

Poor Instruments Lead to Poor Inferences: Comment on Roberts, Glymour, and Koenen (2013)

Drew H. Bailey · J. Michael Bailey

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Roberts, Glymour, and Koenen (2013) reported results of an empirical study concerning the nature of the association between childhood sexual abuse and adult homosexuality. Sexual contact with adults (including childhood sexual abuse) is especially common among young people who will become homosexual adults; the association is robust and worthy of empirical attention. A number of hypotheses, some of which posit that childhood sexual abuse causes adult homosexuality and some of which do not, are consistent with the correlation. The study by Roberts et al. attempted to test the hypothesis that childhood sexual abuse is a cause of adult homosexuality. The study had an admirably large and representative sample, and it employed the sophisticated statistical methodology of instrumental variables regression, which can under some circumstances provide good evidence for causation using correlational data. Indeed, Roberts et al. concluded from their analyses that “childhood maltreatment,” including sexual abuse, causes adult homosexuality, with the effect of sexual abuse being especially strong for males.

Unfortunately, Roberts et al. have applied instrumental variables regression inappropriately, and their analysis cannot plausibly provide good evidence that childhood sexual abuse causes adult homosexuality. The primary defect of their analysis concerns their choice of instruments: presence of a stepparent, poverty, parental alcohol abuse, and parental mental illness.

Editor’s note: I asked Dr. J. Michael Bailey, one of the referees for the Roberts et al. (2013) article, to provide a commentary, to which he kindly agreed and penned with his son, Dr. Drew H. Bailey.

D. H. Bailey
Department of Psychology, Carnegie Mellon University,
Pittsburgh, PA, USA

J. M. Bailey (✉)
Department of Psychology, Northwestern University, Evanston,
IL 60208, USA
e-mail: jm-bailey@northwestern.edu

Roberts et al. claimed that these instruments are equivalent to “natural experiments” and assert that they may be used in instrumental variables analyses because they are “not known to be influenced by or to directly influence nascent sexual orientation” (p. 162). Belief in the reasonableness of this equation—of presence of a stepparent, poverty, parental alcohol abuse, and parental mental illness with “natural experiments”—is certainly a prerequisite for having any faith in the analyses provided by Roberts et al. But it is not a reasonable equation. The gist of the critique that we elaborate herein is that thinking of variables, such as presence of a stepparent, poverty, parental alcohol abuse, and parental mental illness as comprising natural experiments violates the common understanding of “natural experiment,” is inconsistent with some facts already known about sexual orientation, and contrasts sharply and unfortunately with the most admired and widely accepted applications of the instrumental variables approach. Not only do Roberts et al.’s results fail to provide support for the idea that childhood maltreatment causes adult homosexuality, the pattern of differences between males and females is opposite what should be expected based on better evidence, including evidence that relies on what are much more plausibly considered “natural experiments.”

Instrumental Variables Regression and “Natural Experiments”

This statistical technique, most often employed by economists, is an unusual one for the readers of *Archives of Sexual Behavior*. Because our complaint is that Roberts et al. have performed an incorrect instrumental variables analysis, we provide somewhat more background than they did on what a successful instrumental variables analysis would comprise. Instrumental variables regression is intended to investigate whether correlations between putative causes and putative effects are indeed causal in cases where there are likely confounds. In this case, childhood

maltreatment is the putative cause and adult sexual orientation is the putative effect. In general, though, let us designate the putative cause as X, the putative effect as Y, and the instrument as Z. A good instrument is a variable that affects X and can only plausibly be related to Y if X causes Y.

In a classic example employing instrumental variables regression, Angrist and Krueger (1991) tested whether years of schooling affects economic success (i.e., income). The correlation alone between these variables cannot be taken as evidence of this proposed causal model. Ability factors (such as intelligence and conscientiousness) are confounds, because they likely affect both educational and economic attainment. Angrist and Krueger used an ingenious instrument, quarter of birth (i.e., January–March, April–June, July–September, October–December). Because of common laws governing minimum ages for entry into school and dropping out, there was a small but robust correlation between birth month and years of education for the cohort of American men they studied. On average, men born in the first quarter of the year had slightly less education (about one tenth of one year) compared with men born later in the year. Men born later in the year had a small parallel advantage (0.1 %) in their income. We agree with Angrist and Krueger that this provides good evidence that educational attainment affects economic attainment, because we agree with their argument that because birth quarter is “probably unrelated to the person’s innate ability, motivation or family connections (ruling out astrological effects), date of birth should provide a valid instrument for schooling” (p. 74). We also agree with their argument that “the combination of school start age policies and compulsory schooling laws creates a natural experiment in which children are compelled to attend school for different lengths of time depending on their birthdays” (p. 74).

That classic study provides a near-unassailable example of a “natural experiment” conducted using instrumental variables regression. Angrist and Krueger were very clever to think of the birth quarter instrument. How does one generally decide on an instrument? Because the validity of instrumental variables results depends on the validity of assumptions about the instrument (especially that the instrument can affect the dependent variable *only* through the putative cause of interest), choice of instrument is both crucial and difficult. A valid instrument is often not (or more strongly, not often) available. Indeed, one statistician has recently suggested that the usual tactic of instrumental variables researchers is to first find a promising instrument and search for interesting phenomena for which it can plausibly be a valid instrument and natural experiment (Gelman, 2009).

Calling an Instrument a “Natural Experiment” Does Not Make It So

Let us now consider the instruments of Roberts et al. They are good instruments only if, as Roberts et al. argue, presence of

a stepparent, poverty, parental alcohol abuse, and parental mental illness are unlikely to be related to adult sexual orientation except through their effects on childhood adversity. This means not only that the instruments must affect adult sexual orientation only through childhood adversity but that the instruments must not plausibly be related to adult sexual orientation for any reason other than via their causing childhood adversity and childhood adversity affecting adult sexual orientation. Note that in contrast to Angrist and Krueger’s birth quarter instrument, the instruments of Roberts et al. are extraordinarily complex in both their causes and effects. This means that there is a plethora of possible confounds that might account for any association between the instruments and adult sexual orientation. Indeed, referring to Roberts et al.’s instruments as “natural experiments” (as they do several times) violates the intended meaning of that phrase.

Roberts et al. contrasted two potential causal models. The first model posits that “nascent sexual orientation” causes gender nonconformity, childhood maltreatment, and adult minority sexual orientation. The second posits that the instruments (parental alcohol problem, childhood poverty, presence of a stepparent, and parental mental illness) affect the likelihood of childhood maltreatment, which causes adult minority sexual orientation. Roberts et al. settle on the latter model because of the observed relation between the instruments and adult minority sexual orientation. However, neither of these models considers the possibility that a third variable causes both the instruments and the adult minority sexual orientation. For example, genes predisposing parents to neuroticism, a potential cause of all of these instruments and abuse (for a review of links between neuroticism and consequential outcomes, see Ozer & Benet-Martínez, 2006), may also increase the likelihood of adulthood minority sexual orientation: Zietsch, Verweij, Bailey, Wright, and Martin (2011) found a genetic correlation, but no environmental correlation, between sexual orientation and neuroticism. Even in a study that found a small but statistically significant environmental correlation between depression and homosexuality (Zietsch et al., 2012), the majority of the phenotypic correlation could be attributed to genetic factors. Because shared genes may affect the instruments, childhood maltreatment, and adulthood minority sexual orientation, the assumptions of the instrumental variables regression approach are likely violated. Finally, if we assume, as Roberts et al. conclude, that childhood experiences shape adult sexual orientation, environmental conditions that contribute to the instruments and childhood maltreatment may also contribute to adult minority sexual orientation. Therefore, Roberts et al.’s conclusions are questionable whether or not childhood experiences influence adult sexual orientation. Their instruments are simply inadequate to provide a good test of the main hypothesis.

The method of instrumental variables is an ingenious technique, but its ability to yield valid results largely depends on the availability of an unassailable instrument. The instruments chosen by Roberts et al. do not approach adequacy.

Statistical versus Causal Mediation

Roberts et al. found that the instruments were not significantly related to adult sexual orientation after controlling for childhood maltreatment (p. 167), which is to say that childhood maltreatment statistically mediated the effects of the instruments on adult sexual orientation. One interpretation of this effect is that the only possible way that the instruments could affect adult sexual orientation is through childhood maltreatment. However, again, it is impossible to differentiate this model from a more plausible one in which childhood maltreatment does not cause adult sexual orientation.

An assumption of mediation analysis is that the mediator (in this case, childhood maltreatment) cannot be caused by a third variable that also affects the dependent variable, adult minority sexual orientation (Green, Ha, & Bullock, 2010). This is clearly problematic. In fact, one causal model Roberts et al. considered was one in which nascent sexual orientation affects both childhood maltreatment and adult minority sexual orientation. Roberts et al. rejected this model not because of evidence against the hypothesis that nascent sexual orientation affects childhood maltreatment, but because the instruments were correlated with adult minority sexual orientation. However, nascent sexual orientation could easily be related to the instruments, but more strongly and directly with childhood maltreatment and adult minority sexual orientation. Childhood maltreatment and adult minority sexual orientation both involve the participant, whereas the instruments are more directly caused by the participant's family members' characteristics. Therefore, if a third variable (e.g., genetic factors) accounts for the co-variation between the instruments, childhood maltreatment, and adult minority sexual orientation, it will be likely to more similarly affect the latter two variables than the former. Again, this criticism does not depend on the assumption that childhood experiences do not affect sexual orientation. Children may be more similar to themselves than to their parents for genetic, non-social (e.g., prenatal) environmental reasons or because of early childhood experiences. Demonstrating statistical mediation falls far short of demonstrating causal mediation (Green et al., 2010). There are an infinite number of alternative models in which statistical mediation can occur without true causal mediation, because the former depends simply on a fortuitous pattern of correlations.

Sex Differences

Roberts et al.'s analyses yielded stronger results for males than for females, suggesting, if true, that childhood adversity, especially sexual abuse, has a stronger effect on males' than on females' sexual orientations. This result is opposite expected from both current influential theory and the most telling empirical data.

One currently accepted generalization about gender differences in sexual orientation is that women's sexual orientation is more socially influenced and malleable, while men's is more rigidly directed and fixed (Bailey, 2009; Baumeister, 2000; Diamond, 2009). One potential explanation is that most men have sexual arousal patterns that are category specific (i.e., that match their sexual orientations). In contrast, heterosexual women tend to have bisexual arousal patterns, and lesbians are less category specific compared with heterosexual men (Bailey, 2009). Because women's sexual orientations are not directed by a strongly differentiated pattern of sexual arousal, their sexual orientations are more potentially responsive to external factors compared with men's. Regardless of the validity of this explanation, based on sex differences in the phenomenology of sexual orientation, we would expect that women's sexuality would be more responsive than men's to experiences such as childhood adversity. Of course, we could be wrong, as could the other scientists whose work supports our intuition. But the body of work that supports it is an extensive one that would require compelling refutation.

There is compelling evidence that male sexual orientation is fixed early in development, probably before birth and certainly before childhood adversity could plausibly affect it. This evidence comes from cases in which a hormonally normal male infant has been reassigned and reared as a female, due to either congenital abnormality (e.g., Reiner & Gearhart, 2004) or surgical accident (e.g., Bradley, Oliver, Chernick, & Zucker, 1998). In the few cases that have been followed to sexual maturity, every single one is best characterized as having a gynephilic outcome, consistent with causal influences during prenatal development but not during postnatal rearing. If early gender reassignment does not affect a male's eventual sexual orientation, how likely is it that much later childhood adversity does affect it?

Conclusion

Roberts et al. attempted to test for a causal link between childhood maltreatment and adult sexual orientation using instrumental variables regression, an approach that takes advantage of natural experiments to clarify causal relationships between variables. However, their choice of instruments that depend on personal characteristics rather than chance precludes the study from being classified as a natural experiment, rendering their approach unsuitable for answering the research question. Previous research is inconsistent with the hypothesis that childhood experiences play a significant causal role in adult sexual orientation, especially in men, indicating that the prior odds for Roberts et al.'s hypothesis are low. Furthermore, because of a fatal methodological flaw in Roberts et al.'s study, we argue that these odds need not be updated.

The question of why sexual contact with adults (including childhood sexual abuse) is especially common among young people who will become homosexual adults is an important one. Childhood sexual abuse and the etiology of homosexuality are politically sensitive topics, and we commend Roberts et al. for publishing their potentially controversial results. We hope that this debate sparks future research on this topic and informs sexuality researchers about instrumental variables regression in the study of causation.

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