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A Twin Study of Sexual Behavior in Men[1]

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The role of genetic and environmental influences on age of initiation of first sexual relations and engaging in sexual activity with multiple partners (10 or more partners in 1 year) was investigated in male twins ($N = 6,744$) from the Vietnam Era Twin Registry. Individual differences in both types of sexual behaviors were heritable, but only age of onset of sexual relations was significantly influenced by the environment shared by the twins. There was a moderate negative correlation between age of initiation of sexual relations and the multiple partners variable; initiating sexual relations earlier was associated with a higher probability of having multiple partners. The additive genetic influence on age of initiation also influenced the multiple partners variable. The substantial unique environmental influences on each variable were uncorrelated with each other. The data suggest that the observed association between age of initiation of sexual relations and having multiple partners is due to genetic influences common to both behaviors.

KEY WORDS: sexual behavior; multiple sexual partners; twins; genetics.

INTRODUCTION

In the past decade, the question of how much sexual behaviors are influenced by genetic versus environmental factors has been the subject of much debate (Bailey, Kirk, Zhu, Dunne, & Martin, 2000; Haynes, 1995; Pillard & Bailey, 1998; Pool, 1993). The persistence of homosexuality, despite strong cultural opposition and apparent selection disadvantages, has been cited as evidence for the role of genetic influences and made it the focus of most previous genetic studies of human sexual behavior. Less is known, however, about the relative contributions of genetic and environmental factors to other aspects of sexual behavior such as age of initiation of sexual activity and engaging in sexual activity with multiple partners, or about whether these sexual behaviors share genetic or environmental influences. Behavioral genetic studies provide one way of examining the relative contributions of these influences to various types of sexual behavior and to the relationship between these behaviors.

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Numerous studies have provided evidence for environmental influences on sexual behavior. Children from divorced families have been shown to become sexually active at an earlier age and to have more sexual partners (Amato, 1996; Booth, Binkerhoff, & White, 1984; Furstenberg & Teitler, 1994; Gabardi & Rosen, 1992; Glenn & Kramer, 1987). Family structure variables have been found to be related to age at first intercourse, with adolescents from single-parent families more likely to initiate intercourse at younger ages (Miller & Moore, 1990). Higher levels of parental monitoring behavior have been found to be associated with later age of first intercourse (Capaldi, Crosby, & Stoolmille, 1996; Miller, McCoy, Olson, & Wallace, 1986; Small & Luster, 1994) and having fewer partners (Rodgers, 1999). Higher levels of self-reported "parent–family connectedness" (Resnick et al., 1997) and higher levels of self-reported satisfaction with relationship with ones mother (Jaccard, Dittus, & Gordon, 1998) were associated with older age at first intercourse and fewer sexual partners. The strongest psychosocial predictor of early onset of sexual activity has been adolescent participation in deviant or "adult-like" behaviors, such as alcohol and drug use and delinquency (Jessor & Jessor, 1977; Rosenbaum & Kandel, 1990; Whitbeck, Yoder, Hoyt, & Conger, 1999; Yamaguchi & Kandel, 1987). Low educational aspirations and poor school attachment have been associated with early sexual behavior (Hayes, 1987; Lammers, Ireland, Resnick, & Blum, 2000; Small & Luster, 1994). There have also been secular trends in the initiation of sexual relations. Age of first intercourse has been declining for men since the 1930s with the majority of men who reached sexual maturity during the 1960s having their first intercourse before age 18 (Laumann, Gagnon, Michael, & Michaels, 1994).

The genetic influence on the age of first sexual intercourse has been addressed by several twin studies. Dunne et al. (1997) and Martin, Eaves, and Eysenck (1977) found evidence for a genetic contribution in determining the age of first sexual intercourse. However, these studies obtained conflicting results with regard to the direction of the relation between age cohort and the magnitude of genetic influence. Recently, Dunne et al. (1997) found that with more relaxed cultural attitudes toward sexuality, genetic influences on age of initiation of sexual activity have gained importance. These results contradicted previous findings that genetic influence on early sexual intercourse was probably greater among older than among younger twins (Martin et al.,1977). A study using data from the National Longitudinal Study of Youth found that both genetic and nonshared environmental influences were important determinants of age of first sexual intercourse among male–male twin pairs (Rodgers, Rowe, & Buster, 1999). Miller et al. (1999) reported that allelic variation in genes that code for dopamine receptors added significant variance to a regression model predicting age at first intercourse using nine psychosocial variables.

Epidemiological studies suggest that the number of men engaging in sex with multiple partners over a given year has been influenced by changing cultural ideas about sexuality. Data suggest that the percentage of men engaging in intercourse with more than five partners during a given year increased during the "sexual revolution" of the late 1960s and early 1970s and began to decrease following public awareness of the AIDS epidemic starting in the 1980s (Laumann et al., 1994). To our knowledge, we are aware of only one twin study that has examined genetic influences on engaging in sexual activity with multiple partners; this study found no significant genetic influence on the number of opposite- or same-sex sexual partners for men (Hershberger, 1997).

In this paper, we use a large sample of male–male twins from the Vietnam Era Twin Registry (VETR) to examine the relative contribution of genes, the family environment, and aspects of the environment that are not shared by both members of twin pairs to sexual behavior. Specifically, we were interested in the extent to which these factors influence individual differences in the age of initiation of sexual relations and having multiple partners. By using data from a twin registry, we hoped to avoid certain sampling biases associated with alternative methods of sample ascertainment. Data collected from clinical samples or volunteer samples may be biased by characteristics associated with being in treatment or associated with the probability of volunteering for participation, respectively. Additionally, we were interested in examining genetic and environmental influences responsible for any observed association between these two sexual behaviors.

METHOD

Participants

The Vietnam Era Twin Registry consists of male twin pairs in which both twins served in the military during the Vietnam Era (May 1965 – August 1975). Members of the Registry were born between 1939 and 1957. The Registry was constructed using computerized files from the Department of Defense. Further information about the method of assembling the Registry has been detailed elsewhere (Eisen, True, Goldberg, Henderson, & Robinette, 1987; Henderson et al., 1990). Zygosity was evaluated by using a series of questions on twin similarity and limited blood group typing obtained from the military records (Eisen,

Neuman, Goldberg, Rice, & True, 1989). This method has been demonstrated to achieve 95% accuracy (Eisen et al., 1989). Of the total Registry, 43.8% were identified as dizygotic (DZ), 53.5% as monozygotic (MZ), and 2.7% could not be identified as to zygosity; the last group was excluded from further analysis. The relative overrepresentation of MZ pairs is due to the absence of opposite sex DZ pairs.

Of 5,150 eligible pairs, 47 individuals were deceased or incapacitated. Of the remaining cases, 8,169 (79.6%) were successfully interviewed by telephone. The 1,874 MZ and 1,498 DZ pairs in which both members responded to the relevant items are the subject of this report (pairwise response rate = 66.1%). The mean age of respondents was 44.6 years ($SD = 2.8$; range, 36–55 years); 90.4% were non-Hispanic White, 4.9% African American, 2.7% Hispanic, 1.3% Native American/Alaskan Native, and 0.7% "other"; 33.3% were high school graduates and 38.6% college graduates; 92.6% were employed full time and 1.8% part-time. The response rate was higher for non-Hispanic White twins than for any other group and resulted in their relative overrepresentation among respondents compared to all veterans of the Vietnam era. Seventy-five percent were married at the time of a 1987 survey, which was the first study of VET Registry members (Eisen et al., 1989), 11% were never married, and 77% had fathered at least one child.

Procedure

Data reported in this paper were collected during the years 1991 through 1993 as part of the Harvard Twin Study of Drug Abuse. The goal of the study was to investigate genetic and environmental influences on psychopathology and substance abuse. Numerous papers have been published reporting results of that study (for a recent summary of findings regarding substance abuse, see Tsuang, Bar, Harley, & Lyons, 2002). Participants were sent a letter that explained, in general terms, the purpose of the study and informed them that they would be receiving a call from an interviewer. One to two weeks after the letter was sent, an interviewer called the participant, explained the procedure, and solicited his consent to participate. The interview was administered following the granting of consent. This method of obtaining consent and other study procedures were approved by the relevant institutional review board.

Participants were interviewed using a structured psychiatric interview, the NIMH Diagnostic Interview Schedule Version III Revised (DIS-III-R; Robins, Helzer, Cottler, & Goldring, 1989). Interviews were administered by telephone, using a computerized version of the interview. Data were collected by the Institute for Survey Research, Temple University. All interviewers were trained and experienced in telephone interviewing techniques. The initial training of the interviewers was conducted by one of the investigators (MJL). The supervisor of the interviewers attended a DIS-III-R training course at Washington University conducted by the developers of the interview. It was not feasible to conduct face-to-face interviews because of the nationally distributed nature of the sample. Several studies have provided evidence for the comparability of telephone and computerized DIS administration to face-to-face administration (Erdman et al., 1992; Levitan, Blouin, Navarro, & Hill, 1991; Watson, Anderson, Thomas, & Nyberg, 1992; Wells, Burnam, Leake, & Robins, 1988). Participants were asked the following questions from the DIS-III-R: (1) "How old were you when you first had sexual relations?" (Item R-69); and (2) "Have you ever had sex with as many as ten different people within a single year (including your wife)?" (Item R-78). No additional definition of the terms "sexual relations" and "had sex" was provided to participants. Our assumption was that the large majority of participants interpreted this as we had intended to refer to sexual intercourse, but we cannot test the validity of this assumption. To the extent that the ambiguity of the terminology contributed to unreliability of measurement, the true extent of genetic and/or family environmental influences would be underestimated.

Data Analysis

The basic approach of the twin method is to compare the degree of similarity within MZ twin pairs to the degree of similarity within DZ twin pairs. One method for quantifying similarity for dichotomous characteristics is the concordance rate. The probandwise concordance rate is calculated by dividing twice the number of concordant pairs by the number of pairs in which one or both twins has the phenotype of interest plus the number of concordant pairs. This statistic provides rates that are comparable to risk rates from other types of family pairings or population prevalence figures (McGue, 1992). In the present study, probandwise concordance rates were calculated for the dichotomous phenotype of having sex with 10 or more people in one year. Odds ratios were also calculated.

The concordance rate does not use all available information because only pairs in which at least one member is affected are included in its calculation. However, the tetrachoric correlation, calculated from the 2×2 contingency table, is an alternative approach for dichotomous outcomes that uses all available information about the

resemblance within twin pairs. Pairs that are concordant for being unaffected as well as affected are included in its computation. The tetrachoric correlation is also known as the correlation of liability (Falconer, 1965). The polychoric correlation is used for variables with more than two levels, such as age of initiation of sexual behavior. The significance of the correlations assessing the similarity within twin pairs irrespective of zygosity, tests whether the outcome is familial.

The next step in the statistical analyses tested whether genetic effects or family environmental effects alone are responsible for observed familial similarity. The analysis fits univariate structural equation models to the contingency tables separately for MZ and DZ twin pairs. These models explain the twin similarity for liability (i.e., the tetrachoric and polychoric correlations) in terms of additive genetic effects (heritability or h^2); common, shared, or family environmental effects (c^2); and unique or nonshared environmental effects (e^2). Parameters are estimated by the method of maximum likelihood using the MX software package (Neale & Cardon, 1992). The process begins with a full model including the effects of h^2, c^2, and e^2. The term e^2 reflects influences that are specific to individuals rather than the pair and random error; these influences promote dissimilarity within pairs. The full model is compared with reduced models that delete either additive genes or common environment. Models *without* additive genetic effects test whether the twin correlation is due solely to common environmental influences; alternately, models *without* common environmental effects test whether familial aggregation is due solely to additive genetic effects. Models that include only e^2 test for an absence of family resemblance. Models with e^2 only are not presented, because all analyses demonstrated familial resemblance. To assess whether a submodel fits the data worse than the full model, a chi-square difference test is used. This test evaluates the difference in the chi-square of the full versus the reduced model and is distributed as chi-square with degrees of freedom equal to $df_{\text{reduced}} - df_{\text{full}}$. If this test statistic is not significant, the reduced model is accepted as the more parsimonious explanation of the observed results.

Just as the univariate structural equation modeling described above is used to decompose the sources of variance within a single behavior, bivariate modeling is used to decompose the genetic and environmental influences on two behaviors as well as the correlation between the two behaviors. A full bivariate model includes nine parameters that estimate: (1) genetic effects that are specific to Behavior 1; (2) genetic effects that influence both Behavior 1 and Behavior 2; (3) genetic influences that are specific to Behavior 2; (4) common environmental effects that are specific to Behavior 1; (5) common environmental effects that influence both Behavior 1 and Behavior 2; (6) common environmental influences that are specific to Behavior 2; (7) unique environmental effects that are specific to Behavior 1; (8) unique environmental effects that influence both Behavior 1 and Behavior 2; and (9) unique environmental influences that are specific to Behavior 2. In the interest of parsimony, we fitted alternative models that deleted parameters that were not statistically significant (i.e., their 95% confidence interval included 0) in the full model. To assess whether the reduced model fits the data worse than the full model, a chi-square difference test is used. The difference in the chi-square of the full versus the reduced model is distributed as chi-square with degrees of freedom equal to $df_{\text{reduced}} - df_{\text{full}}$. If this chi-square is not significant, the reduced model is accepted as the more parsimonious explanation of the observed results.

RESULTS

Table I contains the results for the age of first sexual relations. The sample was divided into eight categories; we excluded 1.1% of the sample who had missing data or reported never engaging in sexual relations. About half the sample reported first sexual relations at age 17 years or earlier and about half at age 18 or later.

The prevalence of reporting having had "multiple partners," that is, having sex with 10 or more people during a single year was 16.7%. The probandwise concordance rate for multiple partners was 36.9% in MZ twins and 26.1% in DZ twins. The difference between these rates demonstrated a statistically significant genetic influence ($p < .001$). The odds ratio indicated that if one MZ twin had multiple partners the odds that his co-twin also had multiple partners was 4.8 ($p < .001$) times greater that the odds for MZ co-twins of individuals who never had multiple partners. If one DZ twin had multiple partners, the odds that his co-twin had multiple partners was double

Table I. Age of First Sexual Relations

Age of initiation	Percentage of sample
Before age 12	2.1
12–15 years	14.7
16 years	13.2
17 years	14.6
18 years	16.3
19 years	11.7
20–21 years	15.6
After 21 years	10.7
Never/missing	1.1

Table II. Correlations Among Age of Initiation and Multiple Partners for MZ and DZ Pairs

	Age of initiation: Twin 1	Multiple partners: Twin 1	Age of initiation: Twin 2	Multiple partners: Twin 2
DZ twins				
Age of initiation: Twin 1	—			
Multiple partners: Twin 1	−.39	—		
Age of initiation: Twin 2	.44	−.25	—	
Multiple partners: Twin 2	−.19	.24	−.38	—
MZ Twins				
Age of initiation: Twin 1	—			
Multiple partners: Twin 1	−.42	—		
Age of initiation: Twin 2	.60	−.37	—	
Multiple partners: Twin 2	−.36	.49	−.43	—

Note. All correlations were $p < .001$.

the odds ($p < .001$) of DZ co-twins of individuals who never had multiple partners. Thus, there was a large and statistically significant difference in the odds ratios for MZ versus DZ twins ($p < .001$), indicating a significant genetic influence on the probability of having multiple sexual partners.

Table II includes cross-twin same-trait, within-twin cross-trait, and cross-twin cross-trait correlation coefficients for age of initiation and multiple partners. The within-twin cross-trait or phenotypic correlations indicate the pattern of associations between different behaviors within the same individual. Table II contains the cross-twin polychoric correlations of MZ and DZ twins for the age of initiation variable and the cross-twin tetrachoric correlations for the multiple partners variable. The cross-twin same-trait correlations for MZ twins were significantly greater than those for DZ twins for each variable (both ps $< .001$). Univariate biometrical models were applied to the data. The best fitting model for the age of initiation variable indicated that 24% of the variance was attributable to additive genetic influences, whereas 34 and 42% of the variance was due to the common environment and the unique environment, respectively. The best fitting model for the multiple partners variable included significant contributions from additive genetic influences (49%). The common environment did not contribute significantly to individual variation in the multiple partners variable, but the unique environment did (51%).

Inspection of Table II indicates that there were moderate negative correlations between age of initiation of sexual relations and the multiple partner variable (−.39, −.38, −.42, and −.43). That is, beginning sexual relations at an earlier age was associated with a higher probability of having multiple partners. The cross-twin cross-trait correlations quantify the relationship between age of initiation in one twin and multiple partners in the other twin. For DZ twins, there was a modest relationship (−.19, −.25) and a somewhat more substantial relationship in MZ twins (−.36, −.37). The greater MZ than DZ cross-twin cross-trait correlations led us to fit models to explicate the nature of the relationship. The best fitting model included shared genetic influences on age of initiation and having multiple partners. The bivariate heritability for age of initiation and multiple partners was 40%. When we divided 40% by the phenotypic correlation between the two variables ($r = .41$), we found that almost 100% of the association between age of initiation and multiple partners was due to genes that influence both outcomes. The unique environmental influences on age of initiation were uncorrelated with those on multiple partners. Figure 1 presents the bivariate model fitting results in terms of the variance components for age of initiation and multiple partners.

DISCUSSION

Both of the sexual behavior variables demonstrated significant heritability. This indicates that about one quarter to one half of the observed variation in the sexual behaviors examined in this study is attributable to genetic differences among individuals. Additive genetic effects reflect the actions of a large number of genes, each of small effect, whose influences combine in an additive fashion to produce differences at the phenotypic level.

Only age of initiation of sexual relations was significantly influenced by the common or shared environment. These results are consistent with studies of adolescent sexual behavior that have found that family socialization (e.g., social learning) and biological factors (e.g., maturation) significantly influence age of first sexual intercourse for boys (Capaldi et al., 1996; Crockett, Bingham, Chopak, & Vicary, 1996; Halpern, Udry, Campbell, & Suchindran,

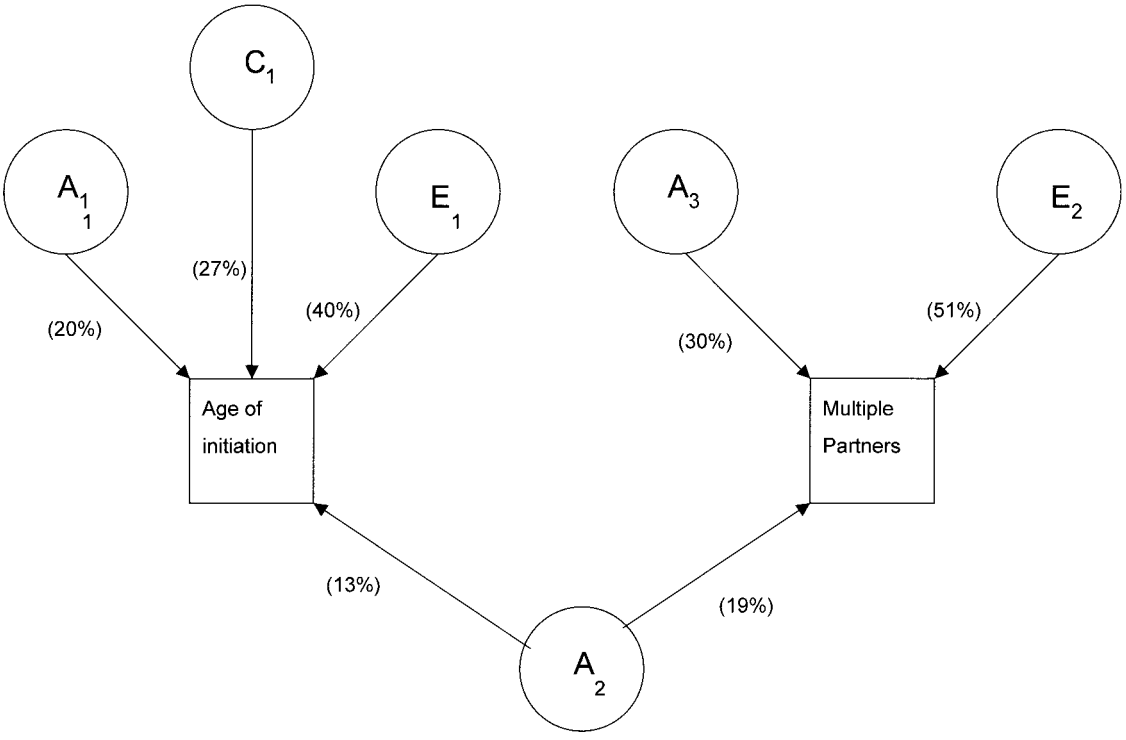

Fig. 1. Results of biometrical modeling of "age of initiation" and "multiple partners." A_1 = additive genetic influences specific to age of initiation; C_1 = common environmental influences specific to age of initiation; E_1 = unique environmental influences specific to age of initiation; A_2 = additive genetic influences that affect both age of initiation and multiple partners; A_3 = additive genetic influences specific to multiple partners; E_2 = unique environmental influences specific to multiple partners.

1993; Udry & Billy, 1987). The common environment would also reflect generational or cohort effects. For example, the age of first sexual relations is likely to be younger for men who graduated from high school in 1970 compared to those who graduated in 1959; however, having multiple partners was not influenced by the environment shared by the twins.

The role of family environment on some aspects of sexual behavior and not others might be explained, in part, by the age of onset of these behaviors. Age of first sexual relations was 18 years or younger for almost 60% of the participants, which suggests that many of the twins were probably living together in the same home when they had their first sexual experience. We do not have data about the ages when participants had sex with 10 or more people, but it may be that this occurred after leaving the family home for many participants. Therefore, the behavior most likely to have occurred while the twins were living together in the home of their family of origin is the behavior for which there is evidence of an influence from the shared environment; however, we do not have the data to confirm this speculation. These results indicate that family, school, and neighborhood characteristics shared by twins while they are growing up do not have a detectable influence on the probability of having sex with 10 or more people in a single year. Thus, the influence of the family environment on this aspect of sexual behavior that seems more likely to occur after the individual has left the family environment appears to be negligible. At the same time, aspects of the environment that are not shared by twins have a substantial influence on both sexual behaviors. This would include experiences that occurred during adulthood after the twins no longer lived together as well as childhood experiences that happened to only one of the twins.

Our results indicate that the observed relationship between age of initiation and multiple partners is due to overlapping genetic influences rather than aspects of the environment that influence both. That is, some of the genes that incline a man toward earlier initiation of sexual relations also increase the probability that he will have sex with 10 or more people during some year of his life. We did not detect any environmental influences that simultaneously influence both outcomes.

This study has several limitations that should be noted. Only males were included and, therefore, these findings cannot be generalized to females. It is also important to consider whether the telephone interview format may have produced different results than would have been obtained from face-to-face interviews. Although it is possible that face-to-face interviews may lead to slightly higher rates of reporting socially undesirable behavior, the results of many studies suggest that the results of telephone interviews seem to be generally comparable to those obtained in face-to-face interviews (Paulsen, Crowe, Nyes, & Pfohl, 1988; Sobin, Weissman, & Goldstein, 1993). We do not have information about the circumstances associated with having 10 or more sexual partners within 1 year; however, all of our participants are military veterans and, in some cases, the probability of having multiple sexual partners within 1 year might be associated with prostitution in the vicinity of the individual's duty station. We did not have data available that would allow us to control for this factor in our data analyses.

Despite these limitations, this study represents an increment in understanding the role of genetic and environmental influences on two aspects of sexual behavior. The sexual behaviors that we studied are very complex and almost certainly multiply determined phenomena. Using the methods of quantitative genetics, we have divided the determinants of these behavioral phenotypes into genetic, shared environmental, and unique environmental components. However, within each of these components, various different mechanisms may operate. For example, genetic influences on the age of initiation of sexual relations might be mediated by numerous independent genetic mechanisms. Initiating sexual activity will be influenced in part by physical maturation that in turn is influenced by genetic factors (Capaldi et al., 1996; Crockett et al., 1996; Halpern et al., 1993). Genetically influenced personality variables, such as novelty seeking and harm avoidance, may also influence the age at which sexual relations are initiated and the probability of having multiple partners. Future studies will need to examine the complex biological and cultural mechanisms underlying genetic and environmental influences on sexual behavior.

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