

Influences on homosexuality: Is it genetic?

A literature review

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Research Methods

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Introduction

The question of whether sexual orientation is biologically and genetically driven, or socially learned, has been a point of interest in sexual research and society dating back to the late 19th century. Sexual orientation (S.O.) can be defined as one's degree of sexual attraction towards people of the opposite or same sex. Various theories on the etiology of homosexual orientation range from certain psychodynamic hypothesis which state males became gay due to being distant from their fathers; to neuroendocrine hypothesis which suggest atypical levels of hormones in development; to behavioral genetics hypothesis which state homosexual orientation is influenced by genetic factors.

It was Kallmann's 1952 study of homosexuality in twins that sparked the belief that S.O. was not socially, but genetically driven. Kallmann found nearly 100% concordance for homosexual orientation in monozygotic (MZ) twins and about 10% concordance in dizygotic (DZ) twins. Over the decades since this published study, various researchers have attempted to prove or disprove his results.

Although twin studies have been generally consistent in indicating a genetic contribution to male and female S.O., several studies have suggested the true MZ concordance rate is less than 100%, and probably nearer 50%. In addition, most results of homosexual twin studies have been questioned due to methodological limitations. Therefore, this literature review will compare recent twin studies on homosexual orientation to test the research hypothesis that there is a higher concordance rate of

homosexual orientation in MZ twins versus DZ twins thus supporting the concept of a genetic and biologic contribution to S.O.

The research question

Is there a higher concordance rate for homosexuality in MZ twins versus DZ twins demonstrating a genetic contribution to sexual orientation?

Search methods

The search methods consisted of 3 main avenues: the Internet, the USF search engines, and references cited in research articles.

The Internet

Using the World Wide Web, the websites for the American Psychiatric Association and the American Medical Association were searched. Both sites had search engines for their respective journals (the American Journal of Psychiatry and the Journal of the American Medical Association). Key words such as homosexuality, sexual orientation, and genetics were used. Titles of articles, which were referenced from these key words, were perused. One to two articles on homosexuality in twins were found and used.

The USF search engines

Through the USF search engine PubMed, abstracts of articles were obtained using key terms homosexuality, sexual orientation, and genetics. Due to PubMed's database including the National Library of Medicine, several journal abstracts pertaining to

homosexuality in twins were located. Due to the limited resources of journals available at USF, all of the articles were found in journals located at the science library of UCSF.

References from articles

Once articles on homosexuality in twins were obtained, the references of each article were reviewed for additional resources. A couple more articles were obtained with this search method.

Inclusionary and exclusionary criteria

Due to the limited amount of articles available for this literature review, most of the articles available on S.O. in twins were used. The main inclusionary criterion was that the study needed to compare S.O. in MZ and DZ twins in a longitudinal, population survey. The main exclusionary criterion was articles published before 1990 in order that more recent data and methodologies could be compared. A total of six articles were used for this review based on the above mentioned search methods and criteria, as well as article accessibility.

Data summary

Study	Random Sampling	M and F MZ twins- 1 twin gay	M and F DZ twins- 1 twin gay	Homosexual Concordant MZ Twins	Homosexual Concordant DZ Twins
Bailey, 2000	No	Not given	Not given	20% M 24% F	0% M 10.5% F
Kendler, 2000	Yes	19	24	6 pairs 31.6%	2 pairs 8.3%

Whitman, 1993	No	38	23	25 pairs 65.8%	7 pairs 30.4%
Bailey, 1991	No	56 Male only	54 Male only	29 pairs 52.0%	12 pairs 22.0%
Bailey, 1993	No	71 Females	37 Females	34 pairs 48.0%	6 pairs 16.0%
King, 1992	No	20	25	5 pairs 25.0%	3 pairs 12.0%

Analysis of article 1

Article: Genetic and Environmental Influences of Sexual Orientation and Its Correlates in an Australian Twin Sample

Theoretical framework: This article describes two different theoretical frameworks: the neurohormonal and behavioral genetics theories. The neurohormonal theory refers to homosexuals having sex atypical neural differentiation caused by atypical levels of hormones in development. The behavioral genetics theory, which is the theory for this study, states that S.O. is familial due to genetic or shared environmental factors. The results did support the framework that S.O. is familial, but the importance of genetic factors was not significant statistically.

Research design: The research design was a nonrandom, longitudinal, voluntary population survey from the Australian Twin Registry assessing the subjects S.O. and 2 related traits: childhood gender nonconformity (CGN) and continuous gender identity (CGI). Since not all of the articles in this review assessed CGN and CGI, this review will limit the discussion to the results of S.O. of MZ and DZ twins. The design also defined S.O. using the Kinsey scale. This scale ranges from 0 (exclusively heterosexual) to 6

(exclusively homosexual). Therefore, there are two sets of results for this study using two different criteria for non-heterosexuality.

Sampling methods and selection of subjects: The **target population** was MZ and DZ twins. The **accessible population** was 9,112 twins who voluntarily belonged to the Australian National Health and Medical Research Council Twin Register (ATR). The **sampling plan** is a nonprobability, convenience plan. This plan consisted of asking the 9,112 ATR twins who completed a postal health and lifestyle survey about their willingness to receive a questionnaire regarding sex.

Size: The twin pairs who participated include 312 male MZ, 182 male DZ, 668 female MZ, and 376 female DZ pairs. The **characteristics** of the sample are as follows:

- Overrepresentation of women and MZ twins
- Generally having more liberal sexual attitudes than nonresponders
- Median age for men and women was 29 years old
- Diverse religious affiliations and social attitudes
- Personality and depression of sample were representative of the Australian population

The **potential biases** are as follows:

- The nonresponse rate was 28%. In an analysis of those who agreed to participate versus nonresponders, there was some indication of a participation bias. Those who agreed to participate had more liberal sexual attitudes, more novelty-seeking and less harm-avoidant personalities, an earlier age of first sexual intercourse, and

- a greater likelihood of childhood sexual abuse than those who refused to participate.
- In the ATR, there are a disproportionate number of young women and people with higher than average levels of education. This caused the sample to be over representative of women and MZ twins.
 - The ATR participants for this study were recruited from two phases of a large twin-family study of alcohol use and abuse. Recruiting from a group with specific characteristics (alcohol problems) may not be representative of the general twin population.
 - There were an insufficient number of nonheterosexual participants to guarantee a high degree of statistical power in the genetic and environmental analysis.
 - Due to the study using two criteria for nonheterosexuality, two sets of results were obtained therefore dividing the percentages of homosexual MZ and DZ twins reported.

Generalizability: The study results cannot be generalized to the general twin population due to the following reasons: participants had more liberal sexual attitudes; overrepresentation of educated, young females; pool of participants have possible alcohol abuse issues; and underrepresentation of nonheterosexual subjects.

Data collection: Data was collected through questionnaires. Due to the sensitive topic of S.O., the best method to collect the most accurate and truthful answers, while maintaining anonymity, is self-report questionnaires.

Analysis of article 2

Article: Sexual Orientation in a U.S. National Sample of Twin and Nontwin Sibling Pairs

Research design: The research design was a random, longitudinal, population survey. The design assessed S.O. by a single item on a self-report questionnaire in a U.S. national probability sample of twin and nontwin sibling pairs. Since not all of the articles in this review assessed nontwin sibling pairs, this review will limit its discussion to the results of S.O. of MZ and DZ twins.

Sampling methods and selection of subjects: The **target population** was monozygotic and dizygotic twins and nontwin sibling pairs. The **accessible population** was a sample of 3,032 respondents that were recruited in a national telephone and mail survey carried out in 1995-96 under the auspices of the MacArthur Foundation Network on Successful Midlife Development. The **sampling plan** is a random, convenience plan. The plan consisted of recruiting from a random-digit-dial sampling frame of the coterminous U.S. **Size:** The final twin sample included a total of 1588 twins, resulting in 794 pairs, 763 of which came from distinct families. The final sample of nontwin siblings was 1,380 individuals, bringing the total sample size to 2,968 participants. The **characteristics** of the sample are as follows:

- Twin and nontwin sibling subjects ranged in age from 25 to 74 years old
- Mean age was 47.2 years old
- Most subjects were white (95.1%)
- 33.5% college graduates, 29.6% some college education, 27.9% high school diploma, and 9.3% less than high school
- Among nontwin sibling pairs, mean age difference was 5.8 years

The **potential biases** are as follows:

- The overall nonresponse rate was 40%. The characteristics of those nonresponders were not discussed and could lead to a participation bias.
- Assessment of S.O. with a single question is inadequate and does not define what S.O. means in this study. This may cause an underrepresentation of nonheterosexuality since low or modest levels of homosexual orientation may not have been reported with a single question.
- The low percentage of homosexual orientation found in the sample size results in quite low statistical power.
- Due to the small sample of nonheterosexuals, it was impossible to examine gender differences in the causes of S.O. with any statistical power.
- The analytic method did not account for the correlated observations in families with more than two siblings.

Generalizability: The study results are generalizable because it was based on a national probability sample and the accessible population was representative of the target population.

Data collection: Data was collected from a single item on a self-report questionnaire. Assessing S.O. by questionnaire, with its relative anonymity, may be more likely than personal interview to elicit accurate responses on something as sensitive as S.O. However, since the data on S.O. was based on only one question, the dimensions of S.O. were not explicitly captured and this may have biased the data.

Analysis of Article 3

Article: Homosexual Orientation in Twins: A report on 61 pairs and Three Triplet Sets

Theoretical and conceptual frameworks: Although the authors conclude the rates of concordance for MZ twins are sufficiently high as to suggest a strong biological basis for S.O., they introduced the following theories or concepts as alternative reasons for the results:

- ❖ Sexual orientation has a high heritability
- ❖ Sexual orientation is partly genetic and partly socially derived and the social environment in which the discordant twins develop, rather than being alike is actually quite different
- ❖ Sexual orientation is biologically but not genetically transmitted and related to an in utero condition such as chorian-type
- ❖ Sexual orientation is biologically but not genetically determined in utero by biochemical mechanisms which remain to be identified

Research design: The research design was a nonrandom, longitudinal, population survey.

Sampling methods and selection of subjects: The **target population** is gay and lesbian twins regardless of type of twin, sex, or S.O. of the co-twin. The **accessible population** was homosexual respondents through ads and announcements in the gay press or through personal referrals by persons acquainted with homosexual twins. The **sampling plan** was a nonrandom, convenience plan. Initial conversations were made by telephone, followed by either personal interviews or self administered questionnaires of

both twins, or only the index twin if co-twin unavailable. **Size:** The sample size consisted of 38 MZ twin pairs (34 male and 4 female pairs) and 23 DZ twin pairs (14 male and 9 male-female pairs). In addition, three sets of triplets were obtained.

The **characteristics** of the sample are as follows:

- Mean age of respondents was 32 with a range of 20 to 68 years old
- Three pairs of twins were African American, two pairs Hispanic, and remainder Caucasian
- A total of 61 pairs of twins and three sets of triplets were obtained
- S.O. was established by use of the 7-point Kinsey scale (Three categories were used based on Kinsey scores: concordance, partial concordance, and discordance)

The **potential biases** are as follows:

- The nonresponse rate was not discussed. The size and characteristics of those who refused to participate are not mentioned and could mean a participation bias.
- Prospective twins were recruited by means of advertisements in homophilic publications. Such sampling can result in volunteer bias that affects twin concordances and heritability analysis.
- Twins deciding to participate in a study clearly related to homosexuality probably considered the S.O. of their co-twin before agreeing to participate. This could result in homosexual concordance bias.

- Information was obtained through personal interviews, telephone interviews, or a questionnaire. Respondents with questionnaires, with its relative anonymity, may have felt more comfortable being truthful about S.O. compared to those respondents who were interviewed personally or by telephone. This may cause an underrepresentation of homosexual orientation in those not given the questionnaire.
- Twins were referred to study by third party. The MZ homosexual concordant twins were likely to be known in the gay community and were thus more likely to be referred to the study by third parties. This could result in homosexual concordance bias.

Generalizability: The results are not very generalizable to the U.S. for the following reasons: compared to other studies, the sample size is small, especially for female MZ pairs; twins with concordant homosexual orientation may be biased due to how participants were recruited; and the twin participants mainly came from the West Coast, Southwest and the South rather than throughout the U.S.

Data collection: Data was collected via personal interviews, telephone interviews, and questionnaires. Due to the sensitive topic of S.O., the best method to collect the most accurate and truthful answers, while maintaining anonymity, is self-report questionnaires. The data may have been biased due to the different methods in which it was collected as well as some co-twins not being available to confirm the information furnished by the index twin about the co-twin.

Analysis of Article 4

Article: A Genetic Study of Male Sexual Orientation

Theoretical framework: This article makes reference to two theories on S.O.: a neurohormonal and behavioral genetics theory. The neurohormonal theory states sexual orientation may be influenced by sex steroid hormones acting on the brain during prenatal and early postnatal development. The behavioral genetics theory states that S.O. is familial due to genetic or shared environmental factors. The results of this study, which align with the behavioral genetics theory, allude to S.O. being influenced by constitutional factors and genetic influence.

Research design: The research design was a nonrandom, longitudinal, population survey. It was used to determine the rate of homosexuality among MZ twins, DZ twins, and nontwin biological siblings, as well as determine if childhood gender nonconformity (CGN) is an indicator of genetic loading for homosexuality. Due to not all of the articles assessing CGN, this review will be limited to the results of S.O. of MZ and DZ twins.

Sampling methods and selection of subjects: The **target population** was homosexual male probands with MZ co-twins, DZ co-twins, or adoptive brothers. The **accessible population** was recruited from advertisements placed in homophilic publications in the Midwest and Southwest requesting volunteers who were gay or bisexual men at least 18 years old with either male co-twins or adoptive or genetically unrelated brothers. The **sampling plan** was a nonrandom, convenience plan. **Size:** The size consisted of 161 proband interviews: 115 probands with male twins and 46 probands with adoptive brothers. The final twin relative subsample was 56 MZ male pairs, 54 DZ male pairs, and 57 adoptive brothers. The **characteristics** of the sample are as follows:

- Probands ranged in age from 19 to 65 years old with mean age of 33.2 years old
- Twins were older than the adoptive brothers (34.5 years versus 29.9 years)
- Of the probands, 150 described themselves as gay/homosexual and 11 described themselves as bisexual

The **potential biases** are as follows:

- The nonresponse rate of the proband's living relatives, which were granted permission by the proband to be contacted, was 5.9%. About 74.3% of the entire sample of living relatives returned questionnaires. The characteristics of the nonresponders were not discussed and may have lead to a participation bias.
- Prospective twins were recruited through advertisements in homophilic publications. Such sampling can lead to a volunteer bias and overrepresent homosexual concordant twins.
- Information was obtained through personal interviews, telephone interviews, and questionnaires. Assessing S.O. by questionnaires, with its relative anonymity, may have lead to more truthful answers compared to personal or telephone interviews, which may cause on underrepresentation of twin homosexuality.
- Some probands were sole informants of information regarding themselves and their co-twins. This may lead to inaccurate information about co-twins S.O.
- Only 5 questions out of 100 were sexually related which may be an inadequate number to fully assess someone's S.O. This may lead to an underrepresentation

of nonheterosexuality because low or moderate levels of homosexual orientation may not have been reported.

- Ages of proband's relatives were as young as 19 years old. Although some homosexuals have accepted their orientation by 19 years old, many have not. Because the sample of relatives included individuals as young as 19 years old, a few relatives who currently identify as heterosexual may eventually develop and accept a homosexual orientation. This may cause an underestimation of homosexual orientation in both twins.
- The probands who decided to participate in a study related to homosexuality probably considered the S.O. of their co-twin before agreeing to participate. This may overestimate the proportion of homosexual concordant twins.

Generalizability: The results cannot be generalized to the U.S. twin population because the participants were solicited from the Midwest and Southwest only, and because participants were solicited solely from homophilic publications. Those who read and respond to gay publications may not be representative of gay twins in general.

Data collection: The data was collected via personal interviews, telephone interviews, or questionnaires. Assessing S.O. by questionnaire may be best way to collect data because respondent feels more comfortable being truthful, with greater anonymity, compared to a personal or telephone interview. The data may have been biased due to the different methods in which it was collected as well as some co-twins not being available to confirm the information given by the proband about the co-twin.

Analysis of Article 5

Article: Heritable Factors Influence Sexual Orientation in Women

Theoretical framework: This article makes reference to biological theories on the cause of female homosexuality. The most influential biologic theory of S.O. posits that the development of attraction to females requires the masculinization of relevant (hypothalamic) brain structures, and that attraction to males results if relevant neural structures do not masculinize. Thus, different processes are hypothesized for male and female homosexuality. This suggests that genetic factors contributing to female S.O. may differ from those of male S.O. This study, based on a biological theory, had two broad goals: To determine if there is a genetic contribution to female S.O. and to investigate the behavioral expression of this contribution.

Research design: The research design was a nonrandom, longitudinal, population survey. The design determines the rate of homosexuality among MZ twins and DZ twins, as well as determines if CGN is an indicator of genetic loading for homosexuality. Due to not all of the articles assessing CGN, this review will be limited to the results of S.O. in MZ and DZ twins.

Sampling methods and selection of subjects: The **target population** was homosexual female probands with MZ co-twins, DZ co-twins, adoptive sisters and nontwin biological sisters. The **accessible population** was recruited using lesbian oriented publications in several major cities across the U.S., requesting lesbian or bisexual women at least 18 years old who have either a female co-twin or adoptive or genetically unrelated sister. The **sampling plan** was a nonrandom, convenience plan. **Size:** The study had 147 probands: 115 probands with female twins and 32 probands with adoptive sisters. The

final twin subsample, including only those relatives whose S.O. and zygosity could be determined, was 71 MZ twins and 37 DZ twins.

The **characteristics** of the sample are as follows:

- Mean age of twins was 31.6 years old and mean age for adoptive sisters was 29.9 years old
- Number of homosexual twin subjects was 97
- Number of bisexual twin subjects was 18
- The mean Kinsey rating for twins was 4.9 +/- 1.2

The **potential biases** are as follows:

- The nonresponse rate of the proband's living relatives, which were granted permission by the proband to be contacted, was 10.3%. About 82.4% of the entire sample of living relatives returned questionnaires. The characteristics of those nonresponders were not discussed and may represent a participation bias.
- Prospective subjects were recruited through lesbian oriented publications. Such sampling can lead to a volunteer bias that affects twin concordance rates.
- Information was obtained through personal interviews, telephone interviews, and questionnaires. Assessing S.O. by questionnaires, with its relative anonymity, may have lead to more truthful answers compared to personal or telephone interviews, which may cause on underrepresentation of twin homosexuality.
- Some probands were sole informants of information regarding themselves and their co-twin. This may lead to inaccurate information about co-twins S.O.

- Only 5 questions out of 100 were sexually related which may be an inadequate number to fully assess someone's S.O. This may lead to an underrepresentation of nonheterosexuality because low or moderate levels of homosexual orientation may not have been reported.
- Ages of proband's relatives were as young as 19 years old. Although some homosexuals have accepted their orientation by 19 years old, many have not. Because the sample of relatives included individuals as young as 19 years old, a few relatives who currently identify themselves as heterosexual may eventually develop and accept a homosexual orientation. This may cause an underestimation of homosexual orientation in both twins.
- The probands who decided to participate in a study related to homosexuality probably considered the S.O. of their co-twin before agreeing to participate. This may overestimate the proportion of homosexual concordant twins.

Generalizability: The results cannot be generalized to the general gay twin population because participants were recruited from only 7 U.S. cities and because participants were solicited solely from homophilic publications. Those who read and respond to gay publications may not be representative of the gay twin population in general.

Data collection: Data was collected via personal interviews, telephone interviews, and questionnaires. Assessing S.O. by questionnaire may be the best way to collect data because the respondent feels more comfortable being truthful, with greater anonymity, compared to a personal or telephone interview. The data may have been biased due to the

different methods in which it was collected as well as some co-twins not being available to confirm the information given by the proband about the co-twin.

Analysis of Article 6

Article: Homosexuals who are Twins: A study of 46 Probands

Theoretical framework: This article discusses two theories: That genetic factors may predispose individuals to environmental influences leading to a homosexual orientation, or that intense identification or other factors related to twinship might explain higher concordance rates.

Research design: The research design was a nonrandom, longitudinal, population survey. The design was to determine S.O. of MZ and DZ twins as well as to determine the likelihood of sexual relations occurring with same sex co-twins, particularly in MZ pairs. Due to not all of the articles assessing sexual relations among same sex twins, this review will be limited to the S.O. of MZ and DZ twins.

Sampling methods and selection of subjects: The **target population** is homosexual twins and their MZ or DZ co-twins. The **accessible population** was recruited using several local and national gay periodicals requesting homosexual men and lesbians who were twins. The **sampling plan** was a nonrandom, convenience plan. A questionnaire was sent to all participants to gather data on themselves as well as their co-twin. **Size:** A total of 48 people responded to the study, of which 46 returned completed questionnaires. Twenty participants were MZ, 25 were DZ, and one was a trizygotic triplet. The **characteristics** of the sample are as follows:

- 46 returned completed questionnaires

- Respondents were predominantly young men (38 males, 8 females)
- Mean age was 31.8 years old
- Middle to higher social class
- 45 homosexual and 1 bisexual
- 42 were single and 4 were married at some time
- In 33 pairs, co-twins were of same sex as the respondent (20 were MZ pairs and 13 were DZ pairs)

The **potential biases** are as follows:

- The nonresponse bias was 4.1%. Although the nonresponse rate is low, the characteristics of the nonresponders were not discussed which may have caused a participation bias.
- Prospective probands were recruited through advertisements in homophilic publications. Such sampling can lead to a volunteer bias and overrepresent homosexual concordant twins.
- Probands were sole informants of information regarding themselves and their co-twins. This may lead to inaccurate information about co-twins S.O.
- The probands who decided to participate in a study related to homosexuality probably considered the S.O. of their co-twin before agreeing to participate. This may overestimate the proportion of homosexual concordant twins.
- The authors did not screen their respondents for crank contacts. They also did not personally attempt to contact either the proband or the co-twin to verify the

information obtained on the questionnaires. This may lead to inaccurate results of homosexual concordance or discordance for S.O.

Generalizability: The results cannot be generalized due to small sample size; participants recruited from gay periodicals may not be representative of general gay twins; and unknown if probands are represented from areas across the U.S.

Data collection: Data was collected by questionnaires, which are the best method to collect such sensitive data as S.O. The following two issues may have made data collection inaccurate: The authors did not attempt to seek confirmatory data from the co-twins and they did not screen their respondents for crank contacts.

Synthesis/Discussion

In accord with findings from the six twin studies in this review, resemblance for S.O. was greater in MZ twins than in DZ twins. The percentages of concordance for homosexuality in MZ twins ranged from 20% to 65.8%, whereas the rates for DZ twins ranged from 0.0% to 30.4%. The results affirmatively answer the research question by demonstrating a higher concordance rate for homosexuality in MZ twins versus DZ twins. Although the percentages of concordance vary in the six articles, they suggest a biological basis for S.O. However, because discordance for S.O. in MZ and DZ pairs is present, this confirms that genetic factors are an incomplete explanation of the development of S.O. Based on these findings, it can be argued that genetic factors may predispose individuals to environmental influences leading to a homosexual orientation.

Remaining issues

Although the studies do support the theory of a genetic and/or biologic component to S.O., the range of results suggests further research is needed. The following issues should be addressed in future studies of homosexuality in twins:

- ✓ Because female homosexuality appears to be less common and presents at a later age than in male homosexuality, future research should focus on female homosexuality rather than assuming that findings for males can be extrapolated to females.
- ✓ Data should ideally be collected in a manner that would minimize ascertainment bias and allow the estimation of the base rate of homosexuality for both sexes.
- ✓ The sampling methods of an ideal genetic study should involve systematic sampling from a well-specified population.
- ✓ Standard criteria for what constitutes homosexuality should be available so studies can refer to only one criterion set. When more than one set is used by different studies, the results are incomparable to other studies.
- ✓ All data in a study should be gathered by the same method so to avoid errors that occur through different collection techniques (interviews, questionnaires, etc).
- ✓ Studies should include enough questions on sexuality and S.O. so to clearly understand what S.O. means to that study participant when interpreting the results.
- ✓ Obtain a large sample of nonheterosexual participants to guarantee a high degree of statistical power in the genetic analysis.

- ✓ Make sure characteristics of those nonresponders are described and taken into account when analyzing results.
- ✓ All data should be validated by both the proband and the co-twin to avoid inaccuracies.
- ✓ All collected data should be screened for crank or false participants.