherent design flaws. Furthermore, much of the empirical evidence provided by these studies actually argues that, contrary to the interpretation, trait-relevant equal environments assumptions have been violated. We conclude that the equal environments assumption remains untenable, and as such, twin studies are an insufficient method for drawing meaningful conclusions regarding complex human behavior.

John Alford, Carolyn Funk, and John Hibbing, in their *American Political Science Review* article (hereafter referred to as “AFH”), employ twin studies to argue that political ideologies (i.e., conservative or liberal political attitudes) are highly heritable and thus strongly influenced by genetics.<sup>1</sup> AFH state that genetic explanations of behavior are “conspicuously absent” from the political science dialogue and charge that “political scientists do not take seriously the possibility of nonenvironmental influences.”<sup>2</sup> They urge “political scientists to incorporate genetic influences” into models of political behavior and to “join forces” with behavioral geneticists.<sup>3</sup> Given the significant criticisms of studies in which twins are used to understand the origins of complex human behaviors and problems with the scientific data supposedly supporting the validity of this method, such a move would be, at best, premature.<sup>4</sup>

AFH argue that the classical twin approach for studying complex human social behaviors is well supported by the evidence. Here, we examine the empirical studies cited by AFH in support of a critical assumption underlying

the validity of these twin studies, the equal environments assumption (EEA).<sup>5</sup> We do not claim that genetic factors play no role in human behavioral traits, but rather we show that the empirical evidence used in support of the underlying premise of these twin studies is weak, far less certain than AFH would have readers believe. In fact, many of the studies cited as supporting the validity of the twin method include data that violate predictions of the EEA. As a result, the conclusions drawn on the basis of classical twin studies, as those presented by AFH, are of dubious scientific value.

## The Heritability Concept

Heritability is a statistical term that should represent, for a trait of interest, the fraction of variation in a population that is due to genetic contributions.<sup>6</sup> Expressed as a number ranging from 0.0 (no heritability) to 1.0<sup>7</sup> (complete heritability), heritability is measured for a specific population, at a specific time, interacting with a specific environment.<sup>8</sup> Thus, as pointed out by Schaffner, “if the environment changes, the heritability will almost certainly change.”<sup>9</sup> This property of heritability is highlighted by a study showing that IQ differences exhibit high heritability in families of higher socioeconomic status, but near-zero heritability in families of lower socioeconomic status.<sup>10</sup> In other words, in an advantaged population, a large fraction of IQ variability was attributed to genetic influences, while in a disadvantaged population, IQ variability was attributed almost entirely to

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environmental influences. In effect, incorporating measures of environmental influences into such studies can yield dramatic variations in heritability estimates. Relatively few such twin studies have treated environment very deeply, usually attempting to rule it out as having a confounding effect on genetic conclusions.<sup>11</sup> As leading behavioral geneticist Eric Turkheimer has put it, this is “hardly the stuff of good environmental analysis.”<sup>12</sup>

### The “Crucial” Equal Environments Assumption

AFH acknowledge that the equal environments assumption is “crucial to everything that follows from twin research.”<sup>13</sup> They conclude that the “caveats” raised have “been subject to sustained and varied investigation and . . . [have] been found to hold up under empirical scrutiny.”<sup>14</sup> In support of this claim, they cite studies that look at the effects of measures of similarity of appearance, treatment, and environment (including so-called “misperceived zygosity studies”) on shared traits between twins.<sup>15</sup> We review the evidence that they argue supports their conclusions.

Studies in which heritability of behavioral traits is based on comparisons of pairs of monozygotic (MZ) and dizygotic (DZ)<sup>16</sup> twins rely on the validity of the EEA. The EEA assumes that MZ and DZ twins each share environments to the same extent. In particular, it is assumed that the two types of twins do not differ in those environmental influences that might affect the trait under study (trait-relevant environments). However, critics argue that, because of their identical appearance, MZ twins are treated and interacted with by parents and the outside world much more similarly than are DZ twins or ordinary siblings. Consider the potential influence of shared physical features of MZ twins on social interactions. Children who are obese, for example, might suffer indignities that others do not. Children thought of as “attractive” might experience a very different world than those deemed “ugly.” MZ twins on average share closer bonds than DZ twins by a number of measures. Both this suggested closer bond between MZ twins and the potentially similar responses of family and society to the identically-featured MZ twins could well influence the behavioral development of the children in the direction of greater similarity. If this were to be the case, the incorrect acceptance of the EEA could lead to heritability measurements in twin studies that would be highly inflated, despite the fact that the trait under study was strongly environmentally influenced.

Thus, in order for heritability estimates to be valid for a particular trait, MZ and DZ twins should experience equal trait-relevant environments. This is a primary problem in the studies cited by AFH, since determining which environmental factors to assess may be difficult to achieve. After all, such studies are meant to sort out the factors

that influence a trait, and should not assume to know *a priori* all of the relevant environmental influences.<sup>17</sup> Even those researchers who do attempt to measure environmental influences, as the authors of one study point out, choose out of “a virtually endless array of possible environmental characteristics.”<sup>18</sup> Indeed, none of the studies we reviewed here sought specific “trait-relevant” environmental effects, but only attempted to rule out effects of general measures of environmental similarity.

### “Misperceived Zygosity” Studies<sup>19</sup>

Misperceived zygosity studies, considered to be tests of the EEA, take advantage of twin pairs for which their twin status (i.e., MZ or DZ) has been wrongly assigned. These studies are made possible by instances where biologically identical twins call themselves or are called by their parents “fraternal,” or where fraternal twins call themselves or are called by their parents “identical.” Trait correlations for these misidentified twins are then compared to those for correctly identified twins in order to test the effects of “true zygosity” (presumed to measure a genetic effect) versus “perceived zygosity” (presumed to measure an environmental effect). Thus, the argument goes, if MZ twins who perceive themselves to be DZ are just as *similar* in trait measures as MZ twins who correctly identify themselves (or DZ twins who misidentify as MZ just as *dissimilar* as DZ twins who correctly identify themselves), then the environmental influence of more similar treatment for MZ twins can be concluded “to be at best irrelevant.”<sup>20</sup>

However, in order for “perceived zygosity” to be a meaningful test of the EEA, it must be a true surrogate for the environmental similarity a pair of twins’ experiences. For example, a genetically identical twin pair who misidentify themselves as “fraternal” must believe themselves as well as be perceived by others to be non-identical fraternal twins. Otherwise, this may merely be a case of genetically MZ twins, who are likely to appear remarkably similar, but confused or were incorrectly told their twin status. Unless self-identification of zygosity is shown to correlate with beliefs about degree of similarity and actual physical similarity, it is questionable whether merely miscategorization is a meaningful measure of how a twin pair will be treated, when MZ twins will still appear physically similar and DZ twins dissimilar. Nevertheless, the authors of these studies, without evidence, assume that DZ twin pairs misidentified as MZ pairs “view themselves as more similar [and] will be treated more alike by parents, family, and society.”<sup>21</sup> This is an untested assumption. We propose the term “misidentified zygosity” as more appropriate for such twin pairs, as “misperception” has not been demonstrated.

In fact, data in two “misperceived zygosity” studies appear to contradict the notion that physical similarity is

the basis for the perception of zygosity status. One study found that, compared to MZ or DZ twins who were correct about their zygosity, MZ twins who incorrectly believed they were DZ “were much less likely to base their opinion on physical appearance, but more likely to base their opinion on what their parents were told at their birth.”<sup>22</sup> Another study found that “when mothers were mistaken about the zygosity of their twins, they usually relied on information given to them from a doctor at the time of the twins’ birth,” as opposed to similarity of physical appearance.<sup>23</sup> These findings raise questions about the utility of using “misperceived zygosity” as a test of the EEA. As the authors of one study using this method acknowledge, “a single measure of self-perceived zygosity may not be the most accurate representation of what critics mean by biasing perception of the two kinds of twins.”<sup>24</sup>

The limitation of using “perceived zygosity” as a surrogate for environmental similarity is revealed by the data presented in a 2002 study.<sup>25</sup> MZ twins sharing classes were significantly more likely to share symptoms of separation anxiety disorder, attention deficit-hyperactivity disorder (ADHD), and oppositional defiant disorder. However, “perceived zygosity” was not associated with shared symptomology, indicating that misidentified zygosity did not capture environmental effects that were seen when accounting for the likelihood of sharing classes. Furthermore, sharing friends by DZ twins predicted similar ADHD scores, although a “perceived zygosity” score for shared ADHD did not have a statistically significant effect. This suggests that “perceived zygosity,” as measured by these studies, is unlikely to be a good indicator of environmental similarity, and thus will fail to truly test the EEA.

## Violations of the EEA

One of the clearest and most consistent results of the studies cited by AFH was that MZ twins are indeed more similar on measures of environmental and physical similarity. MZ twins were “markedly more confusable in appearance than DZ twins;”<sup>26</sup> significantly more likely than DZ twins to report being treated “as two of a kind” by parents, to have dressed identically, to have been in the same class at school, to have played together “almost always,” and to have spent time together “almost always;”<sup>27</sup> and share a much more similar environment based on mothers’ accounts of childhood environmental similarity (including sharing friends, sharing classes, and dressing alike).<sup>28</sup> As the authors of one study state, “we must conclude that the MZ twins in our sample were treated more similarly than were the DZ twins and that therefore the equal environments assumption was violated.”<sup>29</sup>

Ultimately, the authors of all of these studies conclude that despite apparent violations of the EEA generally, their measures of environmental similarity did not influence

the traits under study, and therefore “trait-relevant” EEA was not violated. However, a closer look at the studies in support of the EEA finds that many actually contain significant data arguing that “trait-relevant” EEA was indeed violated. For example, one study found that DZ twins who were more likely to be confused in appearance were more likely to have similar scores for activity and impulsivity traits. MZ and DZ twins as a whole who were more similar in appearance were more likely to share all four measures of personality traits assessed.<sup>30</sup>

In another study, the authors report that “for personality measures MZ twins were significantly more similar than DZs, and DZ twins who believed they were monozygotic were more similar than those . . . who correctly believed they were fraternal pairs.” In other words, “both true and perceived zygosity were related to cotwin similarity on personality measures.”<sup>31</sup> Furthermore, they found that physical similarity (as assessed by eight raters) predicted more similar Raven IQ scores for monozygotic twins. The authors admit their data is evidence of “bias in perceived and physical similarity creating greater cognitive similarity among MZ twins,” although they downplay the effect. Nevertheless, they do conclude, “for personality variables, perceived zygosity may have some effect on fraternal pairs who believe themselves to be monozygotic.”<sup>32</sup>

Another of these studies found significant associations between measures of DZ twins’ preferences for similar treatment, similarity of environment, and preference for similar experience with anxiety and depression scores.<sup>33</sup> For MZ twins, an association was found between measures of environment and depression. The authors conclude that the “equal environments assumption appears to be invalid.”<sup>34</sup> Likewise, a different study found that measures of environmental similarity predicted greater similarity in symptom scores for nearly half of the tested traits.<sup>35</sup> For example, MZ twin pairs who were more frequently in the same classes were significantly more likely to share similar symptom scores for all of the measured disorders than those who were in the same classes less often. Dressing alike predicted greater symptom correlation among MZ twins for separation anxiety disorder, ADHD, or conduct disorder.

Further indicating that environmental similarity of MZ twins confounds twin studies is the fact that the data also show that DZ twins who more often share friends, dress alike, or share classes, were significantly more similar on scores for ADHD, separation anxiety disorder, and conduct disorder, respectively.<sup>36</sup> In addition, they found a significant effect of “perceived zygosity” for MZ twins on shared conduct disorder, and for DZ twins on shared separation anxiety and conduct disorders. These statistically significant findings call into question the EEA. This data is all but ignored by the authors of this 2002 study, and where the effect of environmental similarity is discussed, it is downplayed.<sup>37</sup>

If environmental similarity does influence MZ twin concordance for a trait in question, then this would be expected to inflate estimates of heritability. Accounting for the unequal environments would decrease estimated heritability. In a study measuring the “contact frequency” of twin pairs, the authors found that heritability estimates dropped dramatically when the samples were stratified by level of contact between twins.<sup>38</sup> On average, their heritability measures for twins with infrequent contact dropped 31 percent below twins with frequent contact. Compared with the total sample of twins, controlling for the frequency of contact indicates that their measures of heritability were overestimated on average by 27 percent. The authors note that “the heritability estimates were consistently higher among twin pairs with frequent contact, suggesting a potential violation of EEA.”<sup>39</sup>

Given that several of these studies report findings that appear to violate both general and trait-relevant EEA, how do all of these studies conclude that the EEA is valid?<sup>40</sup> Despite small sample sizes and weak statistical power, several studies do so solely on the basis of negative results, or a failure to find statistically significant correlations between their measures of similarity and the trait in question.<sup>41</sup> Not all of the studies, however, based their EEA-validating conclusions on negative results. One study presenting significant evidence that the EEA did inflate heritability estimates nevertheless emphatically concluded that they “found no support for violation of EEA.”<sup>42</sup> In order to draw this conclusion, they used 40,000 simulated twin pairs and the *new* assumption that MZ twins select their environment on the basis of their genetics.<sup>43</sup> As if to highlight their conclusions in spite of their actual empirical data, they state that “the simulation analyses thus provide an interpretation of our empirical results without violation of the EEA.”<sup>44</sup>

### Retrospective Nature of the Studies

Another problem with studies evaluating the validity of the EEA is that important data is often obtained from retrospective information. One study asked adult twins with a mean age of 34 how they were treated as children. As the authors put it, the subjects were “reporting on events and their feelings about those events some 20 years after their occurrence.”<sup>45</sup> Another study measured emotional and behavioral problems via mother-reported retrospective telephone interviews, recording mothers’ reports of twins’ zygosity, as well as recounts of childhood environmental similarity.<sup>46</sup> This retrospective format is suspect, given that even in a study where parents gave contemporary reports of their children, mothers and fathers independently agreed on the answers only about one-third of the time. When asked the same questions only three months later, their answers changed over 25 percent of the time.<sup>47</sup> This calls into question the reliability

of retrospective data over a matter of weeks, let alone decades.

In addition to methodological flaws, all of the studies cited by AFH in support of the EEA used small samples, ranging in size from 41 twin pairs<sup>48</sup> to 201 twin pairs<sup>49</sup> having “misperceived zygosity.” One of the largest studies (with 3,155 total twin pairs, 185 of which had “misperceived zygosity”) included a power analysis indicating that even that sample size offered weak to no statistical power to detect an influence of misidentified zygosity.<sup>50</sup> A study cited by AFH summarizes the statistical weakness of these earlier reports, noting that studies supporting the EEA may have reached their conclusions “because of limited statistical power” and “because the validity of the assumption is usually established by failing to find a significant effect.”<sup>51</sup>

### Conclusion

We agree with the authors AFH when they state that the EEA is essential for conclusions drawn from twin studies concerning human behavioral traits. However, we conclude that the EEA has not been well tested nor validated. We point out numerous problems with the studies cited by AFH. These studies report small sample sizes with low statistical power, problematic retrospective interviews, and assumptions about misidentified zygosity that are often not supported by data. The attempts to control for trait-relevant environments in these efforts are quite limited, admittedly because it is difficult to know exactly which environmental factors to control for. Furthermore, several of the studies cited in support of the EEA contain evidence that could be interpreted as arguing against the assumption. It is difficult not to get the sense that in the face of inconvenient data, a fair amount of intellectual acrobatics was necessary to arrive at some of the conclusions drawn.

AFH have made a plea for the political science research community to take more seriously twin studies that suggest a strong genetic component affecting political beliefs. While, to many, twin studies seem to present an ideal opportunity to study the relative contributions of genetics and environment to human behavioral traits, these studies face many more problems than has been acknowledged. In a research area that is often misrepresented to the public, we urge political scientists to take a more critical look at the studies that supposedly provide the foundation for this field.

Finally, we point out that in recent years, some researchers in the field of human behavioral genetics have begun to take more seriously the role of environment in influencing human behavioral traits. We have already referred to the studies of Eric Turkheimer and colleagues. Other examples include studies that have incorporated measurements of child abuse into a study of genetic effects on anti-social behavior.<sup>52</sup> A study genuinely accounting for

social factors found that certain measures of greater similarity among MZ twins compared to DZ twins diminished or disappeared.<sup>53</sup> The findings of James Flynn and his colleagues<sup>54</sup> that the mean IQ of populations in many countries (including the U.S.) has been steadily increasing over the last 50 years raise questions about the more deterministic views of genetic influences on human cognition. A recent article looking at concentrated disadvantage found neighborhood-level effects on verbal ability among African-American children<sup>55</sup> and indicates more sophisticated measures of environment may be necessary to truly detect significant environmental influences on complex human traits.

## Notes

- 1 Alford et al. 2005.
- 2 Ibid.
- 3 Ibid.; Alford et al. 2008.
- 4 I.e., Pam et al. 1996, Joseph 1998, Kamin and Goldberger 2002, Rutter 2002, Horwitz et al. 2003a and 2003b, Beckwith 2006, and Ehrlich and Feldman 2007.
- 5 The primary studies reviewed include Plomin et al. 1976, Scarr and Carter-Saltzman 1979, Morris-Yates et al. 1990, Kendler et al. 1993, Xian et al. 2000, Cronk et al. 2002, and Eriksson et al. 2006.
- 6 For an excellent discussion of heritability, see Sober 2001, 47–78.
- 7 This estimated statistic gives the false sense that “heritability” is concrete and fixed.
- 8 It is important to keep in mind that twin studies in principle allow one to make claims regarding the effects of both genes and environment without ever having actually measured anything about genes or the environment.
- 9 Schaffner 2006, 16.
- 10 Turkheimer et al. 2003.
- 11 Three notable exceptions include 1) a study looking at the environments of twins’ first year of life, finding that twins disproportionately experience a number of developmental circumstances that raise questions about generalizing twins studies to the population at large (Ainslie et al. 1987); 2) a study indicating that intrauterine environment may bias psychological and behavioral estimates of heritability (Prescott et al. 1999); and 3) a study demonstrating social sources of shared twin behavior previously attributed largely to genetic influences (Horwitz et al. 2003a and 2003b).
- 12 Turkheimer 2006, 102.
- 13 Alford et al. 2005.
- 14 Ibid.
- 15 AFH also cite Bouchard et al. 1990, a study purporting to test the notion that if common environment is of significance, then “twins reared apart” should be less alike than twins reared together. We have addressed this study elsewhere (Beckwith et al. 1991), finding twins’ reared apart status to be highly questionable. Also see Richardson 1998, 140–145 and Joseph 2004, 97–136 for critical review of Bouchard et al. 1990 and the history of “twins reared apart.”
- 16 The terms “MZ” and “DZ” are used throughout this commentary, except when discussing studies that refer explicitly to “identical” and “fraternal” twins.
- 17 Beckwith 2006, 79.
- 18 Cronk et al. 2002.
- 19 In the interest of space we have not been able to include a full accounting of the methodological limitations of these studies, and have focused on what we believe to be some of the more important points. Other issues that arise include biased sampling, insufficient variation for analyses of variance, and crude measures of “contact frequency.”
- 20 Alford et al. 2005.
- 21 Xian et al. 2000.
- 22 Kendler et al. 1993.
- 23 Cronk et al. 2002.
- 24 Scarr and Carter-Saltzman 1979.
- 25 Cronk et al. 2002.
- 26 Plomin et al. 1976.
- 27 Morris-Yates et al. 1990.
- 28 Cronk et al. 2002.
- 29 Morris-Yates et al. 1990. Although their end conclusion is that the EEA is valid.
- 30 Plomin et al. 1976.
- 31 Scarr and Carter-Saltzman 1979.
- 32 Ibid.
- 33 Morris-Yates et al. 1990.
- 34 Ibid.
- 35 Cronk et al. 2002.
- 36 Ibid.
- 37 Ibid.
- 38 Eriksson et al. 2006; the authors measured the heritability of “physical activity.”
- 39 Ibid.
- 40 The authors of these studies, for example, conclude that violations of EEA “do not appear to bias twin studies in the direction of inflated heritabilities” (Plomin et al. 1976); that “the critical assumption of equal environmental variance for MZ and DZ twins is tenable” (Scarr and Carter-Saltzman 1979); and that “similar treatment imposed upon MZ twins on the basis of their zygosity alone is . . . not a threat to the validity of the twin method” (Morris-Yates et al. 1990).
- 41 Plomin et al. 1976, Scarr and Carter-Saltzman 1979, Morris-Yates et al. 1990, Kendler et al. 1993, and Cronk et al. 2002.

- 42 Eriksson et al. 2006.  
 43 This has been a common appeal made by twin study researchers when faced with the issue of environmental “confounders” of otherwise genetic interpretations—what could be called the “Geneticization of Environment.”  
 44 Eriksson et al. 2006.  
 45 Morris-Yates et al. 1990.  
 46 Cronk et al. 2002.  
 47 Plomin et al. 1976.  
 48 Scarr and Carter-Saltzman 1979.  
 49 Cronk et al. 2002.  
 50 Xian et al. 2000.  
 51 Cronk et al. 2002.  
 52 Although the replicability of these studies has been mixed; see Morris et al. 2007.  
 53 Horwitz et al. 2003a and 2003b.  
 54 Flynn 2007.  
 55 Sampson et al. 2008.

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