



Arsonists at the Cathedral

A Review of

The Trouble With Twin Studies: A Reassessment of Twin Research in the Social and Behavioral Sciences

by Jay Joseph

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Reviewed by

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During the weeks I was reading Jay Joseph's *The Trouble With Twin Studies: A Reassessment of Twin Research in the Social and Behavioral Sciences*, a take-no-prisoners attack on twin studies and behavior genetics generally, a cathedral was erected in honor of twin studies in the prestigious journal *Nature Genetics* (Polderman et al., 2015). The cathedral's architects did something that I would have thought was impossible: They meta-analyzed every single twin study that has been conducted in the last 50 years. They meta-analyzed not just twin studies of intelligence, or just behavior, but twin studies of diabetes, skin diseases, and ophthalmology. For those keeping score, ophthalmology edged ear, nose, and throat in the heritability sweepstakes at .71. The average heritability coefficient was .49, barely rescuing the cathedral's architects from the uninspiring conclusion that when all is said and done, baseball is 50 percent pitching (a remarkable virtual tour of the heritability cathedral is at <http://match.ctglab.nl/#/home>).

Whether the heritability cathedral will turn out to have been worth the effort expended by its gifted architects is not a question that can be decided in the present tense. What I want to consider is how it is possible for reasonable scholars to disagree on this kind of scale. *The Trouble With Twin Studies* is not about weaknesses in the cathedral's foundation: It does not just point out that there are limitations to the heritability concept, that there are assumptions to be made and evaluated in the course of conducting twin studies, that there is an environment as well as a genome that must be considered in questions of nature-nurture, that modern epigenomic biology has complicated simple interpretations of family data, and that one has to be careful lest one's thinking about genetic influence drifts in the direction of determinism or regressive social policies. *The Trouble With Twin Studies* aims to burn the cathedral to the ground. Heritability coefficients are not just context-dependent, they are meaningless; violations of the equal environments assumption completely invalidate twin-study conclusions; consideration of any kind of genetic influence on behavior is inseparable from its worst possible consequences in victim blaming and eugenics.

Like many constructions of its kind, the heritability cathedral is a little anachronistic, a monument to the scientific tastes of an earlier generation. Behavior genetics has not been about the computation of heritability coefficients for at least a decade. There are two paradoxical reasons for this: On the one hand, it has become obvious that human outcomes, however genuinely complex and psychological, are not independent of genetic variation. On the other hand, the critics are right: By the time you are done with the statistical assumptions and biological simplifications, the question of whether the heritability of extraversion is .45 or .62 is pointless, and the distinction is without practical consequences in any case. Heritability isn't zero; it isn't one.

Behavior genetics has moved on in important ways from what used to be known in the back rows of twin symposia as heritability-equals studies. In the social sciences randomized experimental control is generally impossible, and twins offer a useful method for quasi-experimental inference. If teenage mothers are economically disadvantaged at age 25, it may or may not be the case that early motherhood causes later poverty. If we can find identical twins discordant for teenage motherhood and compare their socioeconomic status at age 25, we control for important sources of familial (both genetic and environmental) confounding of the purported causal relationship. Social science genetics has also become deeply involved in questions of gene-environment interaction, the moderation of genetic influences on behavior by environmental differences, and vice versa.

You would never know any of this from reading *The Trouble With Twin Studies*. More than half of the book is taken up by the two most thoroughly worked-over topics in the history of nature-nurture debate: the equal environments assumption (EEA) and the Minnesota Study of Twins Reared Apart (MISTRA). These topics and their attendant arguments were complete in their current form 20 years ago. The EEA is the assumption that the environments of identical twins are no more similar than the environments of fraternal twins. Hundreds of thousands of words have been spilled about the EEA already, arguments and counter-arguments and counter-counter-arguments no one should have to slog through, so I will save you some time: The EEA is false, but it doesn't really matter. Statistical assumptions are always false, and who—behavior geneticists, of all people—could imagine that having identical genomes would not influence parents to treat MZ twins more similarly? Worries about the EEA might well give pause to the cathedral builders as they record the enormous tables of heritabilities calculated to three decimals. The EEA is one reason (among many others) not to fetishize the values of heritability coefficients, just like the assumption of homoscedasticity is a reason not to fetishize the value of ordinary regression coefficients. Heritability isn't zero; it isn't one.

The argument about MISTRA is similar in many ways. MISTRA was conceived in the heyday of binary nature-nurture thinking, and the persistent, undeniable correlations between the separated identical twins were taken as evidence of a victory of "genes" over "environment" by its founder Thomas Bouchard. But were the twins really perfectly separated, without contact, and raised in absolutely independent family environments? Of course they weren't, and there is actually perfectly good evidence (published by the MISTRA investigators themselves) to that effect. In Johnson et al. (2007), an analysis of the 42 ability measurements collected in MISTRA, separated DZ twins were more than half as correlated as separated MZ twins for 29 of them, and they were actually more highly correlated for five. DZ twin correlations that are more than half the corresponding MZ correlations are evidence of shared environment, which in this instance suggests a correlation between the environments of the separated twins. Joseph has a point here, but he ignores the most

interesting implications of his own argument because they are insufficiently absolute. Evidence of the potency of the environment in the notoriously hereditarian MISTRA? That is an interesting possibility, but taking it seriously would also entail considering the fact that the MZ pairs were more similar than the DZ on 37 of those 42 tests, mostly by a wide margin. It should not be so hard to come to grips with it: MISTRA comprises both genetic and environmental effects. Heritability is not zero; it is not one.

Although there may be little new to say about twin studies, technological advances in genomics do offer fresh opportunities. The most important way that behavior genetics has moved on from old-fashioned heritability estimation is via the analysis of measured DNA. For the entire standard roster of heritable human traits, from height to personality, it is now possible to search for the individual units of DNA composing genetic effects previously observed at a distance in covariances among family members. To a quite remarkable extent, it has proven impossible to find anything, a phenomenon known as the missing heritability problem. Scientists have not identified a single gene that would meet any reasonable standard as a "gene for" schizophrenia, intelligence, depression, or extraversion. What can that possibly mean?

The Trouble With Twin Studies, needless to say, has only one answer available: It means that none of these traits were really heritable in the first place. This conclusion is wrong on so many levels; it is difficult to know where to begin. As usual, there is the height problem. There are no genes of large effect for height any more than there are for schizophrenia. Do we conclude that genetic transmission of height is an illusion? If we do not, then we need to take seriously the possibility that the genetic architecture of complex traits is such that heritability can be observed in the absence of individual genes with biologically meaningful main effects. Moreover, *The Trouble With Twin Studies* simply ignores the most recent developments, such as the now numerous statistical "hits" in large-scale genome-wide association studies of height, schizophrenia, and even educational attainment. The effects are still tiny, they still don't explain much of the total heritability, and they still lack biological substance; but, balancing such considerations against their established statistical reliability would involve conceding that genes and complex traits are related in some way. *The Trouble With Twin Studies* cannot make that concession, and it retreats yet again into absolutism.

Finally, there is genome wide complex trait analysis (GCTA), which uses genomic data to estimate background genetic relatedness among the genetically unrelated. (It is good to be reminded that we are all related.) Those low-level genetic relations can be used to estimate heritability coefficients *with no twins and no EEA*. GCTA heritabilities are lower than twin heritabilities, variably so, for reasons that are not fully understood. But except for a couple of rare exceptions they aren't zero. GCTA presents deep challenges to the idea that the EEA is the only reason MZ twins are more similar than DZ twins. Of course, GCTA involves its own statistical and biological assumptions, and there is still no reason to reify heritability coefficients, but it is one more piece of evidence of an amorphous genetic background to even the most complex human individual differences. How does *The Trouble With Twin Studies* analyze the situation? It doesn't: It finds the two traits in a single study for which GCTA heritability did come out to be zero, and it declares the matter closed.

The last chapter of the book is a parable about house fires. Joseph imagines a town in which houses are made out of different kinds of wood, building materials standing in for genes. The town is threatened by marauding bands of arsonists, representing environmental

threats. Civic leaders waste time computing flammability coefficients representing percentage of fire variance accounted for building materials, while giving the arsonists free rein. The book closes with a plea to mind the arsonists who are the real threat, the leverage point where something can actually be done. It's a nice story, but do you notice something? It completely undermines Joseph's own argument. I mean, if you lived in a community under constant threat from arsonists, mightn't you have some interest in a house made of relatively fireproof materials? Like all the rest of *The Trouble With Twin Studies*, the parable lays the groundwork for reasonable arguments: Don't let fascination with the genome blind you to environmental effects, beware blunt determinism or reductionism, mind the complexities of causal systems, and embrace interactionism. But this book permits no such subtlety. It wants the easy comforts of the preached-to choir, the shallow satisfaction of imagining the other side to be stupid or villainous.

What could possibly cause someone like Jay Joseph, with potent rhetorical skills and detailed knowledge of the history and methods of behavior genetics, to conclude his book with an extended example that so transparently undermines his own position? The answer, I think, is to be found in a response to the question with which this review began: How could reasonable people differ so absolutely about the meaning of a body of empirical evidence? That response is: It is not a given that both sides of every argument are being reasonable. In the final analysis, this book is not reasoning forward from a known set of facts, seeking their explanation; it is confabulating backwards from a fixed conclusion, eliding any segments of the evidence that don't lead to the preordained destination. *The Trouble With Twin Studies* is science denial.

References

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