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## A Meta-Analysis of Sibling Sex Ratio and Sexual Orientation

Naomi Irene Gribneau

*College of Saint Benedict/Saint John's University*

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A Meta-Analysis of Sibling Sex Ratio  
and Sexual Orientation

A SENIOR THESIS  
The Honors Program  
College of St. Benedict/St. John's University

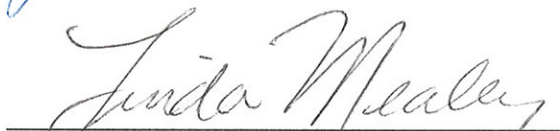
In Partial Fulfillment  
of the Requirements for the Distinction "All College Honors"  
and the Degree Bachelor of Arts  
In the Department of Psychology

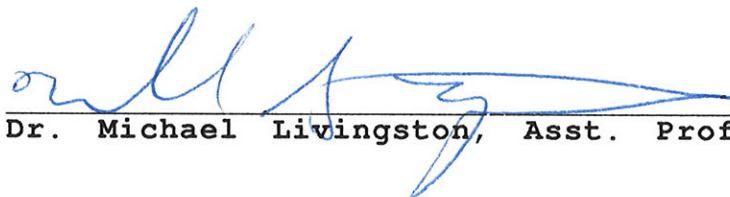
by  
Naomi Irene Gribneau  
April 1991

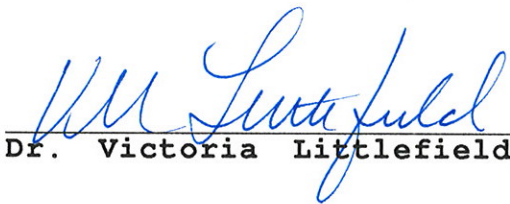
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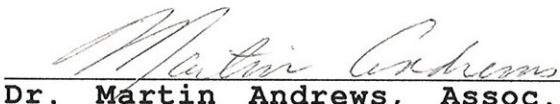
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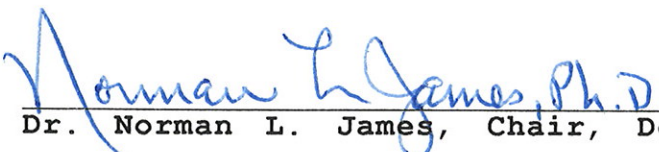
  
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#### ACKNOWLEDGEMENTS

I would like to thank my major advisor, Dr. Jan Leslie Holtz, and all of my evaluators, Dr. Michael Livingston (especially for his help with the meta-analysis), Dr. Linda Mealey, Dr. Victoria Littlefield, and Dr. Martin Andrews, for all of their patient evaluations and revisions. I would also like to thank Dr. Robert Dumonceaux for his help with the statistical section, Dr. Charles Rodell for his comments on biological concepts and all of the College of Saint Benedict's faculty and staff members who responded to my survey.

The help of fellow students Lisa Needham (inter-rater reliability testing), Sara Linde and Kelli Birk (translation of the articles printed in German) was also greatly appreciated.

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ABSTRACT

In the past, several researchers have commented on a disproportionate number of brothers in the siblings of their (generally male) homosexual subjects. Conflicting data has also been presented, and the question remains unresolved. This paper explores the relationship of sexual orientation and sibling sex ratio through a meta-analysis of eighteen previously published studies from 1940 through 1982. A recent survey of adult heterosexual women provides more data, resulting in final sample sizes of 5553 homosexual male subjects, 1100 heterosexual male subjects, 445 homosexual female subjects, 436 female heterosexual subjects and 1880 male controls (sexual orientation undetermined). It was found that significantly more brothers were present in the families of both homosexual men (but not if older or single variable studies are removed) and homosexual women. The proportion of brothers in the families of heterosexual men and women did not differ significantly from the average proportion of male births in the United States. A brief summary of contemporary theories on the development of male and female homosexuality is included, as well as a review of the literature on factors affecting the human sex ratio at birth.

## A Meta-Analysis of Sibling Sex Ratio and Sexual Orientation

Numerous theories and controversies characterize the literature on the development of sexual orientation in humans. Several studies have suggested that the sibships of homosexual subjects contain a significant excess of male siblings, yet other studies of similar magnitude and quality find no difference. To determine the validity of this suggested phenomenon and its possible consequences, a brief overview of contemporary theories on the etiology of sexual orientation is presented. A meta-analysis of all previously published data summarizes the information regarding potentially skewed sibling sex ratios in the families of homosexual men and women.

Sex is important to humans for many reasons. By virtue of sexual reproduction, the genetic traits of two individuals are recombined to form completely new and unique individuals, possibly possessing traits expressed in neither parent. Sex is also important to individuals. The formation of intimate relationships plays a major role in the development of self concept, and may be seen as essential to a fulfilling lifestyle. As humans, the drive to reproduce underlies many complex behaviors and sets the foundation for many beliefs, expectations and regulations within communities.

Central to sex is the issue of sexual orientation. Reproductively, individuals only attracted to members of the same sex will have difficulty directly passing genes to the

next generation, yet psychologically, an individual may have acquired more emotional affinity to members of the same sex, developing an identity distinctly different from that of heterosexual counterparts. Socio-cultural reactions to sexual orientation have many repercussions on both the individual and the community.

The prevalence of homosexuality in human populations also serves to rekindle one of the burning questions of scientific research- nature vs. nurture. Although it is impossible to completely separate the two, most individual scientists have focused either on physiological or psychogenic (psychological and social) explanations. Other researchers have examined evolutionary theory and family studies, which combine the biological and psychosocial approaches.

#### EVOLUTIONARY THEORIES

It is essential to begin with an understanding of potential mechanisms for the continuation from generation to generation of traits resulting in non-reproductive behavior. Sociobiologists seek to explain all existing behaviors in an evolutionarily adaptive manner. Ruse (1981) points out that homosexuality presents a distinct conceptual problem, as the struggle for reproductive fitness is paramount to the view of evolutionary theory. Sociobiologists set forth to examine homosexual behavior and not homosexuality per se. Weinrich (1976) aptly explained the distinction by defining



homosexuality as "the sustained preference, in fantasy or behavior, for sexual relations with members of one's own sex" (pg. 149) and homosexual behavior as "behavior between two members of the same sex which utilizes the mechanisms of sexual arousal" (pg. 145). Clearly, the two are not equivalent, as homosexuality precludes most opportunities to produce offspring, whereas incidences of homosexual behavior do not. Evolutionary theories discussed in this paper include balanced heterozygote fitness, parent/offspring conflict, group selection, male-male competition and kin selection.

#### Balanced Heterozygote Fitness

In balanced heterozygote fitness, it is assumed that a certain gene, for which at least two separate alleles exist (A1 & A2), influences the reproductive success of the individual. If the hypothetical A1 allele is present on both genetically inherited chromosomes, the resulting individual reproduces at an average rate. If both alleles are of the A2 type, the individual reproduces at a much lower rate than average (as would be the case with homosexuals). However, the lack of offspring produced by the less fit homozygotes (homosexuals) is theoretically cancelled by their super-fit heterozygote (heterosexual) siblings, who have a copy of each type of allele (A1 & A2) and a corresponding higher rate of reproduction. The trait is sustained because the individuals who reproduce the most pass on both forms of the gene.

Although probably more complex, this mechanism is hypothesized to work similarly to the sickle-cell anemia trait in humans.

#### Parent/Offspring Conflict

Weinrich (1976) mentions an evolutionary model termed parent/offspring conflict. The conflict occurs when the parent's inclusive fitness (number of genes passed on to the next generation through all methods of transmittal - i.e., through own offspring and relatives' offspring) is maximized by the child's waiting to reproduce while the child is most benefitted by reproducing immediately. For example, the child may be helping with younger siblings at home, which increases the parent's inclusive fitness more than the production of grandchildren would. However, it is in the child's best genetic interest to reproduce immediately. As long as this interaction favors the parent, the child partakes in only non-reproductive behavior, which may include homosexuality.

#### Group Selection

Group selection occurs when an individual's deleterious traits are expressed such that the group benefits. (The group is the focus of selective pressures - not the individual or gene.) Dizinno (1983) points out that conditions under which group selection operates are restrictive and few empirical examples have been described.

### Male-Male Competition

Dizinno (1983) describes a compelling model based on the degree of male-male competition in a given society, mainly stating that as levels of male-male competition increase, so does the frequency of male homosexual behavior. Nine predictions pertaining to the incidence of male homosexual behavior were tested using a cross-cultural investigation of societies in the Human Relations Area File Probability Sample. Seven of these received tentative support, suggesting possible universal validity. Dizinno (1983) found that: as the degree of polygyny in a culture increases, the amount of homosexual behavior increases and the severity of punishments for such behavior decreases; the more important resources become for attracting a female mate, the higher the homosexual behavior; as the average difference between the ages of men and women at marriage increases, so does homosexual behavior; homosexual behavior is mostly found among males of low status; and homosexual behavior is generally transitory.

### Kin Selection

In this model, inclusive fitness is maximized through the reproductive efforts of relatives. If an individual is a low reproducer, but also good at aiding relatives, it makes good biological sense to forego attempts at direct personal reproduction and invest that energy in helping to raise

relatives' fitness. This possibly results in a homosexual orientation. Although the predictions based on kin selection tested by Dizinno (1983) resulted in non-significant world-wide correlations, Weinrich (1976) provides evidence from animal behavior and admittedly limited anthropological studies. He concludes that the acquisition of sexual behaviors is inconsistent with simple learning theory and seems to follow more closely the learning constraints placed on phobias: sexual behaviors occur as a non-random subset of conceivable behaviors, are often acquired effortlessly, are robust and difficult to extinguish, are only weakly influenced by rational arguments, and make evolutionary sense in certain situations.

Weinrich (1987) presents a modified kin selection model based on societies where marriage is nearly universal. Human homosexual behavior remains a reproductively altruistic act, but its magnitude is greatly reduced by the social pressures to marry and reproduce. Conflict over a preferred marriage partner may also be minimized between the parent and the homosexually oriented offspring, since the offspring's preferred mate is not a feasible marriage partner.

Gallup & Suarez (1983) suggest that homosexual behaviors may be a consequence of selection for optimal heterosexual strategies. Optimal heterosexual strategies for males and females are very different, and may result in heterosexual frustration - females may be disenchanted with heterosexual relationships and males may be frustrated with inadequate

opportunities for heterosexual sexual expression, resulting in a shift towards homosexual behaviors and relationships. In this case, the proximate mechanisms that drive heterosexual behavior undermine their own adaptive or functional significance.

#### PSYCHOGENIC THEORIES

Psychogenic theories include all hypotheses that attempt to explain the psychological and sociological development of sexual orientation. Results in this area are controversial, with many researchers presenting conflicting data. Reporting on data collected from 150 homosexual men (prisoners, patients and others) and 100 non-homosexual men (patients and others), Schofield (1965) commented, "this research was expected to show large differences between each homosexual group and its corresponding control, but in fact the differences between the pairs of matched groups were surprisingly small and the differences between the homosexual groups were surprisingly large". Psychogenic theories can be divided into parent-child interactions, nature of parents' relationship, self-motivated childhood behavior, sibling interactions, and peer relationships.

#### Parent-Child Interactions

There are numerous theories involving various aspects of the parents' personality and the way parents interact with their children. Schofield (1965) found that a larger

proportion of male homosexual groups reported unsatisfactory relationships with parents; Miller (1958) suggested that rejection by one or both parents was more frequent in homosexual subjects; and Kenyon (1968) found that homosexual women reported poorer relationships with both their mothers and their fathers. Westwood (1960) suggested that male homosexual subjects often experienced long periods with their fathers absent and Stephan (1973) claimed that male homosexuals had no positive male role models as children. Newcomb (1985) found no significant differences in the perceived parent personality between homosexual and heterosexual men, but lesbian subjects perceived their parents as less sex-typed or more sex-reversed in terms of dependency, affiliation, and aggression than did heterosexual women. Lesbians perceived their mothers as more independent, more aggressive-dominant and less affiliative relative to their fathers. Spencer (1959) found that male homosexuals report disharmonious relationships with their mothers, but not their fathers; Bieber, Dain, Dince, Drellich, Grand, Gundlach, Kremer, Rifkin, Wilbur & Bieber (1962) cited mothers who preferred their homosexual sons to other children as well as fathers who had specifically negative attitudes towards their homosexual sons and/or preferred them least; and Nash & Hayes (1965) reported that their "passive" subgroup of male homosexual subjects had closer relationships with their mothers and worse relationships with their fathers. Bell, Weinberg & Hammersmith (1981a) found that

homosexual men and women were more likely to report a closer relationship with their mothers and more distant relationship to their fathers during childhood and adolescence, a strong mother and weak father, and dislike or hostility from their father. Homosexuals in therapy tended to report "detached-hostile" fathers. Bell et al. (1981a) concluded that identifying with the opposite sex parent had no impact on the development of adult sexual orientation, identifying with the same sex parent had only a weak connection, and that family relationships were more salient for the development of female homosexuality than for male homosexuality.

#### Relationship Between Parents

Although Kenyon (1968) found that homosexual women come from families where the parents have fewer happy marriages and more separations and divorce, Bell et al. (1981a) did not replicate this finding.

#### Childhood Behaviors

Early sexual experience is thought to separate pre-homosexual from pre-heterosexual boys (Manosevitz 1970), as is the attraction to both genders (the groups did not differ in attraction towards females) in childhood (Manosevitz 1972). Miller (1958) reported a median age of eight years for the first homosexual experience of his 50 male subjects.

Stephan (1973) found that homosexual males engaged in

little normative masculine behavior as children, and masculine role behavior was not encouraged by either parent. Similarly, Bieber et al. (1962) claimed that the mothers of homosexual men were less encouraging of masculine behavior than the mothers of heterosexual men. Bell et al. (1981a) suggested that cross-gender interests in childhood are one of the few variables differentiating pre-homosexual and pre-heterosexual children. Homosexual subjects reported less enjoyment of sex-typed activities than heterosexual subjects, and many reported having homosexual feelings during adolescence (95% of homosexuals and 20% of heterosexuals). More heterosexual men (75%) reported being masculine as children than homosexual men (50%), and more heterosexual women (33%) reported being feminine as children than homosexual women (20%). Gender non-conformity was suggested as a more salient feature in the development of male homosexuality than female homosexuality.

McConaghy (1987) cited a study by Kagan & Moss (1962) that discovered that the degree of involvement in same-sex and opposite-sex behaviors remained constant in individuals from age three to fourteen. Furthermore, the reduced involvement in same-sex activities was associated with a reduction of adult heteroerotic behavior in males, but not in females. McConaghy (1987) reported that the correlation between reduced same-sex behavior and homosexuality in males is consistent, but in females the relationship is neither strong nor consistent.



### Sibling Interactions

Bieber et al. (1962) reported that homosexual males had more negative attitudes towards their brothers and more positive attitudes towards their sisters than their heterosexual counterparts. However, strangely enough, homosexual men also wished to identify more with their brothers than heterosexual men. Bell et al. (1981a) did not find any significantly different sibling relationships between their homosexual and heterosexual subjects.

### Peer Relationships

While Bell et al. (1981a) found that homosexual subjects had more opposite sex friends in adolescence, Westwood (1960) determined that nearly all of his male homosexual subjects had the opportunity to mix with girls as children, but one third had always avoided feminine company. Manosevitz (1972) found no support for theories that homosexual men received early punishment for sex play more often than heterosexual men, or that the homosexual men were more isolated from girls as children. However, more of the homosexual males had never dated females on a regular basis. Bell et al. (1981a) also found that their homosexual and heterosexual subjects had equal opportunity to interact with and date the opposite sex, and did so in similar frequencies, but that the homosexuals enjoyed their heterosexual interactions less.

## PHYSIOLOGICAL THEORIES

Physiological theories favor explanations relating to genetics, physical and behavioral traits that may be related to underlying biological factors (such as body build and hand preference), adult hormone levels and the influence of maternal hormones on the fetus (a pre-natal factor that causes structural differences in development).

### Genetics

From calculations of the number of offspring born to a clinical sample of 95 homosexuals, Moran (1972) concluded that a genetic basis for homosexuality was unlikely. Needless to say, this study is biased in a number of ways- it assumes that a parent must express the trait in order to pass it to the child, that clinical homosexual samples are representative of the entire homosexual population, and that 95 subjects can be reliably generalized to millions of people.

### Body Build

Evans (1972) found that male homosexual subjects had less subcutaneous fat, smaller muscle/bone development, less muscular strength, narrower shoulders in relation to pelvic width, and were longer in proportion to bulk than heterosexual male subjects. Perkins (1981) reported that female homosexual subjects had narrower hips, increased arm and leg girths, less subcutaneous fat, and more muscle than

heterosexual female subjects. This was especially true of the lesbians who were 'psychosexually dominant', defined as those who preferred the active role in sexual behavior.

#### Hand Preference

McCormick, Witelson & Kingstone (1990) suggested that the majority of female homosexual subjects had some left-hand preference, but also pointed out that this does not mean the majority of left-handed females are homosexual. However, females showing nonconsistent right-hand preference are four times more likely to have a homosexual orientation than women with consistent right-hand preference. The homosexual males showed a non-significant trend in the same direction. McCormick et al. (1990) suggested that there may be different mechanisms underlying brain lateralization and sexual orientation in the sexes, citing other studies that list genetic, familial, birth order and parental age as possible factors in the development of male but not female homosexuality, and circulating level of sex hormones and secondary sex characteristics as possible indicators for female but not male homosexuality.

#### Adult Hormone Levels

Gladue (1987) reported that although the circulating testosterone levels of homo- and heterosexual men were initially thought to be different, "numerous studies (over twenty at this time) reported no differences between

homosexual and heterosexual men". Regarding the minimal literature on levels of circulating hormones in women, Gladue (1987) concluded "the majority of adult female homosexuals appear to have testosterone and estrogen levels well within the normal female range. Yet, there may be a subgroup of female homosexuals who have slightly elevated testosterone levels, although these levels are far below that seen in men".

#### Fetal Hormones

MacCulloch & Waddington (1981) suggested that brain sexual differentiation may be hormonally determined in utero, resulting in primary homosexuality when abnormalities in fetal exposure to hormones occur. (This theory could potentially explain the presence of homosexual behavior in otherwise genetically and phenotypically normal men and women.) They hypothesize that male homosexuality would be caused by a lack of hypothalamic exposure to androgens, and female homosexuality would develop when a reduction in progesterone resulted in the failure to initiate feminization and a consequent lack of protection against the masculinizing effects of androgens and estrogens.

Money (1986) examined different clinical syndromes with associated fetal hormonal imbalances and suggested a shift from a nature/nurture paradigm to include a crucial period, possibly occurring either during fetal exposure to hormones (when the brain is dimorphically programmed as either

masculine or not masculine) and/or in late infancy and early childhood when brain dimorphism is more complexly programmed by the influence of social stimulation and participation.

Doerner (1976), as cited by Goodman (1983) and Gladue (1987), hypothesized that the feminization or masculinization of the brain during the fetal period in humans may be similar to the mechanism operating in rats, which causes females to show a cyclical pattern of hormone release and males a continuous hormone release. These patterns can be experimentally reversed in the rat with appropriate manipulations. If extended to humans, this theory states that male homosexuals should show female type luteinizing hormone feedback and surge values after the exposure to estrogen, indicating the presence of a partially feminized brain. Goodman's (1983) study claimed that gonadotropin release pattern in humans can not be used as evidence for brain feminization, citing Knobil's (1974) work with rhesus monkeys, in which both sexes have been shown to be capable of positive feedback and surge responses to estrogen exposure. Gladue (1984) also tested the presence of positive estrogen feedback effect in research volunteers- male and female heterosexuals vs. male homosexuals. After administering an estrogen preparation known to enhance the concentration of luteinizing hormone in females but not in males, it was found that male homosexuals showed a secretory pattern of luteinizing hormone in between that of the heterosexual men and women, as well as showing depressed levels of

testosterone for significantly longer periods than the heterosexual men.

As well as potentially affecting the endocrine regulation system, hormones in the fetal environment may influence later behaviors. Reinisch (1981) and Reinisch & Sanders (1984), cited by Gladue (1987), supported a behavioral development towards typically masculine traits in females exposed prenatally to elevated levels of progesterone.

#### FAMILY STUDIES

The general nature of families combines genetic and environmental factors, and thus similarity within the family can be attributed to either genetic resemblance or equivalent learning environments. The composition of the nuclear family is therefore of specific interest to both biological and psychological perspectives. Possible factors include parental age, sibling constellation, [composed of inter-related variables such as sex of surrounding siblings (sibsex), age gaps between siblings (sibgap), sibship size, and ordinal position (birth order)], twin studies, frequency of mental illness in relatives of homosexuals, frequency of homosexuality in families, and the sibling sex ratio in the family.

#### Parental Age

Although Hare & Moran (1979) reported a raised mean

parental age in homosexual males, concluding that the father's age was of greater importance and Slater (1962) reported a higher maternal age in homosexual males, Manosevitz (1970) found no difference in the parental ages of homo- and heterosexual males. Parental age has not been found to differ between homo- and heterosexual females (Hare & Moran 1979, Kenyon 1968).

### Sibling Constellations

Most researchers have reported no difference in family size between their homosexual and heterosexual subjects (Bell et al. 1981a, Gundlach 1977, Kenyon 1968, Siegelman 1973, Stephan 1973), but Schubert, Wagner & Reiss (1976) presented data that yielded a greater proportion of homosexual men from large sibships, and Bieber et al. (1962) suggested that there were fewer only siblings among male homosexuals. Gundlach & Reiss (1967) found that lesbians are more often the only child than heterosexual women. Perkins (1978) similarly reported a higher frequency of only children among lesbians, but the difference was not significant when those who had experienced childhood sexual abuse were removed.

Some researchers have reported a significantly higher mean birth order for homosexual males (Hare & Moran 1979, Slater 1962), but not females (Hare & Moran 1979). Others report no difference in the birth order of homosexual males (Schofield 1965).

Variations in sibling constellation are more diverse and consist of studies that find no differences (Bell et al. 1981a, Kenyon 1968, Schofield 1965, Siegelman 1973, Stephan 1973) and studies that give detailed reports on which sibship positions are most likely to 'produce' homosexuals: youngest son in sibships of three, oldest son in sibships of four, (both reduced if sister is next oldest), youngest and middle sons from all male sibships (Schubert et al. 1976); first born daughter of two children, daughter in fifth through seventh position in large families, not daughter born last in a sibship of three (Gundlach & Reiss 1967); not daughter with nextborn older sister, daughter in middle of three females, not the second of two or four female sibships (Gundlach 1977). In general, men born late in the sibship have been reported to include an excess of homosexuals (Bieber et al. 1962, Slater 1958, Westwood 1960), but women show the opposite trend until there are five or more siblings (Gundlach 1977).

### Twins

Male monozygotic (MZ) twins usually have higher rates of concordance for homosexual orientation than dizygotic (DZ) twins (Eckert, Bouchard, Bohlen & Heston 1986, Heston & Shields 1968, Kallmann 1952a, 1952b), but this is not true for female monozygotic twins (Eckert et al. 1986). Researchers have reported twin pairs in most configurations—discordant male MZ twins (Klintworth 1962, Parker 1964,



Rainier, Mesnikoff, Kolb & Carr 1960) and DZ twins (Parker 1964), concordant male MZ twins (Myers 1982) and DZ twins (Dank 1971), discordant female MZ twins (Parker 1964, Rainier, Mesnikoff, Kolb & Carr 1960), and concordant MZ female twins (Pardes, Steinberg & Simons 1967, Perkins 1973).

#### Family Rates of Mental Illness

Pillard (1988) found no difference between male homosexual and heterosexual subjects in current symptom distress or number of lifetime diagnoses. However, homosexual men showed an increased risk for bipolar mood disorders in themselves, unipolar mood disorders in their mothers, and alcoholism in both themselves and their fathers. Kenyon's (1968) sample of 123 lesbians and 123 controls revealed a higher rate of psychiatric history in the lesbians and in their mothers. As cited by Diamant & Simono (1987), Myers (1980) concluded that homosexual men and women did not show a higher frequency of psychological problems than other men and women seen in the general medical practice, although the homosexual population did have a slightly greater prevalence of alcoholism.

#### Frequency of Homosexuality in Families

Homosexual subjects seem to report more homosexual siblings than heterosexual subjects, and in greater numbers than would be expected. This phenomenon has been noticed by several researchers (Bieber et al. 1962, Hirschfeld 1936) and

reviewed by Pillard, Poumadere & Carretta (1981), who mentioned additional comments from Margolese & Janigen (1973) and Ellis (1922), including the latter's citations of Ellis, Krafft-Ebing, Moll, and von Romer. Dank (1971) reported a family in which all ten siblings were homosexually experienced, with six of them having homosexual or predominantly homosexual orientations. (This family includes the aforementioned pair of male DZ twins concordant for homosexuality.) Kenyon (1968) reported a positive history of homosexuality in the families of 24.4% of lesbian subjects and only 2.4% of control subjects. Westwood (1960) is a minority in reporting that few subjects had siblings known to be homosexual.

Henry (1948) presented detailed family charts of 40 male and 40 female "Sex Variants". 37 of the men and all 40 of the women expressed homo- or bisexual preference. Of these subjects, 14 of the men and 16 of the women (approximately 40%), reported a total of 16 siblings and 32 other relatives that were either thought to or known to have homo- or bisexual orientation. One would certainly not expect this phenomenon in randomly chosen subjects. To further explore this issue, Pillard, Poumadere & Carretta (1982) studied groups of homosexual and heterosexual men and women, inquiring about the sexual orientation of siblings as part of the interview process. They found a higher percentage of homosexuals reporting homo- or bisexual siblings than heterosexuals, but at this point all orientations were merely

guesses from the subjects. These cases were followed up by interviewing the siblings themselves, discovering that, for the most part, the index subjects were correct about their siblings' orientation (Pillard & Weinrich 1986).

### Sibling Sex Ratio

In concordance with the style of the literature in this field, sex ratios at birth are expressed as proportions (i.e., 104 males to 100 females = 0.52; 107:100 = 0.535).

According to the United Nations Demographic Yearbook (1988), the sex ratio of males to females at birth in the United States is 0.5250. If only Whites are examined, Guttentag & Secord (1983) reported an average sex ratio at birth of 0.5289. Many researchers have reported a higher than expected ratio of males to females in the families of their homosexual subjects. Noting an overall sibship sex ratio of 0.605 in 1015 male homosexuals compared to a control group ratio of 0.536, Lang (1940) introduced the intergrade theory, attributing the deviant ratios to a proportion of male homosexuals exhibiting the morphology of a male but the chromosomes of a female. In support of this theory, Lang (1940) cited Goldschmidt's 1934 research with the gypsy moth, in which an intersexuality range from complete male to female sexual intergrade and vice versa was experimentally produced. Darke (1948) cast doubt on this theory when the sibs of 100 male homosexual subjects of his study showed no significant deviation from the expected sex ratio. Further evidence

against the intergrade theory came with the advent of karyotyping (viewing an individual's chromosomes for aneuploidy or structural abnormalities). With few exceptions, the nuclear sex of an individual has always been shown to be consistent with the phenotypic sex, as demonstrated by Pare (1956), and Pritchard (1962). Pritchard (1962) also cited further evidence from Bleuler & Wiedemann (1956), Gentile, Lagerholm & Lodin (1960), Leurs & Schultz (1957), Levij, Van Schaik & Tolsma (1956), and Raboch & Nedoma (1958).

Even after the abandonment of Lang's theory, the debate over variance in sex ratios continued. Additional sibling sex ratios for homosexual males were published by Jensch (1941a, 1941b)- 0.569; Kallmann (1952a)- 0.632 in single born probands, 0.6265 in monozygotic twin probands, and 0.5425 in a control group; and Slater (1958)- 0.557. Giese (1958) found an excess of male siblings in male homosexual subjects from sibships sized two to four (0.5967), and not in families with five or more children (0.5257).

Other researchers mentioned an excess of male sibs in their subjects (Nash & Hayes 1965, Stephan 1973, West 1968, 1977), or no differences in either sex or number of siblings (Manosevitz 1970), but did not report specific data. Schubert et al. (1976) noted that more male homosexual subjects came from all male sibships, but did not comment on the correlating excess with regard to sibling sex ratio. Martensen-Larsen (1957) found more brothers in the sibships

of 63 homosexual males, 42 of their fathers and 21 of their grandfathers, as well as more sisters in the sibships of 44 homosexual females, 45 of their mothers and 25 of their grandmothers. Unfortunately, the actual data were not presented. Spencer (1959) suggests that one pattern of development for male homosexuality is characterized by the presence of more than an average number of brothers at home or the subject's attendance at a boarding school.

Money (1970) comments, "it is possible that the results of all these studies have no more significance than if figures had been drawn from a random number table", and furthermore, that if the male preponderance were actually verified, that it "may signify not a genetic predisposition to homosexuality, but a tendency for an effeminate gender identity to develop more easily in boys whose families have a shortage of sisters and daughters". A possible explanation of the excessive brother to sister ratios was suggested by Morrow, Cupp & Sachs (1965). Their study reported a sibship sex ratio of 0.625 among 335 male freshman college students, indicating that perhaps one should not expect a ratio of 0.53 when sampling from an all male population. The issue remains unresolved.

Using data from many of the studies above, Suarez & Przybeck (1980) created multiplicative and additive risk models relating male homosexuality to the sexual configuration of the men's sibships. Their analysis suggested that approximately 10% of the variance in male

homosexual behavior could be statistically accounted for by the increased number of brothers in the subject's family.

Whether this 10% is meaningful and reliable was the question assessed by this study: a meta analysis of all previous sex ratio data found to be reliable and accessible, as well as data collected from a survey of a small sample of women. In addition to some of the aforementioned studies, the meta-analysis includes data from Bell et al. (1981b), Bieber et al. (1962), Gundlach (1977), Henry (1948), Lang (1960), Pillard et al. (1981, 1982), Saghir & Robins (1973), and Westwood (1960) for a total of eighteen studies published between 1940 and 1982. Altogether, these studies include data from 5553 male homosexual subjects, 1100 male heterosexual subjects, 445 female homosexual subjects, and 436 female heterosexual subjects. A group of 1880 male 'control' subjects are also used for comparison, although the researchers failed to determine the sexual orientation of these individuals.

#### SEX RATIO AT BIRTH

To decide which factors need to be controlled for in sex ratio studies, as well as to determine a valid estimate of the actual sex ratio at birth within a specific population, the literature on the overall sex ratio at birth within populations must be examined. The following information is largely from an extensive literature review by James (1987a).

Although the sex ratio of human infants at birth remains

remarkably homogenous across populations and throughout time (varying from approximate male proportions of 0.52 to 0.535 in White populations), many factors have been identified that seem to influence the sex ratio of children born to specific parents. The majority of the studies in this field are based on thousands or millions of births, and can thus detect significant but minute changes from the expected sex ratio. Although all of the potential factors must ultimately derive from biological differences, it is possible to somewhat arbitrarily define inter-related areas for study: biological (genetic and developmental variations in either parent), medical (medical conditions, diseases and treatments), environmental (exposure to various substances), social/demographic (geographical and sociological positions), behavioral (specific parental actions), psychological (psychological attributes of the parents), and temporal (seasonal and historical variations). Each of these conditions will be addressed in sequence.

#### Biological Factors

Direct biological factors consist of the characteristics of sperm, the levels of maternal hormones at conception, and the immunological interactions between the mother and the embryo, all of which may theoretically vary with age. It is thought that sex-selective spontaneous abortions occur in relation to immunological interactions between different fetal and maternal ABO blood groups, influencing the sex

ratio at implantation, possibly fetal mortality at a later stage, and consequently the sex ratio at birth (Chahnazarian 1988). The timing of fertilization is associated with substantial variance in the sex ratio at birth, forming a U shape in natural insemination with the proportions of male conceptions being greatest at the beginning and end of the cycle. In artificial insemination, this property appears to be exactly reversed, forming a  $\cap$  shape throughout the cycle (James 1987a). Other biological oddities include the propensity for two right-handed parents to have the highest proportion of males in their offspring (James 1987a), and the negative effect of maternal parity (James 1975b, MacGillivray, Davey & Lawley 1986).

Indirect biological factors include race and parental age. Compared to Whites, Blacks have consistently lower sex ratios, even when parental ages and birth order are controlled for (Chahnazarian 1988, Guttentag & Secord 1983, James 1987a), while Orientals have higher sex ratios (James 1987a). This seems to be dependent on paternal factors, as demonstrated by Ruder (1986) in comparisons of inter-racial births. Although maternal age was initially expected to account for variation in sex ratio, it turns out to be an artifact of increased paternal age when birth order and paternal age are controlled for (Chahnazarian 1988). Paternal age continues to have a slight negative effect on sex ratio.

More theoretical biological factors include the



possibility of Poisson variation (does the probability of a male pregnancy remain constant throughout a woman's child bearing years?), Lexis variation (does the probability of a male pregnancy vary from one woman or couple to another while remaining constant within a given couple?) and Markov association (does the sex of antecedent pregnancies affect the sex of a current pregnancy?). James (1987a) claimed that "it seems highly likely that there is a slight measure of Poisson variation" and that "the evidence for either Lexis variation or Markov associations (or both) is strong". Some studies show that the probability of a male birth is positively correlated between adjacent births, yet Gualtieri, Hicks, & Mayo (1984), studying the sibling configurations of 649,366 American secondary school students, found that the sex of a later-born child is negatively influenced by the sex of antecedent siblings. In any event, the birth intervals between male then female siblings are particularly long, the intervals between female then male siblings are short, and both types of same-sex intervals are of intermediate length (James 1975b).

#### Medical Factors

The sex ratio is affected slightly by the location of an anomalously implanted pregnancy. In placenta previa, the conceptus implants near or over the cervical os, and is correlated with more male fetuses. Extrauterine pregnancies, when the blastocyst implants outside the uterus, are

accompanied by a higher proportion of females in both therapeutically removed and delivered pregnancies (James 1987a).

Parental diseases that result in substantial sex ratio differences are numerous. Male and female patients with Non-Hodgkin's Lymphoma experience a decrease in the number of male offspring (James 1987a), while women who develop toxemia of pregnancy and men who later suffer from prostatic cancer conceive significantly fewer females (James 1987a). Although multiple sclerosis in men does not affect the sex ratio of offspring, women with multiple sclerosis produce more sons (James 1987a). Mothers with hepatitis B surface antigen (carriers) have an excess of male births, whereas mothers with anti-HBs have an excess of female births (Drew, Blumberg & Robert-Lamblin 1986). It has also been observed that sporadic rises in sex ratio occur in West African villages prior to measles epidemics (James 1987a).

Medical treatments, generally related to reproductive technology, are associated with significant variation in the human sex ratio. Artificial insemination results in a low sex ratio when ovulation is hormonally induced and a high sex ratio otherwise (James 1987a). In this case, the timing of insemination (as mentioned in an earlier section) is also important, as the regression of sex ratio on cycle day appears to follow a  $\cap$  shape rather than the U regression of natural fertilization. The cause for this is unknown, but has been speculated to be related to female orgasm (Guttentag

& Secord 1983). Men treated for subfertility with Methyltestosterone and hCG (gonadotropin) have an increased sex ratio of offspring, while men treated with clomphene have a decreased sex ratio (James 1987a). In cases of oral contraception failure, the women give birth to more sons (James 1987a). However, prior successful oral contraception seems to have no effect on the sex ratio of subsequent pregnancies (James 1987a). Spontaneous abortions appear to have no effect on the sex ratio of future pregnancies, but prior induced abortions may cause variation in the following years. James (1987a) cites studies that found probabilities of male births at 0.43 within one year, 0.48 between one and two years, and 0.56 in two years or more after the abortion.

#### Environmental Factors

Industrial pollution does not seem to have an effect on the sex ratio at birth (James 1987a), but Chahnazarian (1988) suggested that environmental factors such as radiation damage and trace elements of minerals and chemicals in the drinking water may influence the human sex ratio at birth. Men exposed to the Nematocide DBCP produce a significantly greater number of daughters (James 1987a).

#### Social/Demographic Factors

Social and demographic factors include socio-economic status, demography, occupation and birth order. The sex ratios at birth are known to vary from close to 0.55 in the

highest socio-economic level to just barely 0.50 in the lowest (Guttentag & Secord 1983). Although the extremes are well established (James 1987a), the effect of socio-economic class is uncertain and remains very small (Chahnazarian 1988). Race and birth order are often disregarded in these theories. Mealey & Mackey (1990) suggested that human mothers are able to unconsciously manipulate the sex ratio of their offspring in relation to their social status in the community, supported with data from 1,314 women living in a population of nineteenth-century Mormons. In this case, women of a higher social status produced more male offspring, a phenomenon that has been documented in other animal species as well.

Mackey & Coney (1987) found that the offspring sex ratio at birth for men and women both from the Social Register (interpreted as an index of ascribed status) and from individuals listed in American Who's Who (viewed as an index of achieved status) is similar to population averages. However, the wives of men in Who's Who had a significantly higher than average sex ratio for the first child, which was also higher than the average for the second and third children. Whereas the wives on men in Who's Who were biased towards having a first born son, the women in Who's Who were biased toward having a son as second born.

The differences between the sex ratios of urban and rural populations are inconsistent at best (James 1987a), although the dizygotic twinning rate is mysteriously lower in

urban areas without affecting the sex ratio (James 1987a). (Twin births have a lower overall sex ratio than singleton births, probably due to the low sex ratio in monozygotic twins. The actual sibships of dizygotic twins have a higher than average sex ratio (James 1975a), and the dizygotic twins themselves probably do as well.)

A controversial effect of either parent's occupation has been claimed (James 1987a)- if the parent is in a "masculine" occupation more sons are born, whereas more daughters are born to parents in "feminine" occupations. (The "masculinity" of an occupation is defined by the proportion of members that are men, an unstable characteristic to begin with.)

As birth order increases, the sex ratio at birth consistently decreases (Chahnazarian 1988, James 1975b, James 1987a, MacGillivray et al. 1986).

#### Behavioral Factors

Behavioral attributes of the parents also contribute to slight variations in sex ratio. Women who smoke tobacco have a smaller percentage of sons (James 1987a). Claims have been made that specific diets affect the sex ratio of offspring, but this is unlikely other than the relationship between pre-natal nutrition and fetal death rate. [Fetal death rate, represented by a disproportionate number of males for most of the prenatal period (Chahnazarian 1988, Guttentag & Secord 1983), decreases as maternal nutrition and medical care is

improved. This has been hypothesized to contribute to the slight variations in sex ratio found in differing socio-economic classes, as well as possibly contributing to the lower sex ratios at birth of American Blacks (Guttentag & Secord 1983).]

The most significant behavioral factor appears to be coital rate, which may vary both between and within couples and populations. It is presumed that coital rate affects the sex ratio at birth by altering the time of insemination within the cycle. Coital frequency may vary with parental age, birth order of children, religious beliefs and even the sex ratio of existing children (James 1975b). James (1975a) suggests that high coital rates account for the high sex ratio witnessed among large sibships, sibships with dizygotic twins, and Jewish sibships. Regarding the sex ratios in Jewish populations, Guttentag & Secord (1983) report the sex ratios of different religious groups in Imperial Russia for nine years between 1867 and 1884, "The sex ratios for Jews average [0.685], while for all other religious groups they average [0.525]. With populations so large, and with nine nearly consecutive censuses, these sex ratio differences at birth are highly reliable. The difference between Jewish sex ratios at birth and all other religious groups, in every census year, is so great that they could not have occurred by chance." (pg 86). Only the sex ratios of Orthodox Jews are significantly higher than expected, necessitating a factor related to their religious practices and customs.

It has also been suggested by Guttentag & Secord (1983) that the frequency of intercourse differentially affects men and women, increasing the probability of a male pregnancy in women and decreasing the likelihood of male conceptions by men. Assuming that as the degree of polygyny increases, the frequency of intercourse increases in men and decreases in women, some support to this theory is given by Guttentag & Secord's (1983) personal communication with J. Whiting, who examined 500 populations from the Human Relations Area File and found sex ratios of 0.565 in monogamous, 0.52 in limited polygynous and 0.495 in full polygynous cultures. This factor is potentially important to sex ratio studies that use polygynous societies to determine the effect of social status.

Although the children of illegitimate unions may contain a preponderance of females (James 1987a), it is very slight in magnitude and has not been found by other researchers (Chahnazarian 1988). When a difference is found, it is generally attributed to an assumed low coital rate.

#### Psychological Factors

In the few psychological variables that have been studied - people under stress and manic depressives - the opposite sex of the parent in this psychological condition is over-represented in the resulting offspring (James 1987a).

#### Temporal Factors

Temporal factors affecting the sex ratio at birth are

shrouded in controversy. Historically, belligerent countries in wartime show higher sex ratios of infants born during and just after the war (James 1987a). Some large and small samples show no association of seasonality with sex ratio but other studies disagree (James 1987a). The only well documented variation occurs in the United States, where a significant difference across all populations (Black/White, urban/rural, and live births/still births) produces the largest proportion of males in early summer and the largest proportion of females in late fall and winter (James 1987a).

James (1987a) mentioned that slight increases in a population's proportion of males born over a period of time could be accounted for by the diminishing rate of fetal deaths (presumably slightly male biased) or the diminishing family size. Decreasing trends in the ratio of male births could be due to improvements in the registration of female births.

#### A Theory of Sex Determination

Based on all of these combined observations, James (1987b) put forth a theory of sex ratio determination based on the hormonal levels of the parents at conception. High levels of estrogen and testosterone are thought to increase the likelihood of male births, while high levels of gonadotropin increase the likelihood of female births.

#### Problems

Although most of these effects are very slight and will



not be realized in smaller samples, it is still important that they be reliably controlled to determine if the variable under study is actually the probable cause for the variation observed. Guttentag & Secord (1983) criticize many of the studies conducted for inherent flaws including the lack of differentiation between normal and abnormal populations, the institution of several different sexual practices concurrently and then drawing conclusions from the results (referring specifically to studies where parents attempting to conceive a certain sex child employ experimental methods), the tendency to assume that any condition associated with high or low sex ratios actually causes the high or low ratio and the generalization from animal husbandry experiments.

Studies on the sex ratio of the siblings of homosexual men and women also contain similar flaws. With regard to sex ratio factors alone, variation could be due to paternal age (and correspondingly maternal age), birth order and differing probabilities for male conceptions between couples. Nonetheless, it is useful to examine discoveries in the field and draw tentative conclusions. To do this, a meta-analysis on all sibling sex ratio data is conducted.

#### META-ANALYSIS

Meta-analysis is a powerful statistical method that combines studies reporting similar variables in an attempt to provide a more detailed analysis and, consequently, more conclusive results. This has the potential to uncover

interesting new correlations, as well as offer explanations for the fact that some studies (with equally valid and scientific approaches) result in conflicting information. As all of the data from studies used in a meta-analysis are combined, almost as if each sample were an individual subject, the resulting sample size is much larger and can include numbers from contradicting sources. This is an ideal technique to determine the true relationship between sexual orientation and sibling sex ratio.

In most research, sexual orientation is treated as a dichotomous, or at most, trichotomous variable, even with evidence that preference for and/or experience with same and opposite sex partners falls on a continuum. Ellis, Burke & Ames (1987) found that their 171 male and 257 female subjects (all over age 20) fit a sexual orientation continuum far better than a dichotomous variable. Ellis et al. (1987) concluded that the estimated frequencies of homosexuality, bisexuality and heterosexuality in populations are largely dependent on where the boundaries for the various categories have been demarcated. The proportions of each can thus be substantially altered by making cuts in the continuum at different locations. McConaghy (1987) also presented data supporting the concept of a hetero-homosexual continuum from 3 consecutive year samples of 75%-85% of all the 2nd year medical students at the University of New South Wales. Of 390 males and 152 females, a significant percentage reported awareness of a homosexual component to their sexual feelings

and behaviors. McConaghy (1987) further questioned the notion that bisexuals should display equivalent percentages of homo- and heterosexual behavior, presenting the argument that homosexual preference must be significantly stronger than 50% for homosexual behaviors to equal 50% of experience, due to the extreme social and legal proscription of homosexual behavior. Although not mentioned, the restricted number of available partners may also affect this balance.

Even if one does limit sexual orientation to a dichotomous variable, homosexuals are frequently studied without reference to their heterosexual counterparts. 'Control' groups are occasionally assumed to be heterosexual, without determining sexual orientation. As is largely true of scientific research, female populations are often neglected. The majority of research hypotheses rely heavily on data from exclusively male subjects and generally assume that the hypotheses will work equally well when applied to women. To lessen the numerical gap between the largest sample collected for the meta-analysis (homosexual men) and the smallest sample collected (heterosexual women), a survey of adult heterosexual women was completed. Please refer to Appendix A for a brief account of methods, results and discussion.

## Meta-Analysis Methods

### Locating Studies

Studies utilized in the meta-analysis fulfilled the following criteria: 1) actual number of subjects was reported, as well as number and sex of siblings (or numbers that could be accurately converted into such), 2) majority of sample Caucasian, 3) majority of sample single births, and 4) data on all siblings in sibship for sibship size used, or data on the first eight sibs of samples that did not categorize by sibship size.

Relevant articles were identified through searches of the Social Sciences Index, General Sciences Index, Psychological Abstracts, Dissertation Abstracts, Social Science Citation Index, Science Citation Index, Psychology Information database, Educational Resources and Information Clearing House files (ERIC), and Medline. An annotated bibliography of homosexuality edited by Weinberg & Bell (1972) and the bibliographies of articles and texts were also utilized. Further data used in the meta-analysis was procured from the author's recent survey of adult heterosexual women. Although some studies were not done specifically to determine the sex ratio of subject's families, often the numbers of brothers and sisters were included. This information was utilized where possible.

Coding Data

Since some articles cite numbers slightly different from data reported in the original studies, only information from the original source is used whenever possible.

Unfortunately, information discrepancies within and between articles by the same authors also exist. Generally, the most recently published data is used, and information from the text is preferred to that from tables and charts. Data reported in English is given precedence over data printed in German. For an explicit description of the characteristics of each study, please refer to Appendix B. Complete references for each of the studies utilized is reported in Appendix C. With explicit coding instructions, inter-rater reliability testing on seven of the articles printed in English yielded less than 0.01% variance in total numbers of subjects, brothers and sisters recorded. The sex and orientation of subjects were coded identically in all cases.

Beyond the issue of how to interpret the data presented, it is important to realize that the data themselves may not be reliable. Accurately coding studies for use in the meta-analysis was especially difficult due to the lack of precision by many of the authors. None of the studies explained how sex ratios were calculated, but in many instances it was obvious that the index cases were not included. The rationale behind this is that the birth of each sibling is a theoretically independent event and should

thus result in approximately 50% brothers and 50% sisters in each subject's family. This method necessarily excludes only children, but this fact was not mentioned in the majority of the articles. Another problem arises from the imprecise definition of 'sibling'. The inclusion (or not) of stillborn births, siblings that died at a very young age, half siblings, step siblings and adopted siblings often were left to the reader's interpretations. Obviously, the type of theory one is trying to support determines which of these various groups is included. If studying the social effect of siblings, one would probably include all children in the household, whether biological siblings or not. If interested only in genetic information, all siblings that were born of the same parents would be included. Despite the importance of this distinction, virtually none of the authors specified exactly what data they were collecting. In future research, it would be helpful if these systematic errors were eliminated through thorough reporting of methods and means.

#### Procedure

After the studies were coded, all samples containing a majority of Black subjects or twins were removed. Data on subjects who reported a bisexual orientation (even with a preference for same sex partners) were also excluded.

Proportions were calculated by dividing the total number of brothers by the total number of sisters, not including the subject, for each study sample. To assure independence

between the measures, only one proportion per subject type (homosexual male or female, heterosexual male or female, male control) was used from each individual study. However, separate figures may be used in different calculations. (For example, data for homosexual men of all ages and data for homosexual men above age 25 are sometimes found in the same study. These separate proportions were never combined in an overall weighted mean value.)

Weighted means for each subject group were calculated using the formula:

$$\frac{\sum_{i=1}^k Ns_i (Bs_i/Ss_i)}{Nt}$$

where  $Ns$  is the sample size for each study,  $Bs$  is the total number of brothers reported in each study,  $Ss$  is the total number of sisters reported in each study, and  $Nt$  is the total sample of the entire subject group (sum of individual  $Ns$ ). Although the unweighted means for each group were similar, weighted means were used due to the extreme variance in sample size and corresponding sibling sex ratios between the various studies.

The hypothesis that the proportion of brothers found in the members of a given subject group would exceed the population value ( $p$ ) was tested using confidence belts for proportions from Dixon & Massey (1969). The population value ( $p$ ) was estimated as 0.53, a figure purposefully set slightly higher than the average proportion of white male births in the United States. One tailed confidence intervals were determined for each proportion. A one tailed confidence

interval examines only the pertinent end of a binomial distribution curve. In this case, the data are compared only to portions of the curve above  $p$  (0.53) and not those below, thus allowing a rejection only of the hypothesis that the proportion is greater than  $p$  (0.53) and not commenting on proportions that may be significantly less than  $p$  (0.53). Results for the homosexual men, heterosexual men, and control men are somewhat conservative, since the largest sample size graphed on the confidence belts was 1000. The alpha level reported for each subject group is the smallest obtained.

#### Results

The results show a significantly higher than expected number of male siblings for the homosexual subjects, both male and female. The weighted mean for female subjects is 0.5913, the 2.5% tail for the confidence interval on  $p$  begins at 0.54; for male subjects weighted mean is 0.5846, the 0.5% tail for the confidence interval on  $p$  begins at 0.55. A higher proportion of brothers is even more pronounced in the sibships of male homosexual subjects aged 25 years and older. Weighted mean is 0.6291, the 0.5% tail for the confidence interval on  $p$  begins at 0.59. Both heterosexual groups, however, do not significantly differ from either the overall sex ratio at birth for the United States (0.525) or the sex ratio at birth specific to American Whites (0.5289). Weighted mean for female subjects is 0.5059, the 5% tail for the confidence interval on  $p$  begins at 0.47; for male



subjects weighted mean is 0.5345, the 5% tail for the confidence interval on  $p$  begins at 0.51. The average of the control males falls in between the averages for the homosexual and heterosexual groups, and is not significantly different from the population averages. Weighted mean for males in control groups is 0.5573, the 5% tail for the confidence interval on  $p$  begins at 0.53. Control groups probably contain both heterosexual and homosexual men, just as the general population would, and would thus not be expected to differ significantly from the population value.

In order to determine if a researcher bias or publication bias was present in the studies used in the meta-analysis, several additional comparisons were made. A researcher bias would be present if the older studies with fewer controlled variables and more loosely defined terms were to contribute the samples that influenced the sibling sex ratios of homosexuals to be higher than those of heterosexuals. 'Old' studies are defined as those published between 1940 and 1969, and contain 4868 of the male homosexual subjects (87.7%). The weighted mean proportion is 0.5872. The 5% tail for the confidence interval on  $p$  begins at 0.55, indicating that this subset would support the hypothesis that the proportion of brothers to sisters is greater than 0.53. The 'new' studies were published between 1970 and 1982, and include 685 of the male homosexual subjects (12.3%). The weighted mean proportion for this group is 0.5659, with a 5% tail for the confidence interval

on  $p$  beginning at 0.53. The likelihood of a larger proportion of brothers can no longer be supported, indicating that researcher bias is highly probable. The 'Old' studies contained only 78 of the heterosexual male subjects, 50 of the homosexual female subjects and none of the heterosexual female subjects, and thus would not have yielded meaningful comparisons.

Publication bias is embodied by the tendency for published research to contain more significant results than similar unpublished data. It is thus possible that researchers studying only the variable of sibling sex ratio may have contributed the bulk of higher male proportions to the homosexual subject groups. (Studies with multiple variables would not need the justification of significant sibling sex ratio results to achieve publication, especially in the cases where sibling sex ratio was not under examination.) To determine the possible presence of publication bias, studies researching only sibling sex ratio were compared to all other studies. [Refer to Appendix B for a breakdown of which studies fell into the 'sex ratio research' category.] Ratio studies contributed 3897 male homosexual subjects (70.2%) and yielded a weighted mean proportion of 0.5971; the 5% tail for the confidence interval on  $p$  begins at 0.56. Other studies contained 1656 male homosexual subjects (29.8%) and resulted in a weighted mean of 0.5551; the 5% tailed for the confidence interval on  $p$  begins at 0.53. The presence of a higher proportion of

brothers is again no longer supported. None of the homosexual female subjects, heterosexual female subjects or male heterosexual subjects originated from studies based exclusively on sibling sex ratios.

#### Discussion

Although it is more pronounced in females, both homosexual subject groups have significantly more brothers than the usual sex ratio of births in the American White population. Both heterosexual groups differ only slightly from population averages and do not contain a significantly higher proportion of brothers. Comparing the heterosexual and homosexual groups to each other yields an average discrepancy of 17.08 extra brothers among every 100 lesbians and 10.02 extra brothers among every 100 gay men. The excess changes to 12.48 extra brothers for every 100 homosexual women and 11.14 extra brothers for every 100 homosexual men when the homosexual subjects are compared to the sex ratio at birth of United States Whites. However, the fact that data from newer studies and multivariate studies does not significantly differ from the proportion of male births in the United States casts doubt on the validity of the elevated proportion of brothers in the sibships of male homosexual subjects.

Although Morrow et al. (1965) suggested that when one is sampling from a single sex population, it is possible that one should not expect sibling sex ratios that are equivalent

to male/female birth ratios in the general population (occurring if the proportion of unisexual or nearly unisexual sibships is greater than the proportion expected from a random or binomial distribution), this hypothesis was not supported in the present study. Male subjects did not show significantly more male sibs than female subjects and vice versa. Furthermore, comparing the data from heterosexual male populations with the data from homosexual male populations does show an increased number of males in the siblings of homosexual men, when data from all studies are used. Homosexual women also show a higher proportion of brothers. It has been noted by several researchers that the sex ratio in a given family, let alone a population, does not necessarily remain constant over time or between subjects. This could feasibly affect all of the populations studied (i.e., male homosexuals, female homosexuals, etc.) in differing or similar ways, depending on the specific families chosen. (This is particularly possible in the case of non-random subject selection, which seems to be the rule rather than the exception in this field of study.)

One possible explanation for the increased number of males in the siblings of homosexual individuals is that the biological mechanism influencing the sex of the offspring may be qualitatively different in mothers who produce homosexual children, such that a preponderance of males would be found in these families. Hormonal theories fit this situation well- for example, it is possible that higher levels of

androgens would produce both more sons and more homosexual daughters, assuming that the masculinization of the brain is a feasible hypothesis for the etiology of female homosexuality. Hormones (in the pre-natal environment) may also be related to brain dimorphism (Gladue 1987, MacCulloch & Waddington 1981, Money 1986), hand preference (McCormick et al. 1990), and possibly cross-sexed behavior in children (Gladue 1987), all of which may be potentially linked to adult homosexual orientation.

There are many problems with the existing data on sexual orientation and sibling sex ratio. Studies examining infant sex ratio at birth are based on much larger populations, casting doubt on the use of relatively small samples in sexual orientation research. Studies on sexual orientation and sibship sex ratio are often not rigidly structured, leaving the definition of sibling to the reader's interpretation. Frequently, even the crucial variable of sexual orientation is not demarcated; control groups, if present at all, are often not checked for sexual orientation. Subjects are generally from very biased populations, such as patients in psychiatric counseling and prisoners. More subtle confounding variables are not mentioned, even those that have been found to cause considerable variance in the sex ratio at birth of offspring.

Although this study suggests that a reliable and consistent difference in the sibship sex ratios of homosexual and heterosexual individuals does exist, it is necessary to

determine that this is not an artifact of the age of the studies, the inconsistent definitions of variables, or the differentiating factors notoriously left out. The primary task of future research is to determine without doubt what factors primarily affect the mechanism of sex selection in humans, and whether this mechanism differs with sexual orientation. This would necessitate huge samples and extensive controlling for possible confounding variables.

In conclusion, the data from this study do not indicate whether a biological or psychological explanation is more appropriate to the development of human sexual orientation. Considering the vast variance in both human genetic traits and experience, there is probably no one correct answer. The presence of more males in the sibships of homosexual individuals could indicate a cause, an effect, or only a correlating variable. However, a plausible explanation of either perspective should account for the presence of more brothers in the sibships of homosexual men and women. Although this research could be used in support of either physiological or psychological theories utilizing family variables, further research is needed to determine which paradigm (or combination of factors) is actually the most promising. The next empirical step suggested involves a large-scale study of homosexual and heterosexual men and women that controls for critical variables such as paternal age (and corresponding maternal age), race, birth order and birth cohort. It would be admittedly difficult to control

for other important factors such as parental hormonal level, diseases and genetic variations in the probability of giving birth to sons at conception of the individual under study.

The most promising avenue of future research seems to be the theories on pre-natal hormonal environment. These hypotheses have the potential to illuminate many of the current questions, such as the mechanism for sex determination at conception, and the development of sexual orientation. Furthermore, the most appropriate approach seems to be the interaction of physiological and environmental factors rather than attempting to separate the two. It is most likely that sexual orientation is derived through an interaction of many different variables, each of which may possibly be affected by seemingly insignificant changes.

Appendix A: Survey of adult heterosexual women

Methods

Subjects

The subjects were 235 women employed by a small, private midwestern college as faculty and staff. Most persons employed by this institution are white, middle-class Americans.

Procedure

A short survey requesting age (under 35 or 35 and over), number of full siblings (live births), and sexual orientation (heterosexual, bisexual or homosexual) was sent to all prospective subjects. A self addressed return envelope was included for convenience and confidentiality.

Results

Of the 235 surveys mailed, 162 were recovered (69%) within the designated time period. Eight reported either bisexual or homosexual orientation, 9 had no siblings, and one indicated no age category, leaving 43 heterosexual women under 35 and 101 heterosexual women aged 35 and over.

The under 35 heterosexuals reported 73 brothers and 85 sisters, with an average of 3.67 siblings and a male to female sibling sex ratio of 0.429. The heterosexuals aged 35 and over reported 194 brothers and 196 sisters, with an average of 3.86 siblings and a male to female sibling sex ratio of 0.495. Together, the groups comprised 145 subjects (including the one with undifferentiated age) and had a total



of 269 brothers and 281 sisters, providing an average of 3.79 siblings and an overall proportion of 0.479 brothers.

Inter-rater reliability testing yielded correspondance rates in excess of 99% for all measures.

### Discussion

Speculations about the non-responding subjects (31%) may be made for comparison. If one assumes that they are all homosexual or bisexual (highly doubtful based on population estimates of 4-6%), no additional data would have been collected. If, however, one assumes they are all heterosexual and follow the composition of the actual respondents with regard to age classification and subsequent average numbers of siblings, 22 heterosexuals under 35 and 51 heterosexuals 35 and over are missing.

It is likely that these missing individuals would also report similar ratios of brothers and sisters, but for the sake of comparison I will assume that they may have reported one and a half times as many brothers as sisters or the reverse, unlike the sample obtained. This would alter the data in the following way:

Sample sizes: under 35 - 65; 35 & over - 152.

1.5x as many brothers			
under 35	121 brothers	118 sisters	<u>ratio</u> .513
35 & over	312 brothers	275 sisters	.567
1.5x as many sisters			
under 35	106 brothers	133 sisters	<u>ratio</u> .399
35 & over	273 brothers	314 sisters	.435

Although these numbers are clearly swayed significantly in the direction of assumed excess in the non-respondents, neither is a likely condition. It is more reasonable to assume that a certain percentage of subjects did not return the survey due to perceived lack of utility (adopted children and only children, for example), some subjects simply do not bother to return surveys and some others may have been uncomfortable reporting a homosexual or bisexual orientation. (This last factor is given partial credence by the fact that none of the homosexual respondents were aged 35 years or older. This is not likely to be representative of the actual population sampled, especially considering that women may not have realized a homo or bisexual orientation before age 35.) A few surveys were probably lost due to subject's absence during the study period, change in employment or incorrect campus address. In conclusion, the achieved sibling sex ratios (subject is not included in the calculations) show a slight shift towards an excess of females (overall ratio of .486).

Appendix B: Characteristics of Studies Used in the Meta-Analysis

Abbreviations

For the Column Headings:

Yr = year published / year data collected  
 Lo = location of study  
 D = study design  
 T = subject type  
 G = subject gender  
 SO = subject sexual orientation  
 Age = subject age at time of study  
 N = number of subjects (sample size)  
 L = limitations on study data  
 Rat = ratio of brothers to sisters reported  
 O = subjects with no siblings included in data?  
 H = half siblings included in data?  
 S = step siblings included in data?  
 Y = siblings that died young included in data?  
 B = stillborn siblings included in data?

1st Author Column:

[ ]= unpublished data

(Lo) Location Column:

En= England  
 Gr= Germany

(D) Study Design Column:

I = Sibling sex ratio included with other variables  
 O = Study on other sibling variables  
 R = Sibling sex ratio study

(T) Subject Type Column:

C = College student  
 G = Group member (organization, employees, residents)  
 M = Medical records, patients in counseling or hospital  
 P = Prisoners and police lists (not in treatment)  
 R = Respondent or volunteer  
 S = Several categories (ie respondents & group members)  
 X = Matched sample  
 ? = Not mentioned or unable to determine

(G) Gender Column:

M = Male  
 F = Female

(SO) Sexual Orientation Column:

HS= Homosexual  
 HT= Heterosexual  
 CT= Control (sexual orientation not specified)

Age Column:

0.00 = mean age of subjects  
 N.S. = not specified

(L) Limitations Column:

\* = uncertain data (discrepancies in article)  
 # = limited by certain sibship sizes  
 @ = only sibs of a certain age included

(O) Onlies, (H) Half Siblings, (S) Step Siblings,  
 (Y) Died Young and (B) Stillborn Columns:

Y = (Onlies) are included in the data  
 N = (Onlies) are not included in the data  
 S = (Onlies) data are listed separately  
 ? = (Onlies) are not mentioned in the study  
 R = (Onlies) have been removed from data

1st Author	Yr	Lo	D	T	G	SO	Age	N	L	Bro	Sis	Rat	O	H	S	Y	B
Bell	81	US	I	R	M	HS	N.S.	494#		580	565	0.51	R	?	R	?	?
				R	M	HT	N.S.	235#		279	273	0.51	R	?	R	?	?
				R	F	HS	N.S.	188#		203	184	0.55	R	?	R	?	?
				R	F	HT	N.S.	90#		107	106	0.50	R	?	R	?	?
Bieber	62	US	I	M	M	HS	N.S.	95		103	95	0.54	R	?	?	?	?
				M	M	HT	N.S.	78		84	73	0.55	R	?	?	?	?
Darke	48	US	R	M	M	HS	=<25	27		48	42	0.57	?	S	?	?	S
				M	M	HS	>25	21		30	38	0.39	?	S	?	?	S
Giese	58	Gr	I	?	M	HS	N.S.	306		441	395	0.48	S	N	N	?	?
[Gribneau]	91	US	R	R	F	HT	<35	43		73	85	0.43	S	N	N	Y	N
				R	F	HT	=>35	101		194	196	0.49	S	N	N	Y	N
				R	F	HT	All	145		269	281	0.48	S	N	N	Y	N
Gundlach	77	US	O	G	F	HS	N.S.	138#		130	105	0.62	S	?	?	?	?
				X	F	HT	N.S.	158#		141	128	0.55	S	?	?	?	?
Henry	48	US	O	R	M	HS	N.S.	23		36	42	0.43	S	S	N	Y	S
				R	F	HS	N.S.	11		23	22	0.52	S	S	N	Y	S

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1st Author	Yr	Lo	D	T	G	SO	Age	N	L	Bro	Sis	Rat	O	H	S	Y	B
Jensch	41	Gr	R	P	M	HS	<25	683		961	984	0.49	?	N	N	Y	?
				P	M	HS	>25	1389		2833	2349	0.60	?	N	N	Y	?
Kallmann	52	US	I	M	M	HS	<25	44		95	76	0.63	?	?	?	?	?
				M	M	HS	=>25	68		168	132	0.64	?	?	?	?	?
				G	M	CT	<25	15		24	15	0.80	?	?	?	?	?
				G	M	CT	=>25	101		161	152	0.53	?	?	?	?	?
Lang	40	Gr	R	P	M	HS	<25	516		778	687	0.57	?	S	?	Y	S
				P	M	HS	>25	499		956	745	0.64	?	S	?	Y	S
				?	M	CT	N.S.	1296		3720	3470	0.54	?	?	?	?	?
Lang	60	Gr	R	P	M	HS	<25	309		388	319	0.61	?	?	?	?	?
				M	M	HS	>25	453		756	536	0.71	?	?	?	?	?
Morrow	65	US	R	C	M	CT	N.S.	335		349	278	0.63	?	N	N	Y	?
Pillard	81	US	O	R	M	HS	N.S.	36		45	35	0.64	?	?	?	?	?
Pillard	82	US	O	R	M	HS	N.S.	50@		64	46	0.70	N	Y	?	N	N
				R	M	HT	N.S.	50@		53	63	0.42	N	Y	?	N	N
Saghir	73	US	I	S	M	HS	N.S.	61*		67	51	0.66	S	?	?	?	?
				S	F	HS	N.S.	56		56	43	0.65	?	?	?	?	?
				G	M	HT	N.S.	31*		31	49	0.32	S	?	?	?	?
				G	F	HT	N.S.	43		54	62	0.44	?	?	?	?	?
Schubert	76	US	O	M	M	HS	N.S.	44#		41	25	0.82	S	?	?	?	?
				M	M	HT	N.S.	706#		495	443	0.56	S	?	?	?	?
				C	M	CT	N.S.	133#		104	88	0.59	N	?	?	?	?
Slater	58	En	I	M	M	HS	31.7	286		362	325	0.56	?	?	?	?	?
				M	F	HS	31.1	39*		42	34	0.62	?	?	?	?	?
Spencer	59	En	I	C	M	HS	N.S.	49		38	40	0.48	?	?	?	?	?
Westwood	60	En	O	R	M	HS	N.S.	100		105	114	0.46	S	Y	Y	N	N

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