


Sexual Orientation, Controversy, and Science

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Summary

Ongoing political controversies around the world exemplify a long-standing and widespread preoccupation with the acceptability of homosexuality. Nonheterosexual people have seen dramatic surges both in their rights and in positive public opinion in many Western countries. In contrast, in much of Africa, the Middle East, the Caribbean, Oceania, and parts of Asia, homosexual behavior remains illegal and severely punishable, with some countries retaining the death penalty for it. Political controversies about sexual orientation have often overlapped with scientific controversies. That is, participants on both sides of the sociopolitical debates have tended to believe that scientific findings—and scientific truths—about sexual orientation matter a great deal in making political decisions. The most contentious scientific issues have concerned the causes of sexual orientation—that is, why are some people heterosexual, others bisexual, and others homosexual? The actual relevance of these issues to social, political, and ethical decisions is often poorly justified, however.

Keywords

sexual orientation, causes, sex differences, social implications

Introduction

This article has two related goals. The first is to provide a current summary of scientific findings regarding sexual orientation. Although we focus most on causation, we also address other scientific issues concerning sexual orientation, including its meaning and measurement, sex differences in its expression, its development, and its expression across time and place. Regarding causation, we provide a taxonomy of causal hypotheses and review evidence for them. These include hormonal, genetic, social environmental, and nonsocial environmental influences. Our second goal is less scientific and more analytical: to criticize and improve common but incorrect reasoning in this domain. For example, the commonly phrased question of whether sexual orientation is “a choice” is a poor one for advancing either scientific understanding or policy. A more meaningful formulation is whether sexual orientation is socially influenced.

Our review has led us to the following conclusions.

Sexual orientation refers to relative sexual attraction to men, to women, or to both. People who are sexually attracted to the same sex (whom we denote as “nonheterosexual”) represent a minority of adults. Those with predominantly same-sex attractions comprise fewer than 5% of respondents in most Western surveys. Data from non-Western cultures are consistent with this conclusion. There is no persuasive evidence that the rate of same-sex attraction has varied much across time or place.

Male and female sexual orientations differ in several respects. Women are more likely to report a bisexual than an exclusively same-sex orientation; men show the opposite pattern. Men's sexual orientations are closely

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linked to their pattern of sexual arousal to male versus female erotic stimuli; women's are not. Women appear more likely than men to experience same-sex attraction in the context of close affectionate relationships, and their patterns of sexual attraction appear more likely to exhibit change over time.

Across many different cultures, male and female non-heterosexuality in adulthood tends to be preceded by childhood gender nonconformity: a pattern of behavior somewhat like that of the other sex. Childhood gender nonconformity is a matter of degree, and it can range from subtle to extreme. Often, it emerges at an early age, despite conventional gender socialization. Among some adults, childhood gender nonconformity appears to persist into adulthood.

Individuals' political attitudes about sexual orientation tend to correlate with their views of the causes of sexual orientation. Those who hold positive attitudes (i.e., that there is nothing inherently wrong with nonheterosexuality or its open expression) have tended to believe that sexual orientation is due to nonsocial causes such as genetics. Those who hold negative attitudes (i.e., that nonheterosexuality is undesirable or immoral and that society should restrict its free expression) have tended to believe that homosexuality has social causes, such as early sexual experiences and cultural acceptance of non-heterosexuality. We refer to these as the "nonsocial" and "social" hypotheses, respectively. Both hypotheses require direct scientific support; neither can claim confirmation solely because support for the other is weak.

No causal theory of sexual orientation has yet gained widespread support. The most scientifically plausible causal hypotheses are difficult to test. However, there is considerably more evidence supporting nonsocial causes of sexual orientation than social causes. This evidence includes the cross-culturally robust finding that adult homosexuality is strongly related to childhood gender nonconformity; moderate genetic influences demonstrated in well-sampled twin studies; the cross-culturally robust fraternal-birth-order effect on male sexual orientation; and the finding that when infant boys are surgically and socially "changed" into girls, their eventual sexual orientation is unchanged (i.e., they remain sexually attracted to females). In contrast, evidence for the most commonly hypothesized social causes of homosexuality—sexual recruitment by homosexual adults, patterns of disordered parenting, or the influence of homosexual parents—is generally weak in magnitude and distorted by numerous confounding factors.

With respect to scientific and social policy, we offer three general conclusions:

1. Scientifically, sexual orientation is an important, fundamental trait that has been understudied

because it is politically controversial. This is a mistake. In fact, the more politically controversial a topic, the more it is in the public interest to illuminate it in a revealing and unbiased manner. Our article is offered in the spirit of progress toward that end.

2. Scientists, activists, and policy makers should reason more carefully regarding potential ethical or policy implications of scientific findings. For example, the issue of whether sexual orientation is chosen represents intellectual confusion, and no scientific finding will illuminate this issue in any interesting way. Although clumsy reasoning may advantage a particular political position in the short term, in the long term, clear thinking is best for everyone.
3. The most common meaningful controversy across time and place has concerned the extent to which homosexuality is socially influenced and, more specifically, whether or not it spreads as a result of contagion and social tolerance. There is no good evidence that either increases the rate of homosexual orientation, although tolerance may facilitate behavioral expression of homosexual desire. Suppressing homosexual behavior imposes an immense burden on homosexually oriented people and serves no apparent legitimate social goal that cannot be reached in other ways.

The political rights of lesbian, gay, and bisexual (LGB) men and women have dramatically improved in many Western countries during the past 50 years. In the United States, for example, the Supreme Court ruled in June 2015 that individual states must allow marriages between same-sex couples. This result would have been unthinkable in 1965, when homosexual behavior was illegal, homosexual inclinations were a source of shame, and most Americans believed homosexuality was a mental illness (e.g., "The Homosexual in America," 1966). As of May 2015, 118 nations do not criminalize homosexual behavior (Carroll & Itaborahy, 2015).

The trajectory of LGB rights has been quite different in many other parts of the world, however. Currently, 75 countries legally proscribe homosexual behavior. Eleven countries—all in Africa, Asia and the Middle East—retain the death penalty as a possible sanction for homosexual acts¹ (International Lesbian and Gay Association, 2015; Stewart, 2015).

It might be tempting to assume that much of the world is lagging behind but will ultimately follow the more accepting Western nations toward tolerance. That outcome is not assured, however. In some nations, tolerance of homosexuality appears to be decreasing. For example, Uganda has been struggling with the issue of whether to

increase penalties for criminal offenses related to homosexuality. Same-sex relationships are already illegal in Uganda (as they are in most, but not all, African countries), with penalties as severe as 14 years in prison, but many Ugandan lawmakers have sought to increase penalties substantially. Early versions of proposed legislation included the death penalty for certain offenses (e.g., homosexual acts committed by a person with HIV).

It is important to emphasize that the Ugandan approach to homosexuality is not uniform across Africa—some African nations are quietly moving toward increased LGB rights (e.g., Cowell, 2013), as are parts of the Middle East, Asia, the Caribbean, and Oceania (e.g., “Nepal Court Rules on Gay Rights,” 2007; Brodie, 2014; Hu, 2015; Lavers, 2012; Littauer, 2014). Equally, it is important to note that Uganda is not alone in its attempts to curtail LGB rights (e.g., Canning, 2013; Garcia, 2014). Despite their different political trajectories, there are important similarities among almost all modern nations. All have histories of anti-homosexual prejudice.

Another similarity between pro- and anti-homosexual forces worldwide has been intense debate about scientific findings regarding sexual orientation. In the West,² there has been a strong correlation between political and moral positions about homosexuality and certain scientific positions about the causes of homosexuality. For example, in the United States, the National Association for Research & Therapy of Homosexuality, whose members believe that homosexuality is an undesirable and treatable condition, maintains a website that includes material attempting to debunk claims that sexual orientation is inborn. Scientific findings have often been used to either support or attack gay rights (Horton, 1995; Pitman, 2011; Sprigg, 2012). In Uganda, anti-homosexual activists from the United States have been influential (Gettleman, 2010; Throckmorton, 2010), and science has also figured prominently in their campaigns for anti-homosexual legislation. President Yoweri Museveni initially refused to sign the Anti-Homosexuality Act because he was unsure whether scientific evidence indicated that sexual orientation is either inborn or acquired. Only in the latter case did he believe that the anti-homosexual legislation could be justified (Mugerwa, 2014). Accordingly, he asked for a summary of the relevant scientific evidence. The resulting statement provided by the Uganda Ministry of Health (Aceng, 2014) removed Museveni’s doubts, and he signed the bill. The Constitutional Court in Uganda subsequently struck down the bill, and currently it is uncertain whether legislators will try again (Feder, 2014; Williams, 2015).

The Present Article

After President Museveni’s call for scientific evidence about the causes of homosexuality, some of us were approached by persons hoping to affect the course of

events in Uganda. They requested that we provide a scientific statement regarding the current status of the science of sexual orientation (Throckmorton, 2014). The delay between Museveni’s reconsideration and his decision was brief, however, and not conducive to a thorough and considered scientific review. Subsequently, we decided to write this article, with the aim of providing one. Collectively, we are well positioned to write such an article, given that the five first authors conduct complementary programs of research that inform on the science of sexual orientation and the last author has published extensively on nonheterosexuality in Africa. We have not attempted to time the completion of the article to coincide with any particular decision by the Ugandan government, but we hope that policymakers in Uganda and elsewhere will find it useful. We expect some of the issues we write about to be discussed in political debates about homosexuality—both in Uganda and in the rest of the world—for the foreseeable future.³

Our article has two main goals: first, to review the current science of sexual orientation, and second, to consider the relevance of scientific findings to political debates about homosexuality. Regarding the first goal, we have focused most effort on the question of causation. The question of whether sexual orientation is influenced—and to what degree—by specific aspects of nature and nurture is the most important and contentious scientific question at issue. Yet we have also addressed several related scientific issues concerning sexual orientation, including its meaning, prevalence, sex differences, development, and universality.

Regarding the second goal of this article, we believe that vast amounts of time have been wasted through the use of imprecise language and dubious arguments concerning the linkage of scientific findings on sexual orientation to political conclusions regarding LGB rights. We mean to correct the most common and serious linguistic and logical mistakes in this arena. More specifically, we argue below that the links between scientific findings and desirable social policies have often been overstated and misidentified. We expect our review will clarify which research questions are potentially politically important and which are “merely” scientifically important. We hope to eliminate, or at least to reduce, longstanding arguments that mix the wrong scientific and political questions. If we can do so, perhaps more progress can be made in resolving unavoidable rather than unnecessary conflict. Thus, we have ambitions to convey basic science accurately and to influence political discussions rationally.

The science of sexual orientation is in the public interest for at least two reasons. First, as we have noted, such science is frequently—if not always correctly—used to support political, social, and moral conclusions regarding homosexuality. Second, the science of sexual

orientation—basic inquiry into why some people are sexually attracted to men and others to women—is intrinsically interesting. Because there is so much public interest in the science of sexual orientation, much relevant literature on this topic comes from sources outside of conventional scientific journals, such as news media, political advocacy writings, and blogs. We have freely cited these unconventional sources where relevant.

The science of sexual orientation comprises a very large body of empirical findings, and so we must narrow it in two ways. First, we focus on research areas we believe are most relevant to the public interest, in both of the respects mentioned above. Second, acknowledging current valid concerns about the excess of statistically significant—but incorrect—scientific findings (Simmons, Nelson, & Simonsohn, 2011), we have tried to focus on the most well-established findings. In addition, we focus on research that has garnered considerable public attention, such as Hamer, Hu, Magnuson, Hu, and Pattatucci's (1993) genetic linkage study, LeVay's (1991) brain study, and Regnerus's (2012a) study of children with nonheterosexual parents. Although we are limiting our review in some ways, we are expanding it in others. Namely, we want to address not only the preoccupations of scientists but also those of non-academics interested in sexual-orientation science. With these goals in mind, we commence our scientific review.

What Is Sexual Orientation?

Four related phenomena fall under the general rubric of sexual orientation, but they are conceptually and empirically distinguishable. They are listed here not in order of importance but in an order that reflects their degree of historical attention. The first phenomenon, *sexual behavior*, consists of sexual interactions between persons of the same sex (homosexual), the other sex (heterosexual), or both sexes (bisexual). The second phenomenon, *sexual identity*, is one's self-conception (sometimes disclosed to others and sometimes not) as a homosexual, bisexual, or heterosexual person. The third phenomenon of sexual orientation is one's degree of *sexual attraction* to the same sex, both sexes, or the other sex. The fourth phenomenon is one's relative *physiological sexual arousal* to men versus women (or to male vs. female erotic stimuli), which is more closely related to other aspects of sexual orientation in men than in women.⁴

Terminology also differs among the different phenomena of sexual orientation. People identify as “gay,” “lesbian,” “bisexual,” or “straight.” Scientists primarily concerned with the consequences of same-sex behavior may refer to “men who have sex with men.” In this report, we refer to sexual attraction patterns as “homosexual,” “bisexual,” or “heterosexual.”⁵ Alternatively, it is

sometimes more relevant to distinguish individuals not according to whether they are attracted to same-sex or other-sex partners but according to whether they are attracted to men (*androphilic*) or women (*gynephilic*). In this usage, both heterosexual women and homosexual men would be considered androphilic because both groups are attracted to men; both heterosexual men and homosexual women would be considered gynephilic because both groups are attracted to women.

Although the four aforementioned phenomena of sexual orientation (behavior, attraction, identity, and arousal) tend to go together—homosexually oriented persons tend to identify as gay or lesbian and to have sex with same-sex partners—they do not always. For example, some men who identify as straight/heterosexual have sex with other men and appear to be most strongly attracted to men. Some adolescents engage in homosexual activity yet grow up to identify and behave as heterosexuals. Similarly, some individuals pursue same-sex relationships in sex-segregated environments, such as boarding schools, prisons, or the military, but resume heterosexual relationships once other-sex partners are available. Moreover, the degree of association among homosexual attraction, behavior, and identity varies across individuals in different cultural contexts. For example, in some cultures and communities, homosexually attracted men regularly engage in same-sex behavior while still maintaining a heterosexual identity. In other cultures and communities, such a pattern may be less common, and homosexually attracted men may find it difficult to find male partners without identifying themselves as homosexual or bisexual.

Sexual orientation is defined here as attraction to members of the same sex, both sexes, or the other sex. Most researchers studying sexual orientation focus on self-reported patterns of sexual attraction rather than sexual behavior or identity, because sexual behavior and identity can be extremely constrained by local culture and because sexual attraction motivates behavior and identity, rather than vice versa.

Measurement of sexual orientation

Many scientific studies related to sexual orientation have compared subjects who have been recruited on the basis of identifying as either exclusively homosexual/gay or exclusively heterosexual/straight. That is, such studies have ignored or even excluded bisexually attracted individuals. On the one hand, this approach to studying sexual orientation is incomplete. On the other hand, findings from studies using this approach need not be misleading, provided we acknowledge their limitations.

Two general approaches to measuring sexual orientation have dominated scientific research. By far the most

common approach uses self-report measures. Less common are psychophysiological measures—in particular, measures of genital arousal in men. Table 1 lists a variety of measures that have been used.

Self-report measures. The Heterosexual-Homosexual Rating Scale, commonly referred to as the Kinsey Scale, is the best-known self-report measure of sexual orientation. The scale ranges from 0 (representing entirely heterosexual orientation) to 6 (representing entirely homosexual orientation); the middle score of 3 represents a bisexual orientation with equal attraction to men and women.⁶ The other scores represent gradations between those anchors. Kinsey famously justified his measure of sexual orientation by asserting,

Males do not represent two discrete populations, heterosexual and homosexual. The world is not to be divided into sheep and goats. Not all things are black nor all things white. It is a fundamental of taxonomy that nature rarely deals with discrete categories. Only the human mind invents categories and tries to force facts into separated pigeon-holes. The living world is a continuum in each and every one of its aspects. The sooner we learn this concerning human sexual behavior, the sooner we shall reach a sound understanding of the realities of sex. (Kinsey, Pomeroy, & Martin, 1948, pp. 638–639).

Although Kinsey was ultimately making an empirical claim requiring scientific evidence, his scale provided a simple way of collecting useful data, and it has become widely used. It is important to note that the Kinsey Scale is a self-report instrument. This makes sense and is often optimal—who better to ask about people's sexual orientations than the people we want to know about?—but self-reported Kinsey Scale scores can sometimes be inaccurate or incomplete, especially when people want to conceal their sexual orientations or when they are confused or conflicted about their sexual feelings.

Genital measures. Pioneering sex researcher Kurt Freund invented a technique for assessing penile erection in response to different kinds of sexual stimuli as a window on men's sexual orientation (Freund, 1963). General terms for the measurement of penile erection include penile plethysmography (PPG). Freund's particular method used pictures of nude men and women as stimuli and a barometer-like contraption placed over men's genitals to measure their erections via changes in air pressure. Freund's technology is sensitive to small increases in penile erection, but it is onerous—for example, it requires a technician to place the instrument. Thus,

most research on male sexual orientation with genital measurement has employed circumferential PPG measures, such as the penile strain gauge, which are somewhat less sensitive to small changes in penile erection but less difficult to use (Janssen, 2002; Kuban, Barbaree, & Blanchard, 1999). Increasingly, researchers have begun to use videos rather than still images as stimuli, because the former evoke more arousal and thus allow better measurement.

PPG-measured arousal patterns are considered homosexual (or androphilic) when a man's arousal to adult male stimuli substantially exceeds his arousal to adult female stimuli and heterosexual (or gynephilic) when the opposite pattern occurs. Bisexual arousal patterns do not necessarily imply equal levels of arousal to male and female stimuli. Rather, a man is considered to have a bisexual arousal pattern when the *absolute difference* between his arousal to male versus female stimuli is smaller than the absolute difference observed among heterosexual and homosexual men. To clarify, a homosexual man is typically much more aroused by male than female stimuli, and a heterosexual man is typically much more aroused by female than male stimuli. Both of these patterns yield large absolute differences between arousal to female versus male stimuli. A bisexual man, in contrast, should have levels of arousal to female and male stimuli that are not as discrepant, yielding a smaller absolute difference.

Although Freund invented PPG to assess male sexual orientation as we mean it here (i.e., homosexual vs. heterosexual orientation), that application was never common and has become less so. Use of PPG to assess typical male sexual orientation is almost exclusively done in the context of basic scientific research (i.e., research aiming to answer scientific questions as opposed to applied research on clinical populations, which has the goal of developing useful treatments or assessments), and below we review some important findings from research using that technique. The most common practical applications of PPG assessment have been in the area of diagnosis and treatment of erectile dysfunction (Broderick, 1998) and detection of pedophilia, typically among men accused or convicted of sex offenses (e.g., Blanchard, Klassen, Dickey, Kuban, & Blak, 2001). One general implication of this work is that PPG can be useful in assessing the sexual interests of men who wish to hide them. In studies employing PPG of normal men who vary in sexual orientation—men who presumably have nothing to hide—very high correlations are generally obtained between genital and self-report measures (e.g., Chivers, Rieger, Latty, & Bailey, 2004).

When a man's PPG-assessed arousal pattern differs from his self-reported sexual orientation, what should we conclude? In some cases, PPG measurement is poor,

Table 1. Measures of Sexual Orientation.

Measure	Description	Strengths	Weaknesses
Kinsey Scale	7-point scale of relative attraction to men and women	Relatively non-invasive Quick	Self-report
Reduced Kinsey Scale	5-point scale of relative attraction to men and women	Relatively non-invasive Quick Used in more recent surveys	Self-report
Sexual identity	Self-reported orientation as “gay/ homosexual,” “bisexual,” or “straight/ heterosexual”	Simple and widely understood	Self-report No gradation within categories Some “other” identities (e.g., queer) are ambiguous with respect to sexual orientation
Sexual behavior	Sexual activity with men and/or women	Avoids labels and the need for introspection	The same sexual behavior pattern may reflect a variety of motivations Can be assessed only for sexually active persons Cannot be observed (usually), so assessment relies on self-report
Klein Sexual Orientation Grid	Multidimensional grid that assesses seven different aspects of past, present, and “ideal” romantic and sexual variables	Assesses more dimensions than other measures	Self-report Little research has been conducted on the validity of distinctions among different dimensions More onerous than single-item measurements
Genital measurement	Blood flow to genitals, as measured using a psychophysiological apparatus	Measure most closely captures male sexual orientation Not very voluntarily manipulable In males, can sometimes be more accurate than self-report	Onerous and invasive Sometimes response is too weak for good measurement Does not provide a good measure of female sexual orientation

(continued)

Table 1. *(continued)*

Measure	Description	Strengths	Weaknesses
fMRI	Neural activation while viewing erotic male and female stimuli	Less invasive than genital measurement In principle (though this has not yet been demonstrated), can sometimes exceed the accuracy of self-report May be used with both sexes	Onerous Expensive
Viewing time	Relative time spent looking at pictures of attractive men versus attractive women in a series of photographs	Less onerous and invasive than genital assessment In principle (though this has not yet been demonstrated), can sometimes exceed the accuracy of self-report May be used with both sexes	Can be voluntarily manipulated
Pupil dilation	Relative eye pupil dilation while viewing (typically erotic) pictures or movies featuring males versus females	Less invasive than genital assessment In principle (though this has not yet been demonstrated), can sometimes exceed the accuracy of self-report May be used with both sexes	Potential for voluntary manipulation is unclear Onerous Investigated by few studies so far
Implicit measures (e.g., priming, Implicit Association Task)	Timing of classifications of male and female stimuli (generally pictures)	Less invasive than genital assessment In principle (though this has not yet been demonstrated), can sometimes exceed the accuracy of self-report May possibly be used with both sexes, although to date has been used only with men	Onerous Investigated by few studies so far

generally as a result of low levels of induced erection, and in such cases it would be rash to dismiss a man's self-report and better to ignore the PPG data. However, in cases in which PPG arousal is very well measured—meaning at least that a man produces a clear pattern of arousal that is potentially repeatable—PPG arousal is the better measure. This is especially true when there is reason to doubt a man's self-report. For this reason, PPG arousal measures are important, both conceptually and scientifically, in examining certain issues related to sexual orientation.

Measures of female genital arousal also exist. The most common uses vaginal photoplethysmography (VPP), a technique that is sensitive to changes in blood flow in the vagina. Women's genitals, like men's, have increased blood flow during sexual arousal. Women's patterns of genital arousal to male versus female sexual stimuli do not mirror those of men, and they are different in a way that prevents VPP from being useful in measuring female sexual orientation. We discuss this evidence below in the "Sex Differences in Expression of Sexual Orientation" section.

Other non-self-report measures. During the past decade, several other measures of sexual orientation have been studied that do not rely on self-report. These include viewing time (time spent viewing pictures of males vs. females or rating them for attractiveness; Israel & Strassberg, 2009; Rullo, Strassberg, & Israel, 2010), fMRI activation (activation of relevant brain areas in response to viewing male versus female erotic images; Safron et al., 2007), implicit attitudes (Snowden, Wichter, & Gray, 2008), and pupil dilation (pupil dilation while viewing pictures or videos of males vs. females; Rieger & Savin-Williams, 2012). Studies using these measures have yielded strong correlations with self-reported sexual orientation in samples of individuals with no apparent reason to give inaccurate self-reports. These measures are more onerous to administer than self-report measures, but some have the advantage of being less onerous than genital arousal measures. Many of these newer measures are probably less objectionable than invasive genital measures to many potential research subjects, and in that sense they are easier to use. All require considerably more research to understand their strengths and weaknesses compared with genital and self-reported arousal and with each other.

How prevalent is nonheterosexual orientation?

One of the most common questions scientists are asked concerning sexual orientation concerns the population prevalence of homosexuality and bisexuality. It is

impossible to provide precise estimates, for several reasons. First, the different phenomena associated with homosexuality and bisexuality—behavior, identity, and sexual orientation—vary in frequency. For example, people who identify as heterosexual may still engage in homosexual sex and admit homosexual attraction, and hence one would find different population estimates depending on which phenomenon one assessed. Second, the different phenomena associated with homosexuality and bisexuality may vary over the life course, and hence one would find different population estimates depending on whether one assessed individuals' current patterns of behavior and attractions versus their total lifetime history of behavior or attractions. For example, the percentage of people who have ever had a homosexual experience is larger than the percentage of people who have had one during the past year, which, in turn, is larger than the percentage of people who have had only homosexual experiences for their entire lives. Third, homosexuality remains stigmatized to some degree even in the most liberal nations (Kohut, 2014), and thus some individuals may be motivated to underreport homosexual attractions, identity, and behavior. Fourth, because some aspects of homosexuality—especially homosexual identity and exclusively homosexual attractions—are uncommon, precision requires large and representative samples, which are expensive and difficult to survey. Finally, there is no good reason to expect that a single set of estimated frequencies applies to all places and times. This is especially likely to be true for sexual identity and behavior, which seem to us far more culturally malleable than sexual attraction.

Kinsey conducted the first large surveys of homosexuality in the United States during the 1940s (Kinsey et al., 1948). His results shocked readers because they made homosexual behavior and attractions appear so common. For example, 37% of men surveyed admitted having had a homosexual experience. Most of these occurred during adolescence, perhaps indicating brief experimentation. Approximately 10% of the men had been more or less exclusively homosexual for at least 3 years during adulthood—this is the origin of the "10% of people are homosexual" assertion that was commonly made until recent and more representative surveys supported lower rates. About 4% of his male respondents had been homosexual for their entire lives.

Starting in the 1980s and motivated by epidemiologists' need for better numbers to monitor the AIDS epidemic, several large and careful surveys of sexual behavior have been conducted, primarily in North America, Europe, and Australia. Most of these assessed aspects of homosexuality as well as heterosexuality, and most focused on sexual behavior rather than sexual attraction. Results of these studies are generally consistent in

providing far lower numbers than Kinsey's 10%. Asking about sexual identity—whether respondents consider themselves homosexual/gay/lesbian, bisexual, or heterosexual/straight—is perhaps the simplest way to survey people about sexual orientation. A recent survey of 34,557 U.S. adults yielded rates of 96.6% heterosexual, 1.6% gay or lesbian, and 0.7% bisexual (Ward, Dahlhamer, Galinsky, & Joestl, 2014). Additionally, 1.1% of respondents identified as “something else” or said they “don't know the answer.” These numbers are in reasonably close agreement with a recent review of nine large, careful studies conducted in Western populations (Gates, 2011), which concluded that approximately 3.5% of U.S. adults identified as gay, lesbian, or bisexual. The only careful estimation of nonheterosexual orientation for a non-Western culture focused on Samoan males, and the resulting estimate of 1.4% to 4.7% for androphilia is similar to Western estimates (VanderLaan, Forrester, Petterson, & Vasey, 2013).

Depending on what one means by “nonheterosexual,” nonheterosexual identity may be a conservative measure of nonheterosexual orientation. In the recent review, three studies assessed same-sex attraction as well as identity. The percentage of adults who admitted to “any homosexual feelings” ranged from 1.8% to 11%, exceeding the percentage identifying as “homosexual” or “bisexual” by factors ranging from 1.5 to 3.1 (Gates, 2011); note the wide range of the estimates. But what does it mean to say that one has experienced same-sex attraction “at least once” (Smith, Rissel, Richters, Grulich, & Visser, 2003) or that one's sexual attractions are “mostly” directed toward one sex (Chandra et al., 2011)? In the study that yielded a figure of 11% for a history of any homosexual attractions, only 3.3% of respondents said they were as attracted to the same sex as to the other sex. Are people who say that they have had at least one but possibly very few same-sex attractions intermediate between exclusively heterosexual and homosexual people on a continuum of sexual orientation? Or, alternatively, are they understanding the term “same-sex attractions” differently than most people? We defer consideration of these questions to our section on bisexuality. The percentage of adults who have ever had a homosexual experience is also larger than the percentage of adults who identify as homosexual or bisexual. In the recent review by Gates, three studies assessed both nonheterosexual identity and behavior. The percentage of adults reporting a history of any same-sex sexual interaction ranged from 6.9% to 8.8%, exceeding those reporting a nonheterosexual identity by ratios ranging from 2:3 to 3:3 (Gates, 2011).

Clearly, no one number can provide an estimate of the prevalence of nonheterosexual orientation. Even assessments of highly specific aspects of homosexuality have yielded a fairly wide range of estimates across recent

studies conducted with similar populations. Several conclusions are possible, however, with a high degree of confidence. First, Kinsey's famous survey likely overestimated the frequencies of nonheterosexual attractions and experiences. Second, individuals with incidental homosexual feelings and contacts are much more common than those with substantial (i.e., persistent and strong) feelings and frequent same-sex experiences. Third, individuals with substantial homosexual feelings comprise a small, albeit nontrivial, minority of adults in Western developed nations—a smaller percentage than suggested by Kinsey's data from more than half a century ago—despite the remarkable increase in tolerance of homosexuality (Voeten, 2012).

Although there may be scientific value in conducting future surveys of Western subjects to increase the precision of estimates related to the prevalence of nonheterosexual (and, necessarily, heterosexual) orientation, we do not see this as a high priority. There have already been a sufficient number of carefully sampled Western surveys related to sexual orientation, and hence future meta-analyses of these data may reveal interesting systematic patterns. We worry, however, that variation in prevalence estimates between studies may primarily reflect measurement error, both systematic and random. Asking increasingly detailed questions and perhaps even including non-self-report measures related to sexual orientation have the potential to reveal more than yet another carefully sampled self-report survey. Additionally, rather than continuing to survey the same, very similar, Western populations, it would be more scientifically useful to survey more non-Western populations.

Finally, we note that there has been a tendency for LGB individuals and their advocates to favor higher prevalence figures, whereas those opposed to LGB rights have tended to favor lower figures (e.g., LaBarbera, 2014). To the extent that this dispute is political, it makes little sense. If homosexuality is wrong, then it is wrong even if it is common; if it is not wrong, then nonheterosexual people deserve their rights regardless of how rare they are. As we noted earlier, the conflation of political motives and scientific findings has been common in debates related to sexual orientation, and when this conflation is mistaken, it is to the detriment of both politics and science.

Sex Differences in Expression of Sexual Orientation

In summarizing recent prevalence figures for nonheterosexual orientation, we deferred discussing a consistent, large, and interesting sex difference. Among those who identify as nonheterosexual, women tend to identify as bisexual whereas men tend to identify as homosexual

(Gates, 2011). Studies that have assessed sexual attractions have found similar results. Figure 1 summarizes the distributions from a recent review of sexual orientation among 71,190 adult men and 117,717 adult women who reported their sexual orientations using a 5-point scale: 1 = *entirely heterosexual/straight*, 2 = *mostly heterosexual/straight*, 3 = *bisexual*, 4 = *mostly homosexual/gay/lesbian*, 5 = *entirely homosexual/gay/lesbian* (Savin-Williams & Vrangalova, 2013). The figure reveals markedly different shapes for the two sexes. The large majority of both sexes rated themselves as “entirely heterosexual,” although men (93.2%) were considerably more likely to do so than women (86.8%). Many more women than men rated themselves as “mostly heterosexual.” For women, there is a steep decline in the frequency of “mostly heterosexual” to “bisexual” ratings, and then a more gradual decline to “mostly homosexual” and “entirely homosexual” ratings, which have similar frequencies. For men, the least frequently self-rated category is “bisexual,” with a slight rise in the frequency of “mostly homosexual” and “entirely homosexual” ratings. The male distribution is bimodal. Bimodal distributions are rare and potentially interesting, suggesting that two groups are different in kind and not merely degree. For example, a bimodal distribution would be expected if there were a single cause underlying the distinction between two groups, whereas a continuous distribution would be expected if there were multiple causes. The classic human example is biological sex, which is caused by a dichotomous genotype (XX vs. XY) that leads to a bimodal distribution of prenatal testosterone, generating categorical sex differences in some anatomical features, such as genitalia. One conclusion from the sex difference in distributions of sexual orientation is clear, however: Among the Western populations that have been studied, bisexual patterns of attraction are rarer in men than in women, and exclusively homosexual attractions are rarer in women than in men. The reasons for this sex difference are not known. It might reflect prenatal biological sex differences; it might reflect the influence of cultural factors that create different social contexts for the development of female versus male same-sex sexuality; it might reflect differences in women’s and men’s susceptibility to such social influences (Baumeister, 2000); or it might simply result from measurement error. If there are innate sex differences in the causation of sexual orientation, then we should expect to find that the correlates of sexual orientation differ considerably between men and women. This is the topic we address next.

Sex differences in category-specific sexual arousal

Sexual arousal comprises both subjective and genital response to a sexual stimulus. In men, sexual orientation

is closely related to a pattern of genital sexual arousal. Specifically, homosexual men show genital arousal to men (or, in the lab, sexual stimuli depicting men), whereas heterosexual men show genital arousal to women (or, in the lab, sexual stimuli depicting women). This pattern has been called “category-specific” because men’s genital sexual arousal is specific to the category of person to whom they are most attracted (Chivers et al., 2004). Indeed, one of us has argued that male sexual orientation can be precisely defined as a pattern of sexual arousal, for two reasons (Bailey, 2009). First, as we have mentioned, sexual arousal patterns reliably reflect male sexual orientation. In cases where a man’s self-reported sexual orientation diverges from his sexual arousal pattern (and in which his sexual arousal pattern is robust and dichotomous, consisting of strong erections to one sex but not the other), we believe his sexual arousal pattern best represents his sexual orientation—if not necessarily his self-chosen sexual identity. Second, and more important, is the direction of causation. Sexual arousal pattern motivates sexual behavior, which provides most individuals with the fundamental basis for their sexual self-identification. In contrast, there is no evidence to suggest that individuals can consciously alter their genital arousal to fit a certain sexual identity label.

Women show a much different pattern of linkage between sexual orientation and genital arousal (i.e., genital blood flow as measured by VPP). In the laboratory, heterosexual women show approximately equal levels of genital arousal to male and female stimuli (despite sometimes reporting that they find male sexual stimuli more arousing). Homosexual women show a pattern of genital sexual arousal that is slightly category-specific (i.e., they show stronger genital arousal for female than male stimuli), but their genital responses are not as starkly category-specific as men’s (Chivers et al., 2004; Chivers, Seto, & Blanchard, 2007). One potential interpretation of the sex difference in genital arousal patterns is that female sexual orientation is fundamentally less category-specific than male sexual orientation (i.e., that homosexual women retain some potential for attraction/arousal to men and heterosexual women retain some potential for attraction/arousal to women, even if they are unaware of this potential). This explanation presumes that a woman’s pattern of genital arousal provides a reliable measure of her sexual orientation (as is the case for men). An alternative explanation is that genital arousal is less reliably linked to sexual orientation in women than in men. This explanation remains agnostic as to whether female sexual orientation is less categorical in women than in men; it simply suggests that the measure of genital arousal commonly employed—namely, genital blood flow as assessed via VPP—cannot definitively answer this question, because this measure has a weaker pattern of association with female than male sexual orientation.

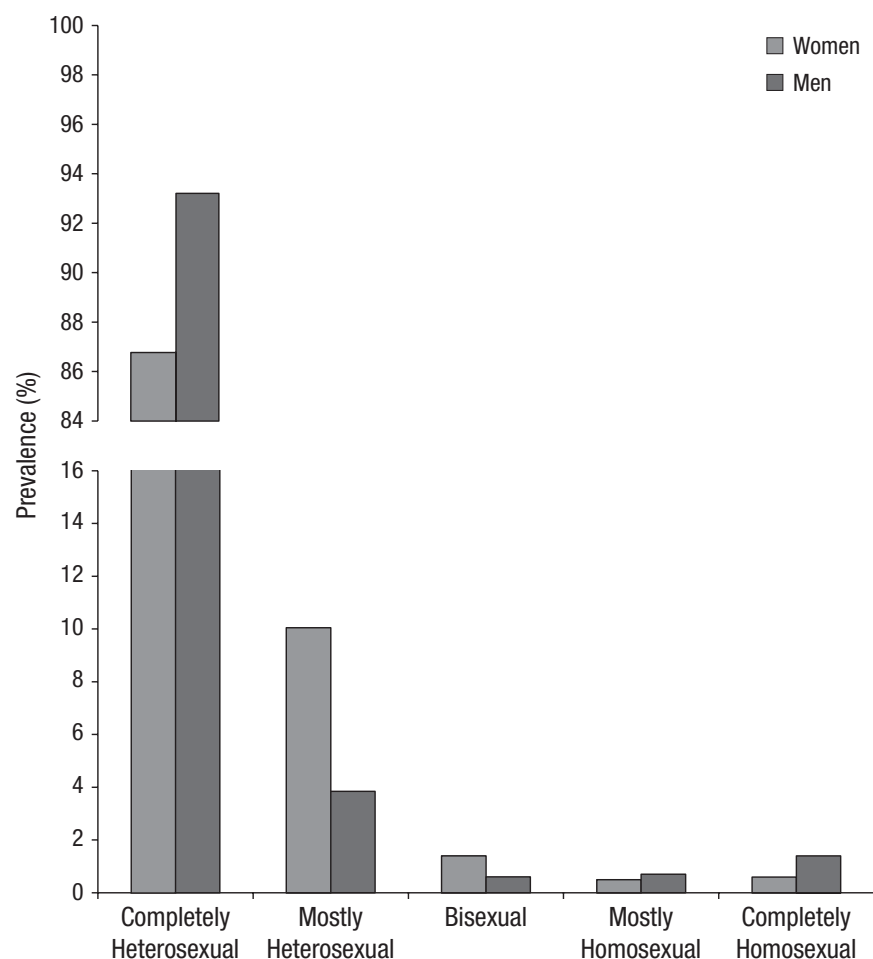


Fig. 1. Average prevalence for each of five categories of sexual orientation in recent Western population surveys. Data are from Table 1 of Savin-Williams and Vrangalova (2013).

There are important differences between measures of male and female genital arousal that need to be considered before accepting the idea that women are less category-specific than men in their sexual arousal patterns. Female genital arousal is measured much differently than male genital arousal (specifically, a device is inserted into the vagina to measure changes in blood flow, in contrast to the erectile measure used for men). Nonetheless, several findings argue against the possibility that the sex difference in category-specific genital arousal is a measurement artifact. First, a study of postoperative male-to-female transsexuals (assessed with VPP) produced a category-specific pattern of genital arousal similar to that of men (Chivers et al., 2004). This would not have been expected to occur if the vaginal measure of arousal was not effective in detecting category-specific arousal responses. Second, women also show substantially less category-specificity in their self-reported patterns of sexual arousal to male and female stimuli. Third, other correlates of sexual interest have been shown to be less category-specific in women than in men, such as

viewing time for female and male sexual stimuli (Lippa, Patterson, & Marelich, 2010), pupil dilation in response to such stimuli (Rieger & Savin-Williams, 2012), and fMRI responses to such stimuli (Sylvia et al., 2013).⁷

Accepting for now the validity of the hypothesis that women's sexual arousal patterns are less category-specific than men's, the question arises as to why this is the case. One possibility is cultural—namely, Western cultures produce omnipresent depictions of female beauty, which are often sexualized, and exposure to these images from an early age may sensitize both men and women to experience sexual arousal to the female body. Although this explanation might account for heterosexual women's genital arousal to female stimuli, it cannot account for the fact that homosexual men, who have experienced just as much exposure to sexualized images of women, do not experience sexual arousal to female stimuli. Similarly, exposure to sexualized images of women fails to account for the fact that homosexual women show more genital arousal to male sexual stimuli than homosexual men show to female sexual stimuli.

Another possibility is that the difference is based in fundamental evolved differences between female and male sexuality (Baumeister, 2000; Chivers & Bailey, 2005), although currently there is no direct evidence speaking to this question. Intriguingly, Goy and Goldfoot (1975) showed over 30 years ago that in many different mammalian species, bisexuality is an intrinsically dimorphic trait that develops (through prenatal hormonal pathways) in either the male or the female of a species, but never both. This suggests the provocative possibility that in humans, women are “the more bisexual sex,” whereas males are more likely to be exclusively heterosexual or homosexual.

Regardless of the reason for sex differences in category-specificity, this sex difference is likely to produce additional sex differences in sexuality. Sexual arousal is a powerful motivating force, and so men’s greater category-specificity might be expected to produce more categorical patterns of sexual behavior (i.e., exclusively heterosexual behavior among heterosexual men and exclusively homosexual behavior among homosexual men). In contrast, the fact that women’s genital arousal is less category-specific might be expected to produce less categorical (and hence more “bisexual”) patterns of sexual behavior, which may help to explain the aforementioned sex difference in bisexual identification.

Sexual fluidity

A related sex difference is the phenomenon of sexual fluidity, which appears to be especially common among women (L. M. Diamond, 2009). Sexual fluidity is situation-dependent flexibility in a person’s sexual responsiveness, which makes it possible for some individuals to experience desires for either men or women under certain circumstances regardless of their overall sexual orientation. Evidence that some women are especially sexually fluid includes results from a longitudinal study of 80 women first interviewed at 16 to 23 years of age (L. M. Diamond, 2000, 2003a, 2008). At the first interview, none of the women identified as “heterosexual”; rather, their reported identities were “lesbian,” “bisexual,” or unlabeled. Many of the women’s sexual feelings toward women versus men changed over time, although typically the changes were not large (about 1 Kinsey Scale point, on average). Yet changes in sexual identity were common. Two years after the initial interviews, approximately one-third of the participants changed their sexual identities (L. M. Diamond, 2000); between the second and third interview, another quarter of the participants changed their sexual identities (L. M. Diamond, 2003a); and between the third and fourth interviews, another third of the participants changed their sexual identities (L. M. Diamond, 2008). Usually, these changes were

between adjacent categories (e.g., “heterosexual” and “bisexual”) rather than larger changes (e.g., from “heterosexual” to “lesbian”). Perhaps more importantly, over time, women were significantly more likely to adopt identities that permitted sexual attractions and/or behavior with both sexes (i.e., “bisexual” or unlabeled) than to adopt exclusively lesbian identities. For these women, their range of potential attractions was limited by their sexual orientations, but fluidity allowed movement within that range. Obviously, these results generalize to nonheterosexual-identified women more readily than to heterosexual-identified women, but Diamond’s findings are consistent with the findings of non-category-specificity in heterosexual women’s genital arousal (Chivers & Bailey, 2005; Chivers et al., 2007) as well as with the growing body of research on “mostly heterosexual” women, who perceive their underlying orientation to be heterosexual despite experiencing periodic same-sex attractions (Thompson & Morgan, 2008; Vrangalova & Savin-Williams, 2010). It is an open question whether the nonheterosexual women in Diamond’s sample were more likely to experience sexual fluidity or whether they were simply more aware of it and willing to discuss it openly.

What accounts for the ability of some women to be sexually fluid? L. M. Diamond (2003b) has theorized that to an extent, romantic love and sexual desire rely on different motivational systems: the former more on the attachment or pair-bonding system, the latter more on the sexual mating system. Although separate, these two systems may affect each other, and the bidirectional links (permitting feelings of strong emotional attachment to give rise to sexual desire) may be especially strong in women. Another possibility concerns sex differences in the reproductive context of female versus male sexual behavior. Whereas all of men’s sexual interactions can result in reproduction, women’s sexual behavior can result in reproduction only if it coincides with ovulation. However, women are capable of becoming sexually aroused at any point in the menstrual cycle, and although their sexual motivation appears to increase as a function of the rising estrogen levels that accompany ovulation, their sexual arousability during the rest of the month appears unrelated to estrogen levels (reviewed in Wallen, 1995). Women’s capacity for arousability independent of ovulation permits them to experience sexual desires and behaviors with same-sex individuals at no evolutionary cost. In fact, researchers have argued that sexual behavior with nonreproductive (and even same-sex) partners can confer multiple evolutionary advantages on females, such as alliance formation (de Waal, 1987; Hohmann & Fruth, 2000). Hence, one possibility is that women’s capacity for sexual fluidity evolved in concert with (or is an artifact of) their capacity for nonreproductive arousability during nonfertile parts of the menstrual cycle.

Development and Psychological Correlates of Sexual Orientation

Having reviewed basic sex differences in orientation, we now turn to the question of when and how sexual orientation emerges. Behavioral correlates of sexual orientation are present during childhood, long before a child has any apparent sexual feelings.

Childhood gender nonconformity

Childhood gender nonconformity—behaving like the other sex—is a strong correlate of adult sexual orientation that has been consistently and repeatedly replicated (Bailey & Zucker, 1995). More specifically, childhood gender nonconformity comprises the following phenomena among boys: cross-dressing, desiring to have long hair, playing with dolls, disliking competitive sports and rough play, preferring girls as playmates, exhibiting elevated separation anxiety, and desiring to be—or believing that one is—a girl. In girls, gender nonconformity comprises dressing like and playing with boys, showing interest in competitive sports and rough play, lacking interest in conventionally female toys such as dolls and makeup, and desiring to be a boy. Childhood gender nonconformity usually emerges by preschool age. It is important to add that children are usually considered to be gender-nonconforming only if they persistently engage in a variety of these behaviors, as opposed to engaging in a single behavior once or twice. Furthermore, childhood gender nonconformity is not an either/or trait but, rather, a dimensional one, so the differences we discuss are a matter of degree and not of kind.

Children who grow up to be nonheterosexual are substantially more gender nonconforming, on average, than children who grow up to be heterosexual. There are two types of studies supporting this. In retrospective studies, homosexual and heterosexual (and sometimes bisexual) adults are asked about their childhood behavior. In prospective studies, extremely gender nonconforming children are followed into adulthood to assess their sexual orientations. Both kinds of studies have limitations that in isolation might lead to skepticism about their validity. Retrospective studies rely on childhood memories, which might be distorted in a way that supports stereotypes about homosexuality and heterosexuality. Prospective studies often focus on highly unusual children, and one might worry about generalizing findings from these studies to less atypical children. Nonetheless, the two kinds of studies have produced highly convergent findings that support a strong association between childhood gender nonconformity and adult nonheterosexuality.

A 1995 review of retrospective studies found large differences in retrospectively reported childhood gender

nonconformity between homosexual and heterosexual men (32 studies; $d = 1.3$) and women (16 studies; $d = 1.0$; Bailey & Zucker, 1995). The review estimated that with respect to male sexual orientation, 89% of homosexual men exceeded the heterosexual median score, whereas 2% of heterosexual men exceeded the homosexual median. For female sexual orientation, the respective figures were 81% and 12%. Although this review was published 20 years ago, there is little reason to suspect that its results would change much if updated. Furthermore, despite the skepticism of some writers (e.g., Fausto-Sterling, 2014), no study has persuasively demonstrated that retrospective studies exaggerate orientation differences associated with childhood gender nonconformity. Retrospective self-report measures have been supplemented by childhood home videos provided by heterosexual and homosexual adults, with similar results: Viewers of the videos could tell, at far better than chance levels, which children would grow up to be homosexual and which would grow up to be heterosexual (Rieger, Linsenmeier, Gygax, & Bailey, 2008). The retrospective studies suggest that some degree of childhood gender nonconformity is a common precursor of adult homosexuality in both sexes. This conclusion holds for both Western and a wide array of non-Western cultures, including those in Asia, Latin America, Polynesia, and the Middle East (Bartlett & Vasey, 2006; Cardoso, 2005, 2009; Vasey, VanderLaan, Gothreau, & Bartlett, 2011; Whitam & Mathy, 1986).

Several prospective studies of highly gender nonconforming children have been conducted, most focusing on boys (for reviews, see Bailey & Zucker, 1995; Zucker, 2014). These studies have identified children through clinical interventions to help the children accept their birth sex identity, as opposed to obtaining sex reassignment surgery in adulthood. Thus, in general, these children exhibited extreme gender nonconformity as well as discomfort with or confusion about their gender identity. For males, all studies have found most men to be homosexually or bisexually oriented at follow-up,⁸ with rates ranging from 64% ($N = 129$; Singh, 2012) to 80% ($N = 66$; Green, 1987). The two studies including females were smaller and had more variable outcomes: 32% of 25 subjects (Drummond, Bradley, Peterson-Badali, & Zucker, 2008) and 100% of 10 subjects (Wallien & Cohen-Kettenis, 2008) endorsed bisexual or homosexual feelings. Not all of the studies had control groups, but all the rates of nonheterosexual outcomes far exceed plausible epidemiological estimates for the general population, which might be generously estimated at 5% (see Fig. 1). Thus, the prospective studies also suggest a large association between (extreme) childhood gender nonconformity and adult nonheterosexuality. In nearly all the studies, there was a significant tendency for subjects self-reporting as heterosexual to be younger than those self-reporting as

nonheterosexual. This suggests that the prospective studies may underestimate the likelihood of a nonheterosexual outcome because younger nonheterosexual individuals are more likely to provide false claims that they are heterosexual (Bailey & Zucker, 1995).

Both retrospective and prospective studies support a strong association between childhood gender nonconformity and adult nonheterosexuality. This does not mean, of course, that all nonheterosexual individuals were more gender nonconforming than average, much less that they were all extremely gender nonconforming. There are at least three potentially important implications, however. First, long before sexual attraction emerges, some children who will become nonheterosexual are markedly different than other children. Indeed, childhood gender nonconformity is often evident by age 2 (Cohen-Kettenis & Pfäfflin, 2003). Second, there is little evidence that gender nonconforming children have been encouraged or taught to behave that way; rather, childhood gender nonconformity typically emerges despite conventional socialization. Third, the differences between children who will become nonheterosexual and those who will become heterosexual are related to sex-typed behavior and gender identity (Bailey & Zucker, 1995; Zucker & Bradley, 1995). The content of these differences provides some potential clues about the causes of sexual orientation, which we discuss further below.

Onset of sexual attraction

Children cannot know their sexual orientations until they experience sexual attraction toward the same or the other sex. When does this happen? At present in North America, it is impossible to study actual children as they become sexually aware. Such a study would be a political minefield if not an ethical one. Therefore, the onset of sexual attraction has been studied using retrospective reports of adolescents and adults.

Studies have shown that subjects recall first having feelings of sexual attraction at age 10, on average (McClintock & Herdt, 1996). Male and female subjects report similar ages. Importantly, so do homosexual and heterosexual subjects. Age 10 is several years before the typical age of onset of sexual activity (Cavazos-Rehg et al., 2009). This is consistent with an earlier retrospective study showing that homosexual men and women recalled their first homosexual feelings as preceding their first homosexual experiences by 3 years (Bell, Weinberg, & Hammersmith, 1981). Although this gap may have changed since that publication, the important point—to which we return—is that the large majority of nonheterosexual people recall that homosexual desires preceded homosexual experiences.

How do nonheterosexual people experience the recognition of homosexual feelings? In a retrospective study,

homosexual men reported that their early sexual attractions were not necessarily a source of any distress (Savin-Williams, 1996). Same-sex attractions were often experienced as an obsession with being near masculine, often older, same-sex teenagers and adults, such as male teachers and coaches. Eventually, these men recognized that their same-sex desires were rarely shared by others, were not condoned, and should be hidden. Although first homosexual male experiences can occur in the context of romantic relationships, it is not uncommon for these experiences to occur with strangers (Savin-Williams & Diamond, 2000).

On average, homosexual women describe their early same-sex attractions as more emotionally than sexually charged. Lesbian or female bisexual self-identification often precedes the onset of homosexual activity, and first same-sex sexual attractions and behaviors are often experienced within the context of a romantic relationship (Savin-Williams & Diamond, 2000).

Bisexual-identified individuals typically experience later recognition of same-sex attractions compared with homosexual men and women. This may reflect the fact that bisexual identity usually follows the establishment of a heterosexual identity (Fox, 1995; Weinberg, Williams, & Pryor, 1994). Homosexual people are atypical in two ways: their lack of attraction to the other sex and their increased attraction to their own. In contrast, bisexual people are atypical in only the latter sense, and this may delay their recognition of their own difference.

Adult gender nonconformity

It would be surprising if the large orientation differences in childhood gender nonconformity disappeared without a trace by adulthood. Several differences between heterosexual and nonheterosexual adults persist. They include patterns of occupational and recreational interests (Lippa, 2005a, 2005b). Research indicates that heterosexual men have greater interest in occupations and hobbies focusing on things and less interest in those focusing on people, compared with heterosexual women (Lippa, 2005a; Su, Rounds, & Armstrong, 2009). In contrast, homosexual men show a somewhat feminine pattern of interests, and homosexual women a somewhat masculine one. The orientation differences are large, although smaller than the sex differences. They are consistent with stereotypes about occupational differences between homosexual and heterosexual people. This makes them more difficult to interpret than childhood differences because both homosexual and heterosexual adults may—either consciously or unconsciously—mold their behavior in accordance with societal expectations.

Other differences between homosexual and heterosexual adults include patterns of movement (i.e., gestures and walking) and speech (i.e., articulation), physical

presentation (i.e., clothing choices and hairstyles; Bailey, 2003; Rieger et al., 2008; Rieger, Linsenmeier, Gygax, Garcia, & Bailey, 2010), and even facial appearance (Rule, Ambady, Adams, & Macrae, 2008). These differences also tend to be large and help explain the phenomenon by which individuals can sometimes judge a target's sexual orientation by observing superficial aspects of the target's nonsexual behavior ("gaydar"). As with gender nonconformity in interests, gender nonconformity in movement, speech, and physical presentation might be influenced by societal expectations. Homosexual and heterosexual individuals also tend to differ in their performance on cognitive and personality tests that show sex differences. For example, studies of visuospatial abilities and verbal fluency show that homosexual individuals are shifted in the direction of the other sex (M. Peters, Manning, & Reimers, 2007; Rahman, Abrahams, & Wilson, 2003). Similarly, studies of neuroticism⁹ have indicated that homosexual individuals are shifted in a sex-atypical direction (Lippa, 2008). It is important to note, however, that the effect sizes for cognitive ability and personality are much smaller—both for sex and sexual orientation—than the effect sizes for patterns of interest.

Before leaving the topic of gender nonconformity, we address a commonly raised question: Might the gender-atypicality of adult homosexual men and women simply reflect a culturally influenced self-fulfilling prophecy? In other words, given that society expects homosexual individuals to be gender atypical, and given that LGB communities often support and facetiously celebrate such gender atypicality, perhaps some homosexual people adopt gender-atypical characteristics to conform to their own stereotypes. Because of the evidence we have reviewed—indicating that gender nonconformity often begins before a prehomosexual child even has a sexual orientation or is aware of cultural stereotypes, and that the link between gender nonconformity and nonheterosexual orientation has been found in a wide variety of cultures—we think it is highly unlikely that gender nonconformity in LGB populations represents a self-fulfilling prophecy due to cultural beliefs. It is possible, however, that cultural stereotypes sometimes amplify gender nonconformity among LGB people. Many LGB individuals report that they have always been fairly gender-typical in dress, appearance, and interests. It is possible that as these individuals come to identify as LGB and participate in the LGB community, they adopt aspects of gender-atypicality.

Bisexuality

The past decade has seen a surge of research about bisexuality. This has reflected (a) growing awareness that a nontrivial proportion of nonheterosexual people identify as bisexual; (b) the widespread acknowledgment that

bisexuals have often been both socially and scientifically marginalized; (c) scientific controversy concerning bisexual orientation; and, notably, (d) appreciable research funding by the American Institute of Bisexuality (Denizet-Lewis, 2014). Until recently, research on sexual orientation often ignored bisexuality, as reflected in the two most common approaches to dealing with potentially bisexual subjects: excluding them or combining them with monosexual subjects.

The topic of bisexuality requires special precision in discussing identity, attractions, behavior, arousal, and orientation, given the prevalence of discrepancies among these domains. Research has found that some individuals who identify as bisexual show patterns of sexual arousal (and sometimes patterns of sexual behavior) that appear to be predominately heterosexual or homosexual, whereas some individuals who identify as heterosexual or homosexual show bisexual patterns of genital arousal, attraction, or behavior. Such discrepancies reflect widespread variability in individuals' and communities' definitions of "bisexual," as well as variability in individuals' motivations for identifying as bisexual. Although it seems reasonable to presume that bisexual-identified individuals exhibit both same-sex and other-sex attractions and sexual behavior, other patterns are possible. Some individuals identify as bisexual because they have previously engaged in sexual activity or intimate relationships with both men and women, even if their current sexual attractions are exclusively toward the same sex or the other sex. Other individuals identify as bisexual because they periodically experience sexual attraction toward both sexes, even if their sexual behavior and identity is exclusively homosexual. As a result of this diversity, the population of individuals reporting bisexual attractions, behavior, or identity contains individuals with a range of different orientations.

Transitional versus persistent bisexuality

Some individuals who will eventually identify as homosexual temporarily adopt a bisexual identity before doing so (Lever, 1994). Transitional bisexual identification appears to be more common in men than in women. In a large U.S. national survey conducted by the LGB-focused news magazine *The Advocate* (Lever, 1994), 40% of gay-identified men reported having previously identified as bisexual. Two recent longitudinal studies of nonheterosexual-identified youth found that changes of identity from bisexual to homosexual were particularly common among males (Rosario, Schrimshaw, Hunter, & Braun, 2006; Savin-Williams, Joyner, & Rieger, 2012). Transitional bisexual identity and behavior may also occur among women on their way to a homosexual identity (Lever, 1995), though women's sexual identities also

not infrequently change from homosexual to bisexual (L. M. Diamond, 2008).

Researchers of bisexuality have often acknowledged the existence of transitional bisexuality (Fast & Wells, 1975; Harwell, 1976; Klein, 1993; H. L. Ross, 1971; M. W. Ross, 1991), but it remains poorly understood. The very limited existing evidence supports the idea that at least among men, transitional bisexuality identity does not necessarily imply a history of bisexual attractions (Guittar, 2013). Rather, men may adopt transitional bisexual identities in the process of trying to make sense of divergent parts of their current and previous attractions and histories, such as the fact that they may have had emotionally satisfying romantic relationships with women despite feeling sexual attractions only toward men, or the fact that their previous heterosexual encounters may have been unsatisfying but not distasteful. Others may feel that it is easier to admit one's homosexual feelings if they are not appearing to "rule out" the possibility of heterosexual attractions and relationships. Finally, some men may initially identify as bisexual because they have bisexual patterns of attraction but, eventually, switch to a gay identity because most of their attractions and all of their sexual behaviors involve men.

Among women, bisexuality appears to be a more stable identity pattern, as well as a more stable pattern of self-reported sexual attraction (L. M. Diamond, 2008; Savin-Williams & Ream, 2007). This is consistent with the fact (reviewed earlier) that women are more likely than men to report bisexual patterns of attraction. Specifically, a woman who comes out as bisexual is more likely to be "correct" in this assessment than is a man, and hence more likely to retain that label over time and to find that it provides an adequate representation of her attractions and behavior. Among both men and women, negative stereotypes about bisexuality, perpetuated within the gay community as well as in the culture at large, make it difficult to interpret individuals' adoption or rejection of bisexual labels. Just as some individuals with homosexual patterns of attraction may identify as bisexual because they perceive it to be an easier transition to make than a direct transition to homosexual, some individuals with bisexual patterns of attraction may identify as homosexual because they are aware that some members of the gay community view bisexuals as untrustworthy, closeted, or promiscuous (Tania & Mohr, 2004).

Sexual arousal patterns of bisexual men

It is because of these complexities in interpreting bisexual identities that researchers have turned to more objective measures of bisexual orientations. Specifically, researchers have used measures of genital arousal to determine whether men who identify as bisexual also

have bisexual arousal patterns (given that some men may identify as bisexual despite having homosexual arousal patterns).

To assess bisexual patterns of genital arousal in men, it is first necessary to decide what such an arousal pattern should look like, relative to a monosexual pattern of arousal. One possibility is that individuals with bisexual arousal patterns should show less of a difference (compared to monosexuals) between their arousal responses to men versus women (Rosenthal, Sylva, Safron, & Bailey, 2012). Another approach emphasizes the overall degree of arousal to one's "less preferred" sex (Rieger, Chivers, & Bailey, 2005). Consider the first approach. To the extent that bisexual-identified men have bisexual arousal patterns, they should have smaller absolute differences between their arousal to male and female stimuli compared with monosexual men. That is, a bisexual arousal pattern implies a relatively similar degree of arousal to male and female erotic stimuli. The rationale for this approach, which focuses on arousal to the less-preferred sex, is that a bisexual man should show greater arousal to female stimuli than would be shown by homosexual men *as well as* greater arousal to male stimuli than generally shown by heterosexual men. Thus, a bisexual man's arousal to stimuli depicting his less-arousing sex—which ever that is—should be greater than that for monosexual men. The dependent variables using the two approaches are highly correlated, and the two analyses tend to provide similar results (Rosenthal et al., 2012).

Three studies have examined the genital arousal patterns of bisexual, heterosexual, and homosexual men. Two found that bisexual men's self-reported subjective sexual arousal patterns were relatively bisexual, compared with those of monosexuals, but that their genital arousal patterns were not (Cerny & Janssen, 2011; Rieger et al., 2005). The other study found statistically robust and strong effects for both subjective and genital measures, supporting the hypothesis that bisexual men have relatively bisexual arousal patterns (Rosenthal, Sylva, Safron, & Bailey, 2011, 2012). Which finding is correct? Likely, both are true, each for a different subset of bisexual-identified men. The studies that failed to find correspondence between bisexual identity and arousal patterns used relatively liberal inclusion criteria for bisexuality—namely, that men considered themselves bisexual and had self-reported Kinsey Scale scores in the bisexual range. In contrast, the study that found correspondence required bisexual men to have had both sexual and romantic experiences with members of both sexes (which may have more effectively excluded men whose orientations were more monosexual in nature despite their identification as bisexual).

The most defensible conclusions from this work are that some bisexual-identified men have bisexual genital

arousal patterns and some do not. This provides strong evidence against the (often stereotyped) notion that male bisexuality does not exist and that all bisexual-identified males are misrepresenting their sexual orientation. Yet basic questions regarding the prevalence of female and male bisexual phenomena and the specific differences between bisexual and homosexual phenomena remain unanswered; this remains an active topic of research.

Causes of Sexual Orientation

The question of what causes different people to be heterosexual, bisexual, or homosexual has evoked intense interest among the general public (e.g., Finkelstein, 2006; Swidey, 2005). However, the question is unusual among interesting scientific questions because it has also provoked intense controversy that in part reflects sociopolitical and moral differences among disputants (Pitman, 2011; for examples, see the relevant sections of the websites for the National Association for the Research and Therapy of Homosexuality, <http://www.narth.com/#!/gay—born-that-way/cm6x>, and Truth Wins Out, <http://www.lgbtscience.org>).

The politics of sexual-orientation causation

There is a strong correlation between beliefs about the origins of sexual orientation and tolerance of nonheterosexuality, a correlation that has been stable for several decades (Lewis, 2009). Specifically, those who believe that sexual orientation is “innate,” “biological,” “immutable,” or “inborn” are especially likely to favor equal rights for homosexual and bisexual people. All four words are often used by participants in the political debate about the causes of sexual orientation, despite the fact that none of the words has a straightforward, consistent, and uniform interpretation.

The association between political attitudes about homosexuality and beliefs about the causes of sexual orientation is largely misplaced (Greenberg & Bailey, 1993). It is based on faulty reasoning about causation and about the relevance of causation to moral judgments. It has intruded unhelpfully into social controversies that affect the lives of homosexual and bisexual people. Furthermore, it has had a harmful effect on the science of sexual orientation. For example, in the United States, funding for basic research on sexual orientation has been limited because of political controversy. We know of several cases in which applicants for federal U.S. grants were asked to change grant titles in order to hide their topic of study from those hostile to such research. Politically controversial topics are precisely where science-based information should be sought, when it is relevant. But it is important to think clearly about what is, and what is not,

relevant. We thus preface our review of scientific evidence on the causes of sexual orientation with a conceptual critique—and we hope, a correction—of the way that people often reason about how these causes relate to social, political, and moral questions.

The question of choice

Do people choose to be homosexual or heterosexual? This question is perhaps the most common causal question asked in the sociopolitical context. It is asked much less commonly in scientific contexts because, as we shall see, it is a bad question. This is partly because there are at least two different, mutually inconsistent meanings of “choice” that are often conflated.

Choice as uncaused action. The correlation between one’s beliefs about the causes of sexual orientation and one’s degree of tolerance of nonheterosexuality appears to be based on the following logic: If there are causes—other than free will—that lead certain people to be nonheterosexual, then those people were never entirely free to be heterosexual and hence cannot be held responsible for their nonheterosexuality. For example, finding a gene that increases the chance a man will be homosexual would mean that the man is not completely free to choose to be heterosexual. To the extent that the gene causes his homosexuality, we should neither blame him nor discriminate against him. This is the essence of the argument regarding sexual orientation and choice.

Yet this is a bad argument, and the word “choice” (and associated concepts such as freedom and responsibility) lies at the root of the problem. Why would discovery of a gene for sexual orientation imply that homosexuality is not freely chosen? It would do so only if we could assume that free will is the null hypothesis on which causal studies chip away. This assumption is not scientific, however, and is not intellectually defensible (Dennett, 1984; Pinker, 2003). For instance, to the extent that a trait is not genetic, it is caused by the environment, not by free will. If a trait is not present from birth, then it is caused by events occurring after birth, not by free will.

Choice as decision to act. There is an alternative sense of “choice” that is more meaningful: the sense of making a decision. This ordinary-language sense of “choice” is something that is commonly understood. “I chose to raise my hand,” “I chose to eat broccoli,” “I chose to rob a bank,” and “I chose to have sex with that person” are all meaningful sentences. It is this sense of “choice” that people likely mean when they debate whether sexual orientation is a lifestyle choice. Note that cause has nothing to do with it. The four sentences all make sense even

though the respective choices to which they refer could all be determined by a combination of genetic and environmental factors. People may choose to do things for environmental reasons—perhaps a woman has been offered a million dollars to raise her hand. Or they may choose them for genetic reasons—perhaps a man chose a blue car because his genetically determined color blindness made red and green cars unappealingly gray. In a deterministic world (which behavioral scientists assume), decisions have causes.

The meanings of words can be illuminated by how people use them, and an important regularity in the way people use “choice” concerns the distinction between behavior and feelings. We choose our actions, but we do not choose our feelings. Consider the following two sentences:

1. “I choose to have sex with partners of my own sex.”
2. “I choose to desire to have sex with partners of my own sex.”

The first sentence is conventional and sensible; the second sentence is neither. Einstein summarized Schopenhauer’s famous argument appropriately and thusly: “Man can do what he wills, but he cannot will what he wills” (as quoted in Planck, 1933, p. 201). Applied to sexual orientation, it makes sense to say that people choose their sexual partners, but it doesn’t make sense to say that they choose their desires. Sexual orientation is defined as relative desire for same-sex or other-sex sex partners. Thus, it makes no sense to say that one chooses one’s sexual orientation. One does, however, choose to behave consistently or inconsistently with one’s sexual orientation. That is a lifestyle choice.¹⁰

A flawed question. The question of whether or not people choose their sexual orientations has clouded rather than clarified thinking. We can answer the question without knowing anything scientific about the causes of sexual orientation, because the answer depends entirely on what we mean by “choice” and “choose.” If a “choice” requires a lack of causes, then people cannot choose their sexual orientation because all human behavior has causes. If “to choose” means “to make a decision,” then we do not choose our sexual orientations because sexual orientations are patterns of sexual desire, and we do not choose our sexual desires. Of course, advocates of therapeutic attempts to change sexual orientation might argue that even if sexual desires are not initially chosen, individuals can choose to alter their desires through processes of conditioning and reinforcement. As we discuss in greater detail below, however, there is no evidence that such attempts are successful.

Is causation relevant at all?

Even if the question of whether people choose their sexual orientations is a bad one, this does not necessarily mean that all questions about the causes of sexual orientation are irrelevant to political, social, and ethical concerns. Unfortunately, such relevance is usually assumed rather than argued for. Furthermore, in cases where the argument is spelled out, it typically amounts to an argument that *any* discernable causes negate free will, which we have seen is invalid.

A more comprehensible basis upon which people differ in their moral and political responses to homosexuality is in their beliefs about its consequences rather than its causes. People who believe that homosexuality has negative effects on psychological, moral, or social functioning will disapprove of homosexuality and may seek to discourage it by restricting its expression and limiting the rights of homosexuals. In contrast, people who believe that there are no negative consequences of homosexuality will favor the rights of homosexuals to live openly and to enjoy the same rights as heterosexuals. These grounds—rather than questions of causation and choice—are the appropriate grounds on which the battle for equal rights for nonheterosexual people should be fought.¹¹

This is not to dismiss the importance of basic research on sexual orientation, including research on causation. Despite our pessimism about causal research’s importance in resolving social questions, there are some specific limited cases in which it is relevant. One example concerns the belief, expressed by President Museveni in Uganda as well as anti-homosexual activists worldwide, that homosexual people attempt to recruit others into homosexuality. Equally important is the question of whether individuals’ sexual orientation can be changed through “conversion,” “reparative,” or “reorientation” therapies and whether such therapies should be deemed safe and effective by psychological organizations. Claims about both homosexual recruitment and the success of conversion therapies are causal claims, and we examine them in a later section.

In our view, the single best justification for studying the causes of sexual orientation is scientific, not sociopolitical. Quite simply, sexual orientation is a basic human trait that influences identity and behavior at both the individual and the group level, and hence it is fundamentally important and interesting to understand its causes and development. Toward this end, in the following sections, we summarize the current state of this understanding.

A taxonomy of causal questions

Non-experts are exposed to scientific findings primarily through the news media. Journalists try to make a

judicious compromise between scientific accuracy and simple comprehensibility; sometimes they fail. Sometimes even scientists are not as precise and accurate as they should be. A plethora of terms have been used as alternatives in the two sides of the nature-nurture debate. For nature: “biological,” “genetic,” “hereditary,” “heritable,” “innate,” “inborn,” “natural,” and “essential.” For nurture: “chosen,” “learned,” “acquired,” “environmental,” “socialized,” “unnatural,” and “socially constructed.” Some of these terms have originated from scientists and have been accurately applied to particular studies but over-generalized to other, inapplicable studies. Other words, such as “chosen,” are rarely used by scientists but commonly (and erroneously) used by laypersons. Importantly, words that are treated as synonyms in informal usage often have quite different formal definitions. Thus, it is important to correct some common misunderstandings about causal terminology before proceeding.

The first two columns of Table 2 list some words most commonly used in the nature-versus-nurture debate. Adjacent words in the same “Nature” or “Nurture” columns represent synonyms—conceptual distinctions that are dissociable but not completely independent. Words in the same row but different columns represent conceptual opposites (or complements). The final two columns of Table 2 convey our judgments of whether the conceptual distinctions implied by a given word are valid and whether those distinctions are precise or require further elaboration.

We have already addressed the conceptual vacuity of “choice.” Another word that obscures more than it clarifies is “biological.” Because all behavior requires participation of the brain and body, and such participation is at least in principle measurable, all behavior is “biological” (Greenberg & Bailey, 1993). Thus, the word denotes nothing unique about any trait or behavior. Although “biological” is often used synonymously with other words in the “Nature” column of Table 2, that practice should stop, and more accurate and precise words should be used instead.

The extent to which a trait is “genetic” or “environmental” is a conceptually meaningful and precise question,

although it may often be practically difficult to provide a precise answer. The extent to which people differ in a trait as a result of genetic or environmental differences among them can be estimated as heritability, which is expressed as a proportion ranging from 0 (only environmental differences matter) to 1 (only genetic differences matter), using methodology including twin and adoption studies.

The idea that hormonal differences may lead to sexual-orientation differences has been especially influential (Ellis & Ames, 1987; LeVay, 2011). The extent to which trait differences reflect differences in hormones is generally meaningful and entirely separate from the question of genetic influence. If genes for sexual orientation exist, they may or may not operate via hormonal pathways. Conversely, hormonal differences may not depend on genetic differences (aside from the initial role of the Y chromosome in triggering androgens in males). Thus, evidence regarding heritability provides no evidence regarding hormonal influence, and vice versa. The extent to which a trait is hormonally influenced is a less precise question compared with the extent to which it is genetically influenced. A trait might be hormonally influenced via levels of hormones currently present in relevant tissue; alternatively, it may have been influenced via levels of hormones present during the organization of the tissue, or it may be influenced by receptivity to hormones, either at present or during organization; there are likely other possibilities. Nor do assessments of hormone levels yield a numeric index comparable to heritability.

Innateness is a famously difficult concept (Elman et al., 1998), in large part because it has a number of different connotations (Mameli & Bateson, 2006). For sexual orientation, the question of innateness is most meaningfully asked as follows: When people have different sexual orientations, is this because they had different postnatal social experiences, or did the different sexual orientations emerge despite their social experiences? If differences in social experiences matter, then sexual orientation is not entirely innate; if they do not matter, then it is.¹² For humans, “social experiences” mean experiences involving

Table 2. Causality-Related Terms Commonly Used in Scientific and Political Debates About Sexual Orientation

Nature terms	Nurture terms	Meaningful?	Precise?
—	Chosen	No	No
Biological	—	No	No
Genetic, inherited, heritable	Environmental	Yes	Yes
Hormonal	Not hormonal	Yes	No
Innate, inborn, congenital	Learned, acquired, socialized	Uncertain	No
Natural	Unnatural	Uncertain	No
Essential	Socially constructed	Yes	No

other people, and the mechanisms through which such experiences are thought to influence development generally comprise diverse forms of learning and reinforcement. In contrast, mechanisms of innate development include practically anything else: genes, hormones, random prenatal developmental perturbations, infections, and other factors too numerous to list. Thus, although genetic and hormonal influences on sexual orientation constitute innate influences, not all innate influences require either genes or hormones. Arguably, the innateness debate is best focused on whether particular candidate social influences matter rather than whether any social influence matters.

The question of whether sexual orientation is “natural” or “unnatural” has tended to be asked in the context of religious debates, with anti-homosexual advocates insisting that homosexuality is unnatural (e.g., TFP Committee on American Issues, 2004) and their opponents insisting it is natural (e.g., A. Jackson, 2013). What can this question mean? It has at least three different interpretations. First, does homosexuality occur in nonhuman animals? Second, is homosexuality a result of human evolution? Third, is homosexuality consistent with natural law? The third question is philosophical rather than scientific (Pickett, 2011), and we do not consider it here. In contrast, the first two interpretations of the question are scientifically meaningful and interesting. Answers to both are of no moral consequence, however.

The final row of Table 2 refers to a debate that is neither conducted mainly by scientists nor by members of the general public. Rather, whether sexual orientation is an essential or a socially constructed categorization of people has largely been the preoccupation of scholars of human culture and society, including philosophers, historians, social theorists, cultural anthropologists, and sociologists (e.g., Norton, 1997; Stein, 1992). One of the main issues in this debate concerns the degree to which sexual orientation manifests, and is recognized, in a similar manner across cultures, both geographically and historically. Those who believe that sexual orientation is socially constructed emphasize cultural variation, whereas those who believe that it is an essential human trait are impressed with its cross-cultural regularities. We address the cross-cultural evidence in the following section.

Sexual orientation across culture and history

In a speech at Columbia University, Iranian President Mahmoud Ahmadinejad asserted, “In Iran, we don’t have homosexuals like in your country” (“We Don’t Have Any Gays in Iran,” 2007, para. 1). The idea that homosexuality exists in some times or places but not others—or, less radically, that it exhibits different frequencies and forms

across different times and places—requires data that are difficult to obtain. Establishing facts about sexuality is complicated enough in the relatively open contemporary Western world, where representative surveys and even objective measures can be employed. Inferring facts about taboo behavior in different cultures or time periods is much more difficult. Such inference making is generally the job of anthropologists and historians, who do the best they can. On the one hand, it is important to recognize the limitations of the data and to be skeptical of surprising claims that would seem to depend on better data than currently exist. On the other hand, these data, with all their limitations, are all we have. We expect that in all cultures the vast majority of individuals are sexually predisposed exclusively to the other sex (i.e., heterosexual) and that only a minority of individuals are sexually predisposed (whether exclusively or non-exclusively) to the same sex. Data that might speak to this issue are exceedingly limited but consistent with this conclusion (e.g., VanderLaan et al., 2013; Whitam & Mathy, 1986).

In contrast, sexual identity and behavior are far more susceptible to cultural variation. Indeed, the sexual-identity categories of “gay,” “lesbian,” and “homosexual” are historically and culturally specific, and they do not necessarily translate to other times and places (Blackwood & Wieringa, 1999; Boswell, 1982/1983; Murray, 2000; Nanda, 2014; Norton, 1997). Consequently, the ways in which many non-Western same-sex-attracted individuals and Western gay men and lesbians think about themselves and pattern their lives (sexual or otherwise) can differ in important respects. Thus, when individuals from non-Western cultures say that there are no “gays,” “lesbians,” or “homosexuals” in their societies, they are not necessarily inaccurate or dishonest: Based on their understanding of what it means to be “gay,” “lesbian,” or “homosexual,” no one in their society identifies or behaves as such, and neither do they identify other members of their culture in that way. However, this does not mean that their culture contains no same-sex-attracted individuals.

One approach to studying same-sex sexuality cross-culturally involves focusing on its *deep structure* rather than its culturally specific constructions and meanings (Vasey & VanderLaan, 2014). The deep structure of same-sex sexuality can be thought of as a set of traits that reliably characterizes same-sex-attracted males and another set that reliably characterizes same-sex-attracted females, regardless of the cultural context in which these individuals are found. To this end, a focus on individuals’ sexual attractions facilitates cross-cultural comparisons, given that individuals in all cultures have been observed to report experiencing sexual attractions, and hence sexual attractions can be considered a universal human phenomenon. In contrast, a focus on sexual identities or behaviors does not facilitate cross-cultural comparisons

of same-sex sexuality, given that not all cultures have a notion of sexual identity and not all cultures permit individuals to pursue sexual behavior that concords with their desires.

“Androphilia” and “gynephilia” are useful terms for denoting basic human sexual attractions. Androphilia refers to sexual attraction and arousal to adult males, whereas gynephilia refers to sexual attraction and arousal to adult females. Homosexual men and heterosexual women are androphilic, and heterosexual men and homosexual women gynephilic. The terms “androphilia” and “gynephilia” are preferable to terms such as “homosexual” and “heterosexual” because the latter terms have been used and defined specifically in a Western cultural context and often do “triple duty” by serving as descriptions of attractions, behavior, *and* identities. The terms “androphilia” and “gynephilia” avoid these problems and therefore provide for more accurate descriptions. Although same-sex-attracted individuals can differ in dramatic ways from one culture to the next, they can all be accurately described as either androphilic biological males or gynephilic biological females.

The manner in which same-sex sexual attraction is publicly expressed varies across time and cultural space (Blackwood & Wieringa, 1999; Murray, 2000; Norton, 1997; Whitam & Mathy, 1986). Same-sex sexuality between adults typically takes one of two cross-culturally recurrent forms, which are related to gender-role enactment and gender identity. These two forms are cisgender¹³ and transgender¹⁴ male androphilia and female gynephilia.

Cisgender male androphiles and female gynephiles occupy the gender role typical of their sex and identify as “men” and “women,” respectively. This is the form of homosexuality that is nearly universal in the contemporary West. In contrast, transgender male androphiles and female gynephiles do not occupy the gender role typical of their sex. Not only do they behave in a highly gender-atypical manner, but they often identify, and are identified by others, as neither “men” nor “women,” but rather, as a member of some alternative gender category. Contemporary examples of transgender male androphiles include the *kathoey* of Thailand (P. Jackson, 1997), the *xanith* of Oman (Wikan, 1977), the *muxes* of Mexico (Chiñas, 1992), and the *fa’afafine* of Samoa (Vasey & VanderLaan, 2014). Some contemporary examples of transgender female gynephiles include the *tombois* of Sumatra (Blackwood, 2010) and the *mahu* of Tahiti (Elliston, 1999).

In some cultures, transgender male androphilia and female gynephilia are linked to particular institutionalized labor practices, which often involve specialized religious activities. This type of transgender male androphilia has been referred to as “profession defined” (Adams,

1986). For example, on the Indian subcontinent, transgender male androphiles known as *bijra* bestow blessings from Hindu gods and goddesses for luck and fertility at weddings and at the births of male babies (Nanda, 1998). In Sulawesi, Indonesia, transgender androphilic males known as *bissu* are shamans who bless people for good health and successful journeys and who play important ritual roles in weddings (Peletz, 2009). These institutionalized religious roles sometimes carry with them the expectation of asceticism, but often this ideal is not realized (e.g., Nanda, 1998; Peletz, 2009). In general, same-sex-attracted individuals self-select to fill these roles, probably because they are recognized as socially acceptable niches (Murray, 2000).

Cisgender male androphiles and female gynephiles behave in a relatively gender-typical manner when compared with their transgender counterparts. However, they are relatively gender-atypical when compared to gynephilic cisgender men and androphilic cisgender women (Bailey, 2003; Cardoso, 2013; Lippa, 2008; Whitam & Mathy, 1986; L. Zheng, Lippa, & Zheng, 2011). Thus, regardless of the form they take, male androphilia and female gynephilia are associated with gender-atypicality. However, the strength of this association varies with the manner in which same-sex sexuality is publicly expressed.

Both the cisgender and transgender forms of same-sex sexuality may occur within a given culture, but typically one or the other predominates (Murray, 2000; Whitam & Mathy, 1986). For example, the cisgender form tends to be much more common in many Western cultures. In contrast, the transgender form appears to be more common in many non-Western cultures. In places where the two forms coexist, their members often consider each other to be part of the same subculture (Whitam & Mathy, 1986). Margaret Mead observed a meeting in which an Omaha *minquga* (i.e., a transgender male androphile) and a Japanese homosexual man (i.e., a cisgender male androphile) who visited her field site in 1961 instantly recognized each other. Within an hour of the Japanese man’s arrival, the sole *minquga* in the tribe turned up and tried to make contact with him (Mead, 1961). Similarly, sociologist Fredrick Whitam (1995) noted that, in São Paulo, *travesti* (transgender male androphiles) are an especially conspicuous presence in gay clubs and are treated with a high degree of respect.

In contemporary Western cultures, cisgender male androphiles typically engage in sexual interactions with each other; the same is true of cisgender female gynephiles. That is, in the West, homosexual relationships are typically between two homosexual individuals. Such individuals comprise the Western gay and lesbian communities. This type of same-sex sexual relationship has been referred to as “egalitarian” and is characterized by partners who are not markedly different in age¹⁵ or

gender-related characteristics (B. D. Adams, 1986). Within such relationships, partners tend not to adopt special social roles, and they treat each other as equals. In contrast, this pattern appears to be relatively uncommon in non-Western cultures and has emerged only recently in certain non-Western urban centers (e.g., P. Jackson, 1997).

Although transgender male androphiles are same-sex attracted, they rarely, if ever, engage in sexual activity with each other; the same is true of transgender female gynephiles (Blackwood & Wieringa, 1999; Murray, 2000; Nanda, 2014). Rather, these individuals engage in sexual activity with same-sex cisgender partners who self-identify, and are identified by others, as “men” or “women.” For example, in Samoa, very feminine natal males called *fa’afafine* (which means “in the manner of women”) have sex with masculine Samoan men. The *fa’afafine* would be aghast at the idea of having sex with one another.

Little research has focused on the cisgender sexual partners of same-sex-attracted transgender males and females. Blackwood (2010, p. 137) noted that, in Sumatra, the cisgender female partners (*femmes*) of *tombois* “assert an uncomplicated attraction to men, [but] position themselves (if temporarily) under the label ‘lesbi’”—a derivative of “lesbian.” This suggests an episodic pattern of bisexual attraction on the part of *femmes*. In many cultures, same-sex sexual interactions between transgender and cisgender persons are not considered “homosexual” because they are understood to be hetero-gendered (Murray, 2000; Nanda, 2014; Norton, 1997). In other words, if a cisgender androphilic male and a transgender androphilic male engage in sex, the former individual is often understood to be “the male partner” in the interaction, whereas the latter individual is often understood to be “the female partner.” Accordingly, the interaction is understood as male-female rather than male-male. The degree to which cisgender individuals who have sex with transgender persons of their same biological sex (i.e., men who have sex with female-appearing men and women who have sex with male-appearing women) are perceived as different from those whose sexual behavior is only with the other sex (i.e., conventional heterosexuals) remains an open question (Norton, 1997).

Same-sex sexual activity appears to have existed throughout human history. Mesolithic rock art depicts male-male sexual activity (e.g., Nash, 2001). Graves containing male skeletal remains and female-typical artifacts have been interpreted as evidence for transgender androphilic males in the prehistoric past (Hollimon, 1997). The earliest written documentation of male-male sexual activity involving humans (as opposed to gods) comes from ancient Egypt and dates to the late New Kingdom (1292–1069 BCE). The story includes a sexual tryst between the

pharaoh Neferkare and the military general Sisene, who lived during the 6th Dynasty of Egypt’s Old Kingdom (2345–2181 BCE; Meskell, 2001). As early as the 7th century BCE, the Greek lyrical poet Sappho wrote about romantic love and infatuation between females (Campbell, 1982). Although one can question whether these examples reflect actual events, they do at the very least suggest that some prehistoric and ancient peoples understood same-sex sexual and romantic activity to be within the realm of possibility.

The historical record also indicates that at many times and in many places, androphilic males and gynephilic females have been recognized by others, and by themselves, as a unique class of individuals owing to their sexual orientations (e.g., Boswell, 1982/1983; Murray, 2000; Norton, 1997). Typologies for same-sex-attracted individuals can be traced back to ancient times. In Plato’s *Symposium* (c. 385–370 BCE), Aristophanes described his theory for exclusively androphilic and gynephilic men and women, asserting that all individuals, in seeking lovers, are trying to reunite with a primordial conjoined twin—in some cases male and in others female—from whom they were severed. Ancient Indian medical texts from the 1st century contain typologies for same-sex-attracted individuals that are strikingly similar to modern ones (M. Sweet & Zwilling, 1993; Vanita & Kidwai, 2001).

Male same-sex sexual activity appears to have existed in most cultures for which data are available (e.g., Murray, 2000; Nanda, 2014), and the population prevalence rate for male androphilia appears to be similar (approximately 1.5%–5%) across a range of different contemporary cultural settings (e.g., Smith et al., 2003; VanderLaan et al., 2013; Whitam & Mathy, 1986). Claims that male androphilia is “absent” in a particular culture are often demonstrably false, even when the culture in question seemingly lacks words to describe male androphilia or male same-sex sexual activity (Boswell, 1982/1983; Norton, 1997; VanderLaan, Garfield, et al., 2014). Although male-male sexuality may truly be absent in a minority of cultures (e.g., Hewlett & Hewlett, 2010)—especially if population size is small—these exceptions do not invalidate the conclusion that male androphilia appears to be a predictably and reliably reoccurring phenomenon in the large majority of human cultures.

Female gynephilia has also been reported in many cultures worldwide, but less often than male androphilia (Blackwood, 1999; Blackwood & Wieringa, 1999; Elliston, 1999; Murray, 2000). Based on this evidence, some scholars have concluded that female gynephilia is less common than male androphilia across cultures and, when it occurs, is less enduring over the life span (e.g., Murray, 2000). It is possible that romantic relationships between women have been more common historically and cross-culturally than relationships involving genital sexuality

(Faderman, 1981; Murray, 2000; Sahli, 1979). Arguably, the exclusivity and longevity of female gynephilia may relate to whether the individual in question is a “butch” (masculine) or “femme” (feminine) female gynephile. Research suggests that gynephilia is expressed in a more exclusive and enduring manner in butch/masculine as opposed to femme/feminine women (Blackwood, 2014; L. M. Diamond, 2009). Another possibility is that because female gynephilia often occurs within close relationships between women or among young women who are not of marriageable age, it has been less visible and less concerning and therefore has escaped accurate documentation (Blackwood & Wieriga, 1999; Kendall, 1999).

Historical and cross-cultural evidence suggests that if a sufficient number of people exist in a society, subcultures populated by same-sex-attracted individuals will appear within it (Gaudio, 2009; Norton, 1997; Whitam & Mathy, 1986). The formation of these subcultures appears to be more common among androphilic men, compared with gynephilic women. In Europe, recognizable centers of homosexual activity can be traced at least as far back as the 11th-century Anglo-Norman court of King William II (Goodich, 1979).

Shared interests and personality characteristics beyond a common sexual orientation likely facilitate the formation of such subcultures. Same-sex-attracted individuals often have more in common with each other, even when they come from disparate cultures, than they do with their larger culture, in part because of gender nonconformity (Norton, 1997; Whitam & Mathy, 1986). For example, across cultures, androphilic men tend to be more female-typical and “people-oriented” in their interests compared to gynephilic men; conversely, gynephilic females tend to be more male-typical and “thing-oriented” than androphilic females (Cardoso, 2013; Lippa, 2008; L. Zheng et al., 2011). Not surprisingly, androphilic males in many cultures worldwide share interests pertaining to the house and home, decoration and design, language, travel, helping professions, grooming, and the arts and entertainment (Whitam & Mathy, 1986).

Even in small, isolated, and traditional cultures, the rudiments of such subculture become apparent. Whitam and Mathy (1986) described one such example:

In the Guatemalan Indian town of Chimaltenango, two men lived together as lovers, wearing typical Indian clothing in an outwardly traditional Indian adobe house. The house, however, was decorated in a manner strikingly different from the other Indians. It was meticulously and elaborately decorated, a characteristic frequently found in homosexual subcultures. . . . The occupation of the lovers was that of stringing pine needles in decorative strands, traditionally used in Guatemala for holidays and other festive occasions,

and supplying flowers for weddings. In essence these two men were florists, involved in the arts of embellishment, which in larger societies are universally linked with homosexual subcultures. (p. 84)

Homosexuality in Africa. Because there have been proposals to increase legal penalties against homosexuality in several African nations, we briefly address the cultural history of homosexuality in Africa. The transgender form of same-sex sexuality predominated in traditional societies in Africa (Epprecht, 2008). Notwithstanding commonplace claims today that “homosexuality is un-African,” same-sex-attracted transgender male androphiles and female gynephiles were observed from the earliest recorded times and in hundreds of discrete cultures across the continent (Epprecht, 2006; Murray & Roscoe, 1998). European observers, with all their assumptions, prejudices, and linguistic limitations, were not necessarily reliable witnesses, and, for this reason, many of the accounts produced in the colonial periods can be misleading. There are, however, a wide range of ethnographies that document exceptions to heterosexual norms.

Same-sex relationships typically involved a male-bodied person said to be possessed by a female ancestral or other spirit. To avoid offending that spirit, the man needed to avoid sex with women and perhaps, to win the favor of the female spirit, actively seek out sex with a male partner. Male spirits could similarly be embodied in living females, demanding that a woman remain celibate or take female sex partners. Sometimes this was a source of mocking humor to the majority population, but often the “possessed” person had a respected, even cherished role in society as a healer or seer (Epprecht, 2008; Nkabinde, 2008). In some cases, particularly in Islamic Africa, same-sex-attracted transgender people have occupied specialized occupations, much like the stereotypical ones observed in the West and described above (Gaudio, 2009). In urban centers, communities of same-sex-attracted males have developed out of friendship networks and around shared locations for meeting or work (Gaudio, 2009; Moodie & Ndatshe, 1994).

In addition to being highly gendered, same-sex relationships were frequently age-stratified as well, with the elder partner assuming the masculine role (in conventional terms) and the younger partner the feminine role. With maturity, the younger partner would commonly graduate into a heterosexual marriage. Because the younger partners were not recognized socially as fully adult “men” (a moniker that comes with marriage), they were often referred to as “boys.” It is important to note, however, that these “boys” were usually postpubertal and thus, although these relationships often involved age discrepancies, they were not pedophilic. In a strongly homosocial environment, same-sex sexual bonds could

continue into adulthood without being explicitly named as such (Carrier & Murray, 1998; Gay, 1985; Kendall, 1998).

Aspects of gay identity as lived and performed in the West since “gay liberation,” including the egalitarian model of overt same-sex relationships, are attractive to many Africans who chafe under traditional, heterosexual family norms and obligations. As a result, small numbers of Africans began to come out in politically recognizable ways as lesbian and gay beginning in the 1990s (Hoad, Martin, & Reid, 2005; Morgan & Wieringa, 2005).

Homosexuality in nonhuman animals

Animal studies have informed the science of human sexual-orientation causation in several ways. Experimental studies of nonhuman animals have helped generate models of sexual-orientation development. Field studies of animals have allowed tests of hypotheses regarding the situations that are most likely to be associated with increased homosexual behavior. Although same-sex interactions involving genital contact have been reported in hundreds of animal species (Bagemihl, 1999), they are routinely manifested in only a few (Sommer & Vasey, 2006). In this sense humans are rare, but we are not unique.

Same-sex genital interactions between nonhuman animals can take a variety of forms, including mounting (with and without pelvic thrusting), oral-genital contact, and manual-genital contact. In many instances, same-sex genital interactions can be accurately described as “homosexual behavior” because they involve genital arousal, stimulation, and orgasm. For example, it is not uncommon for males to exhibit erections during these interactions (e.g., Japanese macaques [*Macaca fuscata*], Leca, Gunst, & Vasey, 2014), and ejaculation occurs occasionally (e.g., mountain gorillas [*Gorilla beringei*], Yamagiwa, 1987). Intromission between males has also been reported (e.g., bottlenose dolphins [*Tursiops* sp.], Mann, 2006), but rarely, perhaps in part because of the challenges associated with recording such behavior. In some species, females actively stimulate their genitals during same-sex mounts (e.g., bonobos [*Pan paniscus*], de Waal, 1987; Japanese macaques, Vasey & Duckworth, 2006). Orgasm between female partners is difficult to document unambiguously but has also been reported (stump-tailed macaques [*Macaca arctoides*], Goldfoot, Westerborg-van Loon, Groenevelde, & Slob, 1980). In addition to these genital interactions, same-sex courtship has been reported in numerous animal species, and some same-sex individuals form temporary or even long-lasting pair-bonds (e.g., male greylag geese [*Anser anser*], Kotrschal, Hemetsberger, & Weiss, 2006).

There is abundant evidence that nonhuman animals engage in same-sex genital interactions under free-ranging conditions, and therefore this behavior cannot be explained as a result of captivity in abnormal environments. Skewed sex ratios can facilitate the expression of same-sex genital interactions among the more numerous sex (Poiani, 2010), but such conditions are not necessary for such behavior to be manifested (Bagemihl, 1999; Sommer & Vasey, 2006). Even when opportunities to engage in heterosexual contact are available, individuals sometimes prefer to engage in homosexual behavior (Leca, Gunst, Huffman, & Vasey, 2015). Quantitative research indicates that species' mating systems, rates of development, and disparities in parental care all influence the expression of homosexual behavior in birds. For example, the frequency of male-male sexual behavior in birds increases with the degree of contextual polygyny, whereas female-female sexual behavior is more frequently expressed in monogamous species that exhibit precocial development (MacFarlane, Blomberg, Kaplan, & Rogers, 2007).

Many of the same-sex genital interactions exhibited by animals are, at least in part, sociosexual in character—that is, sexual in terms of their outward form, but primarily enacted to facilitate adaptive social goals (Wickler, 1967). The context-specific manner in which such behavior is expressed often cues researchers to its adaptive function. For example, in female bonobos, a close temporal relationship exists between same-sex genital interactions and food sharing. Females entering a food patch that is monopolized by a same-sex competitor are more likely to acquire food if they first engage in genital rubbing with that competitor (de Waal, 1987; Hohmann & Fruth, 2000). In this way, same-sex genital rubbing functions to reduce inter-individual tension and facilitate food sharing. In male savanna baboons (*Papio cynocephalus anubis*), there is a close temporal relationship between same-sex mounting/genital fondling and successful alliance formation. Males will often engage in these behaviors just prior to challenging a same-sex rival (Smuts & Watanabe, 1990). Sociosexual interactions can be devoid of sexual arousal, but more often than not, they are characterized by some mix of both sexual and social motivation (Wickler, 1967). However, in some species, same-sex mounting appears to be entirely sexual, with no discernable sociosexual component whatsoever. For instance, in certain populations, female Japanese macaques will sometime choose other females as sexual partners despite the presence of sexually motivated male mates (Vasey & Duckworth, 2006). Female Japanese macaques will even compete intersexually with males for exclusive access to female sexual partners (Vasey, 1998).

Exclusive same-sex sexual orientation across the life course is, however, extremely rare among animals. The

only conclusively documented example is among males (rams) of certain breeds of domestic sheep (*Ovis aries*, Perkins & Fitzgerald, 1997). Approximately 6% to 10% of rams in these domestic breeds choose to court and mount other rams, but never ewes, when given a choice (Roselli, Larkin, Resko, Stellflug, & Stormshak, 2004). During some mounts between rams, penile-anal intromission and ejaculation occurs (Perkins & Fitzgerald, 1997). In all other animal species, with the exception of humans, individuals that engage in same-sex genital interactions engage in heterosexual ones as well.

Hormones

The previous two sections have focused on observable expressions of same-sex sexuality in humans and animals. In the remainder of our review, we focus on various mechanisms that have been hypothesized to explain variation in human sexual orientation, particularly the propensity to experience same-sex sexual attraction.

The possibility that people differ in sexual orientation because of hormonal differences has been the most influential causal hypothesis involving a specific mechanism (Dörner, 1976; Ellis & Ames, 1987; LeVay, 2011; Meyer-Bahlburg, 1984; Money & Ehrhardt, 1972; Zucker, 2005). On the one hand, several considerations point to this hypothesis; on the other hand, it has difficulties explaining some key facts. In addition, there is little direct evidence for this hypothesis and, of course, such evidence is unlikely to be forthcoming, given that it would be unethical to undertake direct testing on human subjects.

If we conceptualize sexual orientation as a sexual predisposition toward males or toward females (androphilia or gynephilia) instead of a sexual predisposition for the same sex or the other sex, then we can immediately see that there are large sex differences in sexual orientation. Specifically, far more women than men are androphilic, and far more men than women are gynephilic. We can therefore think of androphilic men and gynephilic women as being gender-atypical with regard to their sexual orientation, since each shows a pattern of sexual interest that is more characteristic of the other sex. We also know, as reviewed earlier, that androphilic men and gynephilic women are gender-atypical in a variety of other ways, sometimes even in childhood. Thus, it seems reasonable to wonder whether gender-atypical sexual orientations (i.e., homosexuality and bisexuality) are caused by the same factors that drive differences between male and female development more generally. Two factors are known to create these differences: hormones and sex-role socialization. We discuss the possible role of socialization in a later section, and begin with the organizing role of prenatal hormones.

The organizational hypothesis. The development of most physical sex differences strongly depends on hormones. Some of these differences (e.g., patterns of muscle and fat distribution) are caused by circulating hormones and are thus reversible to some extent. Others (e.g., the internal and external sex organs) are caused by hormonal differences during a critical period and are mostly irreversible (Sisk, Lonstein, & Gore, 2013). Early, irreversible effects of hormones are *organizational*, and later, reversible effects are *activational*. The organizational-activational distinction is conceptually useful, although some effects do not fit neatly into either category; for example, some later effects of circulating hormones are irreversible (Arnold & Breedlove, 1985).

Early studies of possible hormonal influences on sexual orientation focused on circulating levels of the sex hormones testosterone and estrogen. In general, homosexual and heterosexual men do not differ in levels of these hormones (Meyer-Bahlburg, 1984). In contrast, studies have tended to find higher testosterone levels in homosexual women compared with heterosexual women (Meyer-Bahlburg, 1984; Singh et al., 1999). The meaning of such differences among females is unclear, however. Circulating hormone levels are affected by many factors, such as body weight, and lesbians may be taller and heavier, on average, than heterosexual women (Bogaert, 1998; Singh, VIDAURRI, Zambarano, & Dabbs, 1999). Although some studies have statistically controlled for known correlates of circulating testosterone, they may have unknowingly neglected important confounds. If the results were valid (i.e., not due to some third variable), it would remain unclear how having higher testosterone might cause a woman to be sexually attracted to other women. Perhaps, instead, the testosterone differences are the results of brain differences that cause sexual-orientation differences. Scant recent research has addressed sexual-orientation differences in levels of circulating sex hormones.

The possibility that sexual orientation reflects the organizational effects of early hormones, especially testosterone, has been far more influential. This hypothesis is a special application of a general hypothesis: the organizational hypothesis of mammalian sexual differentiation, according to which the same prenatal factors that shape the body as male-typical or female-typical also shape the brain to perform in a male- or female-typical fashion (Phoenix, Goy, Gerall, & Young, 1959). The general hypothesis has been confirmed for a remarkably diverse range of behaviors in every mammalian species examined so far (De Vries & Simerly, 2002). The sexuality of the body and behavior of mammals does not appear to be directly affected by their genetic sex (XX vs. XY). Rather, it is an indirect consequence of genetic sex—namely, whether ovaries or testes develop prenatally.

Testicular release of steroid hormones, specifically androgens such as testosterone, act early in life to induce the formation of male genitalia (penis, scrotum, etc.) and alter the developing brain to promote male sexual behavior in adulthood. The absence of these testicular secretions leads to the development of female-typical genitalia (clitoris, labia, vagina, etc.) and brain organization that, in adulthood, is more likely to drive female-typical sexual behavior.

The organizational hypothesis applied to human sexual orientation holds that during an early—probably prenatal—sensitive period, the brains of homosexual people are subject to atypical influences of androgens. Specifically, homosexual men's fetal brains were androgenized less than heterosexual men's; homosexual women's were androgenized more than heterosexual women's. Two lines of research have been influential in convincing researchers that the organizational hypothesis of sexual orientation is plausible, and these include research on the consequences of early hormonal manipulation in mammals, especially rats, mice, and ferrets, as well as research on the psychosexual outcomes of individuals with atypical hormonal development.

In studies of mice, rats, and ferrets, experimentally depriving males of testosterone or exposing females to male-typical levels of testosterone early in development dramatically alters their adult sexual behavior. That is, males can be made to exhibit aspects of female-typical behavior and females to exhibit aspects of male-typical behavior (Henley, Nunez, & Clemens, 2011).

Furthermore, in some well-studied mammalian species (e.g., rats, mice, ferrets, sheep), particular brain regions show sex differences in size, and this sexual dimorphism depends entirely on exposure to early sex hormones. The largest and best studied of these is a brain region called the sexually dimorphic nucleus of the preoptic area (SDN-POA), which is located in the hypothalamus. This sexually dimorphic area has been identified in a wide range of mammalian species and is always larger in males than it is in females (Henley et al., 2011). The SDN-POA sex difference is caused by sex differences in perinatal hormones: By controlling testosterone levels just before and after birth, researchers can induce the SDN-POA to be as masculine or as feminine as they like in adulthood. This brain region appears to play important roles in both the appetitive and consummatory behavior of male mammals (Balthazart & Ball, 2007). Furthermore, in sheep, the best animal model for human homosexuality—a minority (approximately 7%) of male sheep (rams) exclusively mount other males—the SDN-POA is half the size in male-mounting rams as it is in female-mounting rams (Roselli et al., 2004). Clearly, organizational androgens have important influences on the brains and sexual behavior of nonhuman

animals, and there is every reason to expect this to be true in humans as well.

Atypical prenatal androgen exposure in humans.

Some humans are exposed to atypical levels of prenatal hormones, most often because they have unusual genetic syndromes. For example, in congenital adrenal hyperplasia (CAH), both male and female fetuses are exposed to high levels of testosterone in utero. Usually, after birth, they receive medication to reduce testosterone; thus, later differences are likely attributable to organizational effects of testosterone. As adults, women with CAH report homosexual orientation at elevated rates, compared with unaffected women. Despite this elevation, most women with CAH report exclusively heterosexual attractions (Meyer-Bahlburg, Dolezal, Baker, & New, 2008)—thus, the high levels of prenatal androgens do not ensure homosexuality in these women. Similar to unaffected, homosexual women, women with CAH tend to exhibit gender nonconformity throughout their lives, on average (Berenbaum & Beltz, 2011). Although other syndromes (e.g., 5-alpha-reductase deficiency) provide relevant evidence to the organizational hypothesis, CAH remains the best instantiation of the theory.

Finger length ratios. The animal and human studies just discussed at best establish the plausibility of the organizational hypothesis of human sexual orientation. Direct evidence would include studies showing that homosexual people had a variety of signs of atypical early androgen exposure. Besides gender nonconformity (which might in theory reflect the influences of socialization), there are few replicated findings of this type.

One exception is the 2D:4D digit ratio, or the ratio of index to ring finger length. This index shows a moderate sex difference ($\delta = 0.46$),¹⁶ with women having larger ratios and men having smaller ones. Several lines of evidence pertaining to digit ratios are consistent with the organizational hypothesis. First, women with CAH exhibit smaller (i.e., more masculine) 2D:4D ratios (Hönekopp & Watson, 2010). Second, genetic male (XY) individuals with androgen insensitivity syndrome display a feminine pattern of digit ratios, which supports a hormonal rather than a genetic mechanism for the sex difference (Berenbaum, Bryk, Nowak, Quigley, & Moffat, 2009). Third, the same sex difference is present in mice, in which experimental manipulations have confirmed that prenatal androgens act directly upon osteoblasts in the digit to engender the sex difference (Z. Zheng & Cohn, 2011). Fourth, a meta-analysis (Grimbos, Dawood, Burriss, Zucker, & Puts, 2010) confirmed that homosexual and heterosexual women differ, on average, in terms of their 2D:4D ratios, with homosexual women having a more masculine ratio. Taken together, this evidence

suggests that prenatal androgens are responsible for the development of gynephilia in at least some human females (Williams et al., 2000). These results also suggest that most men are gynephilic in orientation because of their exposure to prenatal androgens, an idea we return to below in our discussion of cloacal exstrophy. Interestingly, there is no difference in digit ratios between homosexual and heterosexual men, which indicates that variance in prenatal androgen does not account for variance in sexual orientation in men. Alternatively, variance in brain responsiveness to prenatal androgen may contribute to variance in male sexual orientation.

Although the 2D:4D evidence supports the organizational hypothesis of female (but not male) sexual orientation, it is not decisive evidence. The sex difference in 2D:4D is not large, and therefore 2D:4D cannot be an especially accurate marker of prenatal androgen exposure. On the one hand, this could mean that the female-sexual-orientation findings are especially impressive, given the weak 2D:4D signal. On the other hand, variation in 2D:4D surely has many causes unrelated to prenatal androgens, and these could contribute to the association with female sexual orientation.

The human SDN-POA. The brain is the fundamental cause of all impulses, desires, thoughts, and behaviors. Hence, *any* difference between the thoughts and feelings of two individuals can be called a neurological difference. But where exactly does the difference reside? Does it reflect the same basic brain structures functioning in different ways (through different patterns of neural connections), or does it reflect differences in brain structures themselves?

In 1991, neuroscientist Simon LeVay of the Salk Institute for Biological Studies created an international furor by publishing a paper in *Science* with the finding that 19 homosexual and 17 presumed heterosexual men¹⁷ differed in the size of the third interstitial nucleus of the anterior hypothalamus (INAH-3), a brain region in the preoptic area, such that the INAH-3 was larger in heterosexual men. Heterosexual men's INAH-3 volume was more than twice that of homosexual men's, whose volume was similar to that of a control group of presumed heterosexual women. LeVay's study required autopsied brains, and all his homosexual subjects had died of AIDS. However, LeVay ruled out AIDS as the cause of the difference, because the difference remained significant when he restricted his heterosexual male sample to those who had also died of AIDS. Also, among heterosexual subjects, there was no correlation between brain volume and AIDS. The common assertion that LeVay's findings may have reflected AIDS rather than sexual orientation has no apparent merit.

LeVay did not choose brain areas for analysis haphazardly. Rather, he focused on four clumps of cells in the

hypothalamus: the INAH-1, INAH-2, INAH-3, and INAH-4. These cell groups had been previously compared between men and women of unspecified orientation; two of the cell groups—INAH-2 and INAH-3—were sexually dimorphic, such that the INAH-3 was two to three times larger in men (Allen, Hines, Shryne, & Gorski, 1989). Thus, the importance of LeVay's finding was magnified by the fact that the brain region that differed between homosexual and heterosexual men was sexually dimorphic; indeed, LeVay replicated this finding. A second important fact is that the INAH-3 is in the hypothalamus. It appears to be similar in some ways to the previously mentioned SDN-POA, which shows sexual dimorphism due to organizational hormonal effects in most mammals that have been studied (Byne et al., 2000; Byne et al., 2001; LeVay, 2011). This argues against the common criticism of LeVay's findings—that they could be a consequence of the “homosexual lifestyle.” LeVay's study was important precisely because it supported the organizational hypothesis of human sexual orientation with direct neuroscience data.

LeVay's findings were from a small sample. Although they were highly statistically significant, it is obviously important that the findings also be replicable. Replicating the study was difficult because it required dissecting brains of people with known (or well-inferred) sexual orientations. The tragic AIDS epidemic was waning when neuroscientist William Byne began collecting specimens for a replication. He assembled a sample of brains of 14 HIV-positive homosexual men, 34 presumed heterosexual men (10 of whom were HIV positive), and 34 presumed heterosexual women (9 of whom were HIV positive). Byne's laboratory replicated the sex difference in INAH-3 size among heterosexual subjects (Byne et al., 2000; Byne et al., 2001), such that heterosexual men's INAH-3 had both more neurons and larger volume compared with heterosexual women's. Furthermore, Byne argued on the basis of cytoarchitectonic evidence that the human INAH-3 (as well as the dorsocentral portion of the anterior hypothalamic nucleus, or AHdc, in rhesus macaques [*Macaca mulatta*]) is a likely homologue of the SDN-POA that has been so well studied in other species (Byne, 1998).¹⁸

LeVay's key sexual-orientation finding was not clearly replicated (Byne et al., 2000; Byne et al., 2001). Byne et al. found a statistical trend (i.e., $.05 < p < .10$) whereby homosexual men had a smaller INAH-3, but they found no difference in the number of neurons. To be sure, Byne et al.'s sample was also small, with even fewer homosexual men than LeVay's. Scientifically, Byne et al.'s research should not be the last word on the INAH-3 and sexual orientation. Practically, however, it is likely to be the last word for the foreseeable future. The INAH-3 is so small—about the size of a grain of sand—that it cannot

be accurately measured without dissecting brain tissue. With effective treatments for HIV, there is no longer a steady stream of brain tissue from homosexual men—an entirely happy development, but one that prevents further study of the human INAH-3 and sexual orientation, for now. If the true INAH-3 difference between heterosexual and homosexual men is intermediate between LeVay's and Byne et al.'s results, it would still be consistent with the organizational hypothesis of sexual orientation. However, even if this were true, it would be unlikely that the INAH-3 size would be a key factor regulating sexual orientation. This is because there would be too many exceptions—homosexual men with a large INAH-3 and heterosexual men with a small INAH-3—to believe that INAH-3 size is crucial.

There have been several other reports of brain differences between homosexual and heterosexual subjects, some of which were detected using brain imaging (e.g., Ponseti et al., 2007). Although we find those studies interesting, we do not review them in this article. None of the brain areas in these articles has been studied as intensively as the INAH-3, and none is as relevant to the organizational hypothesis of sexual orientation.

Limitations of the hormonal evidence. Both experimental nonhuman-animal studies and clinical human studies of the effects of atypical early hormone exposure support the possibility that such exposure can influence sexual orientation. However, both lines of evidence have important limitations. The main limitation of the animal research is the lack of a close correspondence between the animal behaviors studied and human sexual orientation. For example, one of the main behaviors hormonally manipulated in laboratory mammals is the propensity to either mount (a male-typical behavior) or exhibit lordosis (i.e., move the body in a way that permits penile penetration; a female-typical behavior). Neither of these behaviors maps well onto human sexual orientation.

Limitations of clinical studies of humans include the lack of a model of male homosexuality analogous to the CAH model of androgen influences on female homosexuality. Furthermore, atypical early hormonal exposure typically results in atypical genital development. For example, girls with CAH are often born with masculinized genitalia including enlarged clitorises. However, there is no conclusive evidence that homosexual and heterosexual people differ in their genital anatomy. In principle, atypical androgen exposure could cause human homosexuality without also causing abnormal genital (or, more generally, gross anatomical) development if there were different critical periods for brain and genital differentiation and if atypical androgen exposure occurred only during the former. This suggestion is plausible, given that different sensitive periods for genital and

behavioral masculinization have been demonstrated for some nonhuman species, such as rhesus macaques (Goy, Bercovitch, & McBair, 1988).

Given the limited direct evidence for the organizational hypothesis that prenatal androgens cause human sexual orientation, some may be tempted to reject the hypothesis. We think that would be premature. Sometimes good hypotheses are difficult to test. Furthermore, a remarkable natural experiment whose results are strongly consistent with the organizational hypothesis has been underappreciated. We review this natural experiment in the next section.

The near-perfect quasi-experiment. Imagine that scientists wanted to conduct a single study to determine the degree to which sexual orientation is influenced by nature versus nurture. Imagine also that scientists were not ethically constrained. The following study would be difficult to beat: Take newborn boys, surgically feminize them (i.e., castrate them and surgically transform their penises into plausible facsimiles of female genitalia), and present them as girls to naive adoptive parents. (An analogous study of natal females would also be desirable, but it is currently impossible to transform female genitalia into a facsimile of a penis.) Follow these children into adulthood and assess their sexual orientations. If only nurture is important in determining whether people are sexually attracted to men or women, then these individuals should all be attracted to men, because they were raised female. In contrast, if only nature is important, then they should all be attracted to women, because before birth, and consistent with the organizational hypothesis, they were exposed to typical male hormonal and genetic influences and the large majority of men are attracted to women. Of course, intermediate results and appropriate interpretation would also be possible.

An unintentional version of this study has been conducted on a few unfortunate subjects, all born male, because they either were born with malformed penises or lost their penises in surgical accidents. Between 1960 and 2000, many doctors in the United States believed that such males would be happier being socially and surgically reassigned female. This belief has changed, as has medical practice (Diamond et al., 2011), but not before a generation of these individuals were made part of this natural experiment. Besides surgical accidents, the other medical reason for early sex reassignment that we consider here has been cloacal exstrophy, a severe abdominal malformation that includes penile malformation in boys. Importantly, neither cloacal exstrophy nor surgical accidents are associated with abnormalities of prenatal androgens. Thus, the brains of these individuals were male-organized at birth, or at least as male-organized as those of typical boys are at birth, on average.

Table 3. Sexual Orientations of Hormonally Typical Males Reassigned as Females Early in Life

Study	Condition	Age at reassignment	Age at follow-up	Gender identity at follow-up	Sex attracted to
M. Diamond and Sigmundson (1997)	Surgical accident	17 months	32	Male	Females
Bradley, Oliver, Chernick, and Zucker (1998)	Surgical accident	7 months	26	Female	"Predominantly" females
Reiner and Gearhart (2004; Subject 9) ^a	Cloacal exstrophy	0 months (birth)	21	Male	Females
Reiner and Gearhart (2004; Subject 10) ^a	Cloacal exstrophy	0 months (birth)	11	Male	Females
Reiner and Gearhart (2004; Subject 14) ^a	Cloacal exstrophy	0 months (birth)	20	Male	Females
Reiner and Kropp (2004) ^a	Cloacal exstrophy	0 months (birth)	NR	Male	Females
Reiner and Kropp (2004) ^a	Cloacal exstrophy	0 months (birth)	NR	Male	Females

Note: NR = not reported.

^aOriginal publications included only summaries of a series of patients. Specific information for this table obtained from William G. Reiner.

Far more attention has been paid to the eventual gender identities of these cases than to their sexual orientations. Indeed, sexual orientation has often not been assessed, presumably because of the sensitivity of asking the question (Meyer-Bahlburg, 2005). But the few published cases that have provided sexual-orientation information have shown remarkably consistent results (Table 3). In all seven cases, sexual orientation was predominantly or exclusively gynephilic (i.e., attraction was toward women).¹⁹ This is the result we would expect if male sexual orientation were entirely due to nature, and it is opposite of the result expected if it were due to nurture, in which case we would expect that none of these individuals would be predominantly attracted to women.

These results comprise the most valuable currently available data concerning the broad nature-versus-nurture question for sexual orientation. They show how difficult it is to derail the development of male sexual orientation by psychosocial means. If one cannot reliably make a male human become attracted to other males by cutting off his penis in infancy and rearing him as a girl, then what other psychosocial intervention could plausibly have that effect? These cases establish a strong *prima facie* case that in males, heterosexual orientation is at least partly established before birth. And if male heterosexual orientation is so difficult to alter after birth, there is no reason to doubt the same is true of male homosexual orientation.

However, these cases fall short of the perfect experiment. Most obviously, assignment to condition is not random, so we call it a "quasi-experiment" rather than an experiment. Another imperfection is that parents know the birth status of these children (i.e., male) and might conceivably treat them differently than natal girls and in a way that influences their sexual orientation. Although this possibility cannot be presently excluded, it is vague and *ad hoc*. After all, the parents have agreed to surgical feminize these children and to raise them as girls. What subtle parental signals could trump these massive interventions?

In any case, the available evidence indicates that in such instances, parents are deeply committed to raising these children as girls and in as gender-typical a manner as possible (Colapinto, 2000).

A second limitation of this evidence is the small number of cases: only seven published, although several more cases are potentially available (Reiner & Gearhart, 2004). For two reasons, rejecting these findings because of their small sample size would be a mistake, even though a larger sample size would obviously be desirable. First, the findings comprise the closest test of nature versus nurture with respect to sexual orientation, and right now they are all we have. Second, the seven cases have remarkably similar outcomes with respect to sexual orientation. There is no good reason to suspect that this would change if additional cases similar to these were added. Because of the limited sample size, however, the data provide much stronger support for the importance of nature than they do for the lack of importance of nurture.

A third limitation pertains to gender identity. Gender self-reassignment in these cases—boys reassigned and reared as girls renouncing their sex of rearing and declaring that they are male—is not unusual. It is also not universal. A disproportionate number of the cases for which we have sexual-orientation information—six of seven—identified as male at follow-up. Several of the other cloacal exstrophy cases were still living as female. Notably, none of them would discuss their sexual attractions, in contrast to two adolescents with cloacal exstrophy who were born female, and who discussed their attractions to males. We suspect that the former cases—natal males reassigned as female and still living in the female role—are highly likely to be gynephilic. Certainly, however, it is scientifically important to obtain data from such cases. It would also be desirable to support any self-reported claims of androphilia (i.e., attraction to males) with objective measures. This is because those individuals still in

the female role may feel social pressure to claim attraction to males even if none exists.

The importance of these cases applies only to male sexual orientation. As noted, there is no close analogue of this natural experiment in which hormonally normal girls are reassigned and reared as boys. Female sexual orientation could be different—less fixed by early hormonal and genetic factors—although evidence from CAH and digit-ratios studies supports some early influences.

Genes

Two very different kinds of empirical studies have been used to investigate genetic influences on sexual orientation: twin studies and molecular genetics studies. The aim of twin studies is to estimate the general importance of genetic versus environmental influences on sexual orientation. Molecular genetics studies aim to identify particular genes that influence sexual orientation.

Twin studies. Twin studies quantify the magnitude of genetic compared with environmental influences. Conceptually, the most straightforward version of a twin study involves identical (monozygotic, or MZ) twins separated shortly after birth and reared in separate, uncorrelated environments. Any similarity between the separated twins must be due to the fact that they are genetically identical and shared the same intrauterine environment, and any differences must reflect postnatal environmental differences. Unfortunately for science, early-separated twins are quite rare, and separated twin pairs in which at least one twin is homosexual are still rarer. Thus, our knowledge of sexual orientation among separated twins is limited to a few case reports, insufficient in number to draw firm conclusions (Eckert, Bouchard, Bohlen, & Heston, 1986).

In contrast, the classical twin design relies on jointly reared twins, who are far more common. This design depends on the fact that there are two kinds of twins: MZ and dizygotic (DZ) twins (also known as fraternal twins). MZ twins are genetically identical, and DZ twins share half their genes.²⁰ The classical twin design allows estimation of the magnitudes of genetic influences and two kinds of environmental influences: shared and nonshared environment. The respective estimates are heritability (h^2), shared environmentality (c^2), and nonshared environmentality (e^2). (Shared environment causes siblings reared together to be similar; nonshared environment causes them to differ.) Each estimate is bounded by zero and one, and the sum of the estimates equals one; they are interpreted as the proportion of trait variance attributable to variation in the respective influences. These estimates require knowing the correlations of trait values separately for MZ and DZ twins.²¹

It should be noted that existing twin studies all assessed sexual orientation via self-report. It is possible that some reports are false, and false reports seem most likely to be denial of homosexual interests. It is possible that true discordance is less common than implied by these studies. Research supporting the validity of twin discordance—that twins who report different sexual orientations truly have them—is currently lacking, and would be most desirable for MZ pairs. In males, persuasive evidence for valid twin discordance would consist of different patterns of PPG-measured arousal to male and female erotic stimuli. In females, viewing time for male versus female stimuli would provide a potentially objective measure.

Table 4 includes the twin concordances from studies of sexual orientation.²² Two general categories of twin studies are distinguished: those using targeted sampling and those using twin registries or probability sampling (e.g., random telephone sampling). In targeted sampling, homosexual (or, more generally, nonheterosexual) twins are recruited explicitly, via advertisements or word of mouth. This method of recruitment may be especially vulnerable to sampling bias, because homosexual twins not only must hear about the study, they must also decide whether to participate, likely knowing that the researcher is studying homosexuality. When deciding whether to participate, the potential participants of such studies may consider their twins' orientations (in order to avoid suspicion or tension that may be more likely between siblings of different orientations), thus leading to an overrepresentation of concordant pairs (Kendler & Eaves, 1988). Furthermore, concordant MZ pairs may be especially likely to be recruited, because they are especially likely to both meet potential referrers (Torrey, 1992). Such bias would inflate MZ relative to DZ concordances, leading to spuriously high estimates of heritability. Studies using twin registries or probability sampling are less susceptible to sampling bias because the population of interest has been assembled without regard to sexual orientation. Table 4 confirms the likely increased bias in the targeted samples. Median MZ and DZ concordances are .52 and .17, respectively, in the targeted samples, compared with .24 and .15 in the registry/probability samples. Note that the median concordances also show a larger MZ-DZ difference for the targeted samples than for the registry/probability samples. It is likely that the latter figures provide better estimates of the true concordances.

What can we conclude from the results of the better samples? We provide only a rough summary here, rather than engaging in rigorous estimation and hypothesis testing. There are too few registry/probability samples of either sex to provide separate analyses, and therefore we consider male, female, and mixed samples together. The MZ concordance rate exceeds the DZ rate in six of seven

Table 4. Probandwise Concordances of Published Twin Studies of Sexual Orientation

Recruitment	Location	Study	Definition of nonheterosexuality	Sex	Number of MZ nonheterosexual probands	Number of MZ cotwins also nonheterosexual	Number of nonheterosexual probands	Number of DZ cotwins also nonheterosexual	MZ probandwise concordance	DZ probandwise concordance	Adjusted odds ratio	Rate of nonheterosexuality in sample
Targeted	United States	Kallmann (1952)	Kinsey score of 3 or greater	Male	37	37	26	3	1.00	0.12	503.57	NA
Targeted	United States	Bailey and Pillard (1991)	Kinsey score of 2 or greater	Male	56	29	54	12	0.52	0.22	3.65	NA
Targeted	United States	Bailey, Pillard, Neale, and Agyei (1993)	Kinsey score of 2 or greater	Female	71	34	29	3	0.48	0.10	6.97	NA
Targeted	United States	Whitiam, Diamond, and Martin (1993)	Kinsey score of 4 or greater for probands, 2 or greater for cotwins	Male	34	22	14	4	0.65	0.29	4.20	NA
Targeted	United Kingdom	King and McDonald (1992)	Self-reported sexual identity ("homosexual" or "bisexual")	Mixed	17	4	24	4	0.24	0.17	1.52	NA
Targeted median	—	—	—	—	—	—	—	—	0.52	0.17	4.20	NA
Probability sampling	United States	Kendler, Thornton, Gilman, and Kessler (2000)	Self-reported sexual identity ("homosexual" or "bisexual")	Mixed	19	6	15	2	0.32	0.13	2.60	0.03
Twin registry	United States	Hershberger (2001)	Uncertain	Male	16	4	8	2	0.25	0.25	0.94	0.04
Twin registry	United States	Hershberger (2001)	Uncertain	Female	11	6	8	2	0.55	0.25	3.07	0.03
Twin registry	Sweden	Långström, Rahman, Carlström, and Lichtenstein (2010)	Any lifetime same-sex partners	Male	78	14	56	6	0.18	0.11	1.75	0.06
Twin registry	Sweden	Långström et al. (2010)	Any lifetime same-sex partners	Female	240	52	153	26	0.22	0.17	1.34	0.08
Twin registry	Finland	Alanko et al. (2010) ^a	Score of at least 1.5 on the Sell Assessment of Sexual Orientation	Mixed	16	6	23	0	0.38	0.00	29.10	0.02
Twin registry	Australia	Zietsch et al. (2012) ^a	Self-reported sexual preference for same sex, other sex, or both sexes	Mixed	134	32	154	20	0.24	0.13	2.08	0.04
Nontargeted median	—	—	—	—	—	—	—	—	0.25	0.13	2.08	0.04

Note: Only studies with at least 10 monozygotic (MZ) and 10 dizygotic (DZ) probands were included. *Probandwise concordance* represents the probability that an index twin with the trait (in this case, nonheterosexuality) has a twin who also has the trait. Both members of a twin pair are *probands* if they were ascertained independently, as they typically would be in a twin registry study. Probandwise concordance contrasts with *pairwise concordance*, which is the probability that a twin pair will be concordant. Although probandwise concordance tends to be the less intuitive index, it is the correct one (McGue, 1992). NA = not applicable.

^aConcordance data were not in the original publication but were obtained from the authors.

studies (with the exception a statistical tie), and the average effect size (log odds ratio) significantly differs from zero ($z = 3.14$, $p = .0017$). This supports the hypothesis that heritability exceeds zero, although the alternative hypothesis is not resoundingly rejected. The median MZ and DZ concordances are .24 and .15, respectively, and the median rate of nonheterosexual orientation is .04. These figures translate into tetrachoric correlations of .57 and .41, and heritability is estimated as $2 \times (.57 - .41) = .32$, meaning that about a third of variation in sexual orientation is attributable to genetic differences. The best estimate of the nonshared environmentality is simply one minus the MZ correlation, .43, and shared environmentality is the remainder, .25.

Twin studies that have included retrospective childhood gender nonconformity have yielded some additional intriguing findings (Bailey, Dunne, & Martin, 2000; Bailey & Pillard, 1991; Bailey, Pillard, Neale, & Agyei, 1993). First, the probability that either male or female MZ twin pairs were concordant for sexual orientation was unrelated to the degree of homosexual twins' childhood gender nonconformity. Thus, there is no evidence that homosexuality associated with childhood gender nonconformity is especially heritable. Second, among discordant MZ twin pairs, there were significant and substantial differences in childhood gender nonconformity, with the homosexual twin recalling much more gender nonconformity compared with the heterosexual twin. This suggests that nonshared environmental influences on sexual orientation begin early, at latest by childhood. Third, among concordant MZ pairs, there was a high correlation for childhood gender nonconformity: Both twins tended to have shown high, moderate, or low levels of gender nonconformity in childhood. This finding has been replicated in a study of nontwin brothers (Dawood, Pillard, Horvath, Revelle, & Bailey, 2000). It suggests that genes or shared environment may affect the particular developmental expression of sexual orientation.

In conclusion, the evidence supporting a genetic influence on sexual orientation is consistent, although sampling biases remain a concern even for the best available studies. Our best estimate of the magnitude of genetic effects is moderate—certainly not overwhelming. In contrast, the evidence for environmental influence is unequivocal, given that MZ twin concordances tend to be far less than 100%,²³ assuming that the MZ twin pairs are truly discordant. It is important to recognize that the limits of this evidence reflect the difficulty of conducting twin studies of sexual orientation. Nonheterosexual orientation is relatively rare, and so even a large twin registry will have an insufficient number of twin pairs with nonheterosexual members to provide very good estimates. Twin studies of some rare phenomena such as schizophrenia have succeeded because some nations keep good records

of both who is a twin and who has the trait, allowing the assembly of a sufficient sample (Cardno & Gottesman, 2000); no analogous situation for nonheterosexual orientation is likely for the foreseeable future.

Based on the evidence from twin studies, we believe that we can already provide a qualified answer to the question "Is sexual orientation genetic?" That answer is: "Probably somewhat genetic, but not mostly so." On the one hand, that answer is not surprising, given the evolutionary pressure against genes that diminish reproduction, as genes for homosexuality likely do, especially in males (Vasey, Parker, & VanderLaan, 2014). On the other hand, we expect many people will find the conclusion surprising, mainly because they have misconstrued the meanings of "genetic" and "environmental." There can be little doubt that sexual orientation is environmentally influenced. However, to acknowledge this does not imply that the social environment shapes sexual orientation. There is a social environment, but there is also a vast and largely unexplored nonsocial environment. Thus, the conclusion that sexual orientation is socially influenced requires evidence in addition to that produced by twin studies. In a later section, we examine the evidence for social environmental effects on sexual orientation.

Molecular genetics studies. Twin studies provide information about the broad question of how important all genes are, together, in causing a trait. In contrast, molecular genetics studies have the potential to identify particular genes and elucidate the causal pathway from gene to trait. One of the most famous studies of the causes of sexual orientation was a molecular genetics study published in 1993 by the geneticist Dean Hamer of the National Cancer Institute (Hamer et al., 1993). Hamer used a sibling-pairs linkage design: First, he recruited pairs of homosexual brothers, from whom he collected DNA. In the data-analysis phase, he looked for chromosomal segments that were shared more often by these brothers than one would expect by chance (i.e., on average, any particular segment should be identical by descent [IBD] 50% of the time). Any segment with increased sharing may have a gene inside it affecting the trait. (It is often not understood that in linkage analysis, detected chromosomal segments have many different genes, and so linkage analysis is in this sense a precursor to more precise gene mapping.) Hamer found one chromosomal region with increased sharing: Xq28, which is located at the tip of the X chromosome. The finding seemed especially interesting because Hamer also reported evidence that homosexual men were more likely to have homosexual male relatives on their mothers' sides than on their fathers' sides, a finding consistent with X-linkage.

Hamer's linkage finding was controversial, in part because the linkage sample contained only 40 pairs of brothers. Although Hamer's lab reported a successful replication (Hu et al., 1995), another lab failed to replicate the results with a sample of 52 pairs of homosexual brothers (G. Rice, Anderson, Risch, & Ebers, 1999). Later, Hamer's own lab published a linkage study from an expanded sample, including their original subjects (from 1993 and 1995), in which they failed to find significant linkage evidence for Xq28 but instead found evidence for linkage to regions on chromosomes 7, 8, and 10 (Mustanski et al., 2005). No significant genetic linkage has been reported for female sexual orientation.

During the years after Hamer's original report, it became clear that molecular genetics findings were not replicating well (Ioannidis, Ntzani, Trikalinos, & Contopoulos-Ioannidis, 2001), a conclusion that has extended to most of science (Ioannidis, 2005). Partly this reflected genetic phenomena such as heterogeneity—that is, the fact that different genes can lead to the same outcome. Partly it reflected Type 1 statistical error due to (massive) multiple testing. There has been universal recognition of the importance of using much larger samples than Hamer's. The largest linkage study of male sexual orientation to date, which included 409 pairs of homosexual brothers, was recently published (Sanders et al., 2014). The study's main positive findings included both the detection of linkage for the pericentromeric (i.e., situated near the center) region on chromosome 8 and replication of the Xq28 linkage. Although it is encouraging that the largest study replicated some findings from smaller studies, the case is not closed. Still larger studies are needed to provide the degree of certainty now expected in molecular genetics, and in any case, the mapping case is not closed in molecular genetics until one has identified the genes that affect a trait.

To this end, there has also been a shift from linkage studies, which look at patterns of DNA sharing within families, to genome-wide association studies (GWAS), which compare DNA between individuals with and without a trait variant of interest. In the only completed GWAS study of sexual orientation to date, researchers from the genomics company 23andMe examined genetic markers from nearly 24,000 people who provided self-reports of their sexual orientations (Drabant et al., 2012). The sample comprised 1,181 exclusively homosexual men and 10,679 exclusively heterosexual men, as well as more than 1,500 men of intermediate orientations, and 733 women whose degree of nonheterosexuality was at least bisexual, 7,599 exclusively heterosexual women, and more than 2,000 women of intermediate orientation. GWAS studies examine group differences in thousands of markers, and so statistical corrections must be made to minimize Type 1 error. After these

corrections, the study yielded no significant effects. Still, the genetic marker closest to statistical significance in men was located on pericentromeric chromosome 8 in the same region identified by Mustanski et al. (2005) and Sanders et al. (2014). (Results for women did not reach conventional levels of statistical significance after necessary corrections for multiple testing.) Although these findings are interesting, we note that even the 23andMe sample was modestly sized—particularly the nonheterosexual portion—and potentially underpowered in the present era of GWAS (Moonesinghe, Khoury, Liu, & Ioannidis, 2008). Based on what we know about molecular genetics findings in general (Manolio et al., 2009), we expect that any sexual-orientation genes will have small effects individually. Thus, consortia of cooperating research teams may be necessary to obtain sufficiently large samples.

Molecular genetics findings can also be used to illuminate environmental influences. In particular, the concept of epigenetics—chemical modifications of the genome, such as DNA methylation—is consistent with environmental influences on gene expression. Epigenetics could play a role in some MZ twin discordance (Petronis et al., 2003). In the case of sexual orientation, indirect evidence for epigenetic influence on male sexual orientation includes the high MZ discordance rate, the fraternal-birth-order effect, and some interesting but as yet unreplicated molecular genetic associations (Ngun & Vilain, 2014).²⁴ However, a preliminary report of a study of 34 male MZ twin pairs discordant for sexual orientation revealed no support for this hypothesis (Bocklandt et al., 2011).

Evolution and homosexuality. Human homosexuality has rightly been called an evolutionary paradox. Both male and female sexual orientation appear to be moderately heritable, and homosexuality is known to have existed for many generations. Yet it tends to reduce reproductive success (Bell & Weinberg, 1978) and, in one non-Western sample, has reduced it to zero (Vasey et al., 2014). Although it is likely that in some cultural contexts, nonheterosexuality decreases reproduction to a lesser extent (Murray, 2000), a genetic contribution to sexual orientation is paradoxical unless there is no difference in reproduction rates between heterosexual and nonheterosexual people. Thus, the paradox concerns how any gene that increases the likelihood of homosexuality could persist. Furthermore, even if heritability of sexual orientation were zero, we would still need to understand how the processes regulating the development of sexual orientation allow a nontrivial rate of variants associated with reduced reproduction to exist.

Most research on the evolution of same-sex sexuality in humans has focused on explaining the origin and

persistence of male androphilia. (We refer here to androphilia and gynephilia rather than homosexuality because some of this work was conducted with populations for whom the term “homosexuality” does not make sense.) The evolution of female gynephilia remains underresearched (but see L. M. Diamond, 2006).

To date, research has addressed two main hypotheses that attempt to explain the persistence of genes for male androphilia: the *kin selection hypothesis* (KSH) and the *sexually antagonistic gene hypothesis* (SAGH). The KSH holds that genes for male androphilia could be maintained to the extent that having androphilic males as close relatives helps people to reproduce more than they otherwise would have (Wilson, 1975). In theory, androphilic males could increase their indirect fitness—a measure of an individual’s impact on the fitness of kin (who share some identical genes by virtue of descent), weighted by the degree of relatedness (Hamilton, 1963)—by directing altruistic behavior toward kin, which, in principle, would allow kin to increase their reproductive success.

Consistent with the predictions of the KSH, research conducted in Samoa on transgender androphilic males (*fa’afafine*) has repeatedly demonstrated that they show elevated avuncular (uncle-like) tendencies compared to Samoan women and gynephilic men. (This is measured via a 9-item scale measuring willingness to care for, and to give resources to, nieces and nephews.) Furthermore, this finding does not appear to reflect a general tendency to help others, but a specific preference for kin (Vasey & VanderLaan, 2010). In contrast, research on cisgender androphilic males in Western populations (Abild, VanderLaan, & Vasey, 2014; Bobrow & Bailey, 2001; Rahman & Hull, 2005) and non-Western industrialized cultures (Vasey & VanderLaan, 2012) has garnered virtually no support for the KSH. It is possible that elevated avuncularity is not expressed unless male androphilia takes on the transgender form. More research is needed to ascertain whether other populations of transgender male androphiles exhibit elevated kin-directed altruism or not.

The SAGH for male androphilia holds that genes associated with the development of androphilia result in decreased reproduction in male carriers but increased reproduction in female carriers. The female relatives of androphilic males are especially likely to carry these genes, and so their increased reproductive success helps balance the diminished reproductive success of their androphilic male relatives. Sexual-antagonism-balancing selection works especially well for genes on the X chromosome. This is because males have only one copy of any gene on the X chromosome, whereas females have two copies. Thus, in theory, females have twice the chance of benefit by fitness-enhancing X-linked genes compared with their androphilic male relatives. (This is one reason why scientists have found the idea of a gene

on Xq28 so exciting.) Over time, modifier genes should be selected that suppress male androphilia but allow the adaptive effects of the genes when carried by females (W. R. Rice, 1984).

The strongest support for the SAGH has been garnered exclusively in Western Europe, where the mothers and maternal aunts of male androphiles have been repeatedly shown to exhibit elevated reproductive output compared to those with no androphilic sons or nephews (e.g., Camperio-Ciani, Corna, & Capiluppi, 2004). The dearth of such studies in non-Western cultures is unfortunate, because reproductive output in the West is artificially low because of family planning and birth control. For example, the contemporary birth rate in Italy, where several studies have been conducted, is 1.4 births per woman during her lifetime (World Bank, 2014). In contrast, the typical hunter-gatherer female will give birth to 6 children (Pennington, 2001). For this reason, studies of evolutionary hypotheses that focus on reproductive rates in contemporary Western populations are of very limited value for explaining the origin and persistence of traits (Perusse, 1993). Several studies conducted in Samoa, a non-Western culture with higher fertility rates, have indicated that the mothers and grandmothers of androphilic males exhibit elevated reproductive output compared to those with only gynephilic male relatives (VanderLaan, Forrester, Petterson, & Vasey, 2012; VanderLaan & Vasey, 2011; Vasey & VanderLaan, 2007). However, elevated reproduction among mothers and grandmothers furnishes inconclusive evidence for the SAGH. This is because reproductive output among these categories of female kin could be influenced by the genetic contributions from fathers and grandfathers (VanderLaan, Garfield, et al., 2014). As with the KSH, further work is needed to clarify the degree to which the SAGH can explain the evolution of male androphilia.

An important limitation of this evolutionary research is that it remains unclear how either kin selection or sexually antagonistic selection could offset the reproductive costs associated with male androphilia. This is because the direct reproductive costs of male androphilia are severe (Bell & Weinberg, 1978; Vasey et al., 2014), and the indirect benefits to kin via the androphilic male’s investment (KSH) or genes (SAGH) would need to be very high indeed to completely balance the costs. According to the KSH, each child an androphilic male could have via direct reproduction, if he were gynephilic, would need to be balanced by four extra nieces or nephews who survive to reproduce as a result of the androphilic male’s provision of resources, including protection and child care. Conservatively assuming that gynephilic males father two children who survive to reproductive age, androphilic males would have to contribute an extra eight surviving nieces and nephews. Similar calculations

could be made for the SAGH, although the presumed mechanism underlying the calculations would differ. Of course, both theories may help explain a portion of male androphilia, even if they cannot explain it completely. Further research is needed to quantify the relative inclusive fitness of androphilic and gynephilic males.

Societies in which transgender male androphilia predominates exhibit a significantly greater presence of human ancestral sociocultural conditions compared to societies in which the cisgender form predominates (VanderLaan, Ren, & Vasey, 2014). This suggests that the transgender form of male androphilia was likely the ancestral form. As such, transgender male androphilia likely represents the best model for testing evolutionary hypotheses, given that more derived forms of this trait may reflect recent cultural/historical influences that might obscure the outcome of evolutionary processes. Consequently, the most promising results from tests of both the KSH and SAGH are from studies of Samoan *fa'afafine*. The evidence would be much stronger if other populations of transgender androphilic males showed similar effects.

The nonsocial environment

The most persuasive evidence that environment affects sexual orientation is the fact that the MZ twin of a non-heterosexual person is usually heterosexual. What is the nature of the environmental influence that causes the sexual orientations of genetically identical twins to diverge?²⁵ We have already noted that the environment comprises more than social influences. One striking example of the importance of the nonsocial environment comes from a review of twin concordances for the congenital brain defects hydrocephaly and anencephaly (Torrey, Bowler, & Taylor, 1994).²⁶ Among MZ twin pairs in which one twin was born with one of these conditions, the other twin was usually normal—although MZ concordances were also higher than those for DZ twins. The prenatal, nonsocial environment is clearly implicated in these differences, and just as clearly the social environment has nothing to do with them. The causes of MZ differences are a source of exciting speculation, but so far they are poorly understood (Matias, Silva, Martins, & Blickstein, 2014; van Dongen, Slagboom, Draisma, Martin, & Boomsma, 2012). In this section, we review the evidence for nonsocial environmental influences on sexual orientation.

The fraternal-birth-order effect. One of the most consistent findings in sexual-orientation research is the fraternal-birth-order effect for male sexual orientation. This is the finding that homosexual men tend to have a greater number of older brothers compared with

heterosexual men, heterosexual women, and homosexual women (Blanchard, 2004; Bogaert & Skorska, 2011). Plausible confounds that cannot explain this effect include parental age and other kinds of siblings. After statistically controlling for number of older brothers, there is no difference in number of younger brothers or sisters or older sisters. Nor is there any effect of the number of older or younger siblings of either sex on female sexual orientation. The fraternal-birth-order effect applies only to male sexual orientation. Notably, it has also been detected among the Samoan *fa'afafine* (VanderLaan & Vasey, 2011; Vasey & VanderLaan, 2007) and among androphilic transgender males (who self-identify as transwomen) in Western nations (Blanchard & Sheridan, 1992).

The effect is almost certainly causal, with each additional older brother causing an increase in the chances of a man's being homosexual. The effect is also large, in the sense that it increases the odds of a man's homosexuality appreciably, by an estimated 33% to 34% (Cantor, Blanchard, Paterson, & Bogaert, 2002; VanderLaan & Vasey, 2011). Assuming that a man without any older brothers has a 2% chance of being homosexual, a man with one older brother has a 2.6% chance; with two, three, and four older brothers, the chances are 3.5%, 4.6%, and 6.0%, respectively. Estimates of the proportion of homosexual males who owe their sexual orientation to the fraternal-birth-order effect have ranged from 15.1% (Cantor et al., 2002) to 28.6% (Blanchard & Bogaert, 2004).

The fraternal-birth-order effect appears to depend only on biological, not social, older brothers. We know this because of a study by Bogaert (2006) that compared homosexual men who had biological older brothers (defined as those with the same biological mother as the index subject) with a specially recruited sample of homosexual men who had nonbiological older brothers (i.e., half-, step-, or adoptive siblings not from the same biological mother). The fraternal-birth-order effect was found only among homosexual men with biological older brothers. The crucial factor appears to be the number of older brothers one's mother has given birth to, whether one is reared with them or not.

Blanchard (2001) has offered a specific, immunological hypothesis that can account for the fraternal-birth-order effect as a maternal effect. Male fetuses carry male-specific proteins on their Y chromosome, called H-Y antigens. Blanchard hypothesized that some of these antigens promote the development of heterosexual orientation in males (it is likely that such development also requires circulating testosterone at a critical period). Because these H-Y antigens are not present in the mother's body, they trigger the production of maternal antibodies. These antibodies bind to the H-Y antigens and prevent them from functioning, which, in turn, impedes

sexual differentiation of brain centers mediating male sexual orientation. The degree of this reaction, the likelihood of its happening, or both increase with successive pregnancies with male offspring. Blanchard and colleagues have identified candidate male-specific antigens that are preferentially expressed in the brain and hope to test for antibodies to them in both mothers of homosexual men and mothers of only heterosexual men. Blanchard's theory predicts that the former should have an excess of antibodies, whereas the latter should not. This maternal immune hypothesis is also consistent with the possibility that genes on the Y chromosome play a role alongside sex hormones in sexual differentiation (Ngun, Ghahramani, Sánchez, Bocklandt, & Vilain, 2011).

Blanchard's theory could help reconcile a combination of findings that are difficult to explain with the theory that sexual-orientation differentiation relies only on organizational androgens. Both females with CAH and female-reared males with cloacal exstrophy are exposed to high levels of prenatal androgens, but only the latter seem especially likely to become attracted to women. Like all females with the normal complement of sex chromosomes, females with CAH lack a Y chromosome, which is hypothetically necessary for male heterosexuality. Like all males, natal males with cloacal exstrophy have a Y chromosome. Thus, perhaps it is the Y chromosome—in the presence of prenatal androgens, which both groups have—that accounts for the different sexual-orientation outcomes in the two groups. A Y chromosome is not sufficient to cause male heterosexual orientation, however. Individuals who have a Y chromosome but are completely insensitive to the effects of androgen usually are attracted to men (Wisniewski et al., 2000).

The fraternal-birth-order effect is at least partly environmental, because birth order is obviously not genetic. It could conceivably have a genetic component, however, because some mothers or sons may be genetically more or less likely to cause or experience the effect. The environmental component causes some brothers to have different sexual orientations (i.e., firstborn heterosexual sons vs. later-born sons who are homosexual as a result of the effect), but it also causes other brothers to have the same sexual orientations (i.e., multiple younger brothers who are homosexual as a result of the effect). In this sense, it is part of both the shared environment and the nonshared environment. Two phenomena the fraternal-birth-order effect seems incapable of explaining are homosexuality in firstborn sons and sexual-orientation discordance in MZ twins. With respect to the former, the limitation of the theory is obvious. As for the latter, both MZ twin brothers have the same number of older brothers that might have induced a fraternal-birth-order effect. Thus, additional nonshared environmental factors must affect male sexual orientation. We have already noted

that the nonshared environment causing twin discordance for sexual orientation tends also to affect childhood gender nonconformity, and hence is an early influence; perhaps the nonshared environmental influence is prenatal like the fraternal-birth-order effect. Given the nonsocial nature of the fraternal-birth-order effect, as well as the results of the near-perfect quasi-experiment regarding the outcome of sexually reassigned hormonally normal boys, we hypothesize that these additional factors may be nonsocial.

The social environment

Several hypotheses regarding potential social influences on sexual orientation have a long history of social and scientific controversy. These include the following ideas: that homosexuality can be caused by "recruitment," or the sexual seduction of a younger, sexually naive person by an older homosexual person; that the children of nonheterosexual parents have increased rates of nonheterosexuality due to social influences; and that psychotherapy can change homosexuality. All of these are hypotheses of "nurture."

We have reviewed evidence from twin studies showing that environmental influence on sexual orientation is considerable. As we have tried to make clear, MZ twin differences generally signal environmental influence, but the environment causing the differences need not comprise social influence. That is, MZ twins may differ in their sexual orientation not because of different social experiences but because of nonsocial differences, including those that took effect before they were born. In other words, environment can be part of what is generally understood to be "nature" rather than solely of "nurture."

We have also pointed to reasons why nonsocial environmental influences on sexual orientation appear especially likely. These include the facts that many discordant MZ twins tend to remember being treated differently in childhood; that the fraternal-birth-order effect is at least partly environmental and appears entirely nonsocial; and that, for males, the results of the near-perfect quasi-experiment suggest that even the most severe social environmental pressure (i.e., early anatomical and social transformation of males into females) does not affect eventual sexuality.

We find this evidence strongly suggestive of nonsocial rather than social influences, but if one disagrees, one cannot merely assume instead that social influences are important; one must make the scientific case that they are. Hypothetically, the best way to provide evidence for a particular social environmental hypothesis would be with an experiment: Randomly assign people to have, or not to have, a particular social experience and then later

assess their sexuality. Of course, in this case, the hypothesized social influences—including sexual seduction and/or abuse, psychotherapy to change orientation, and parental sexual orientation—cannot be assigned at random given ethical considerations. This means that we must evaluate these hypotheses non-experimentally, with all attendant limitations.

As any undergraduate student knows, correlation does not necessarily imply causation. A major threat to the validity of inferring causation from a correlation is selection bias. That is, people with different social experiences may differ prior to having those experiences. In this case, subsequent differences might reflect the preexisting differences rather than be caused by the social experiences. For example, children who are physically punished by their parents are more likely than other children to have later behavior problems. But it would be a mistake to conclude that all, or even most, of this effect is due to the causal effect of punishment. Much of the effect is due to the fact that children tend to receive physical punishment for especially severe misbehavior, and this tendency to misbehave persists (Larzelere, Kuhn, & Johnson, 2004). At the very least, one must attempt to statistically control for the potential confound of initial misbehavior level. This is easier said than done, because doing so requires an accurate, objective measure of child misbehavior, which would be onerous and expensive. And even after controlling for obvious confounds, it is possible that one will have omitted important, less obvious additional variables. In examining each of the specific social environmental hypotheses below, therefore, we take pains to consider selection effects.

Before we review particular hypotheses, we note that some people sympathetic to homosexual rights are uncomfortable with research on whether certain social factors increase the likelihood of homosexuality. They argue that because homosexual people are as worthy as heterosexual people, no one should care if certain experiences increase that likelihood. Although we are entirely sympathetic to homosexual rights and also believe that homosexual people are as worthy as heterosexual people, we believe it is important to address putative social environmental causes of sexual orientation for three reasons. First, some existing social environmental hypotheses about homosexuality are intrinsically repugnant—for example, the idea that it is caused by older people seducing younger people. Second, showing that a particular social hypothesis is false helps avoid unnecessary arguments with people who do not share the same values about the equal worth of homosexual and heterosexual people. For example, showing that having a homosexual teacher is unlikely to cause schoolchildren to become homosexual may be easier than convincing some parents that even if it did, they should not care. Third, scientists

should study controversial topics with the aim of finding what is true, rather than declaring some topics off-limits because they are sensitive. Indeed, it is in controversial arenas where a scientific approach is most needed.

Recruitment/seduction. In an address before his signing of the Anti-Homosexuality bill, President Museveni of Uganda decried “those who were promoting homosexuality and recruiting normal people into it” (“President Museveni’s Full Speech,” 2014, para. 5). The idea that homosexual people recruit heterosexual people into being homosexual has also been promulgated in the West by a variety of anti-homosexual forces, including anti-gay activists Anita Bryant (Fejes, 2008), Judith Reisman (Blumenthal, 2004), and Paul Cameron (Klingenschmitt, 2014), the anti-homosexual organizations Abiding Truth Ministries and Traditional Values Coalition, and the Nazis of prewar Germany (Oosterhuis, 1997). To mention these groups, even the Nazis, is not sufficient to dismiss the validity of the “recruitment hypothesis,” which must be evaluated scientifically. Rather, we do so to make the point that a belief in the recruitment hypothesis has often been associated with strongly negative attitudes toward homosexual people. In general, those endorsing the recruitment hypothesis have not also explicated the published empirical basis for their belief. But establishing the scientific plausibility of a belief requires evidence. Is there any? And what would supportive evidence look like?

It would surely not be persuasive to show, as seems generally true, that nonheterosexual people are much more likely than heterosexual people to have a first sexual partner of the same sex (e.g., Bell et al., 1981). This result would be expected under two opposing hypotheses: that nonheterosexuality is spread by recruitment, and that nonheterosexual orientation is present upon sexual awakening, so nonheterosexual people are more likely to choose same-sex partners—no recruitment necessary. Consistent with the idea that early nonheterosexual experience is the result, not the cause, of sexual orientation (even if sexual orientation not acknowledged until later in life), the large majority of nonheterosexual people recalled experiencing homosexual feelings preceding homosexual behavior by an average of 3 years in one study (Bell et al., 1981).

It may also be more common for nonheterosexual people—especially nonheterosexual males—to have early sex partners who are older than they are. For example, Holmes and Slap’s (1998) review suggested that boys who had age-discrepant early sexual experiences, especially with men, were up to seven times more likely to identify as homosexual or bisexual as adults. (Age-discrepant sexual experiences tend to be operationalized as having a partner at least 5 years older when one is

below the age of 18.) This pattern would be predicted from the recruitment hypothesis; would it also be predicted from the alternative hypothesis that recruitment is not a cause of homosexual orientation?

For males, the answer is surely “yes.” To see why, imagine two hypothetical 16-year-old male adolescents named Jerome and Stephen. Jerome is heterosexually oriented and Stephen is homosexually oriented. Who is more likely to have sex with a significantly older person? Jerome is openly heterosexual and interacts with many female adolescents who might be sexually attracted to him. In contrast, women at least 5 years older than Jerome tend not to be interested in 16-year-old sex partners, even in states in which having sex with them would be legal (Silverthorne & Quinsey, 2000). Thus, Jerome will most likely have sex with adolescent females around his own age. What about Stephen? There is a good chance that Stephen knows of few other homosexually oriented adolescent males. This is partly due to population base rates—even in a large high school, we would not expect many of the male students to be homosexual—but it is also partly due to the fact that in most places, homosexual adolescents like Stephen are likely to be hiding their homosexuality from others. Hence, Stephen is especially likely to want to have sex with someone outside of his social circle. Where might he find someone? In many cities, there are places where homosexual males meet and socialize, and these males will tend to be older than Stephen. Assuming that Stephen’s body is sexually mature (i.e., that he is in the final stage of puberty), he will be sufficiently attractive to homosexual men—just as 16-year-old females in the final stage of puberty are sufficiently sexually attractive to heterosexual men. Whether or not Stephen is above the legal age of consent, some men at least 5 years older may take the chance and have sex with him; the likelihood that they would do so is much higher than the likelihood that older women would have sex with Jerome (Silverthorne & Quinsey, 2000).

Thus, an array of forces—some social and some likely due to putatively universal human mating preferences (Buss, 1989)—ensure that age-discrepant early sexual relationships are more common among homosexual than heterosexual adolescent males. Furthermore, given simultaneous interest in sexual activity, we might expect Stephen to have sex earlier than Jerome, because his desired partners (males) have higher sex drives (Baumeister, Catanese, & Vohs, 2001) and a greater desire for casual sex (Bailey, Gaulin, Agyei, & Gladue, 1994) compared with Jerome’s desired partners (females). The hypothesis of homosexual recruitment is not needed to explain the fact that homosexual males tend to have earlier, and more age-discrepant, sexual interactions compared with heterosexual males.

What about females? The same argument predicts that homosexual females should be much more likely than heterosexual females to have early sexual experiences with other females, even if the recruitment hypothesis is false. Homosexual, but not heterosexual, females are attracted to their own sex, and thus the former are more likely to be open to the idea of same-sex sexual and romantic interaction. The recruitment hypothesis is not necessary to explain why homosexual women are more likely than heterosexual women to have early same-sex experiences.

Some studies have found that nonheterosexual females also have a higher rate of early age-discrepant sexual interactions compared to heterosexual females (e.g., Tomeo, Templer, Anderson, & Kotler, 2001), although some other studies have failed to find this (e.g., Bell et al., 1981). Among the various factors that make homosexual males more likely than heterosexual males to have early age-discrepant sexual experiences, some but not all also apply to homosexual females. For example, female homosexuality is also stigmatized and relatively rare, and thus young homosexual females do not generally have sexual and romantic opportunities with similar-aged peers that are equivalent to those of heterosexual females. This would increase the chances that early experiences of nonheterosexual women would be age-discrepant. However, adult homosexual women are less likely than adult homosexual men to be sexually interested in substantially younger partners (Silverthorne & Quinsey, 2000), making age-discrepant relationships less likely for young homosexual females. Another possibly relevant factor concerns personality. Homosexual women’s scores on the personality trait openness to experience are about half a standard deviation higher than heterosexual women’s (Lippa, 2005a). Openness to experience is related to erotophilia (Wright & Reise, 1997), a more specific personality trait related to a person’s tendency to react to sexual cues in a positive (erotophilic) versus negative (erotophobic) way. Erotophilic individuals tend to have sex earlier than other individuals, among other sex-related differences (Fisher, White, Byrne, & Kelley, 1988), and are likely to be more open to age-discrepant sexual interactions.

This is not to suggest that all early sexual experiences of nonheterosexual people are positive and consensual. In a recent, carefully sampled, and very large ($N = 33,902$) study, T. Sweet and Welles (2012) found that nonheterosexual adults of both sexes were much more likely than heterosexual adults to have experienced childhood sexual abuse, defined as “sexual experiences with an adult or any other person younger than 18 years when the individual did not want the sexual experience or was too young to know what was happening” (p. 401). As is common in research on childhood sexual abuse, this

definition combines a number of different experiences likely to have different causes and effects—for example, sexual experiences of children too young to have understood what was happening and sexual experiences of late adolescents who understood those experiences but did not want them, as well as abusive experiences with the same sex and with the other sex. Thus, it is difficult to know what to make of the findings. Still, the risk was much higher for nonheterosexual respondents: 38.1% for lesbians, 43.5% for bisexual women, and 14.2% for heterosexual women; 18.6% for gay men, 19% for bisexual men, and 4.6% for heterosexual men. The authors rejected the interpretation of their data according to which abuse caused nonheterosexual orientation. Instead, they speculated that childhood gender nonconformity makes pre-homosexual children especially vulnerable to predation. For example, pre-homosexual children are to some extent identifiable, and they may be especially susceptible to same-sex experiences even at young ages. (For example, they may be recognized by older opportunistic individuals with same-sex desires. Alternatively, they may be victimized by others who dislike gender nonconformity.) Another possibility is systematic reporting bias, whereby heterosexual respondents may underreport or nonheterosexual respondents may overreport sexual abuse; there are doubtless many other plausible hypotheses. Although these results merit attention, concern, and further study in order to understand them, they provide no additional reason to consider the recruitment hypothesis to be a promising one.

Pedophilia. An idea sometimes related to homosexual recruitment is that homosexual men are especially likely to molest children. The main data leading some (e.g., Dailey, 2002) to this conclusion show that about one-third of child molestation victims are male (Freund, Watson, & Rienzo, 1989). Homosexual men comprise a much smaller percentage of the population, perhaps 3%. *Assuming it is homosexual men who are molesting boys*, then they are much more likely to molest children than heterosexual men, *assuming it is heterosexual men who are molesting girls*.

The italicized assumptions are wrong, however. This is a circumstance in which the word “homosexual” can be misleading. We have been using the term “homosexual men” to refer to men attracted to sexually mature males; their sexual orientation is more precisely called “androphilic.” Androphilia contrasts with homosexual pedophilia, which is sexual attraction to sexually immature males.²⁷ Male androphiles and homosexual pedophiles do not have the same sexual orientations; nor do male gynephiles (i.e., heterosexual males oriented toward sexually mature females) and heterosexual pedophiles. We know this from basic research on sexual-arousal patterns.

Androphilic men have far less arousal to sexually immature than to sexually mature males; homosexually pedophilic men have the opposite pattern. The same is true of gynephilic men and heterosexually pedophilic men (Blanchard et al., 2012). In a recent survey of men sexually attracted to children, those men rated their attraction to children as 9.5 on a 10-point scale. In contrast, they rated their attraction to adults as 4.2 (Bailey, Hsu, & Bernhard, 2013). Androphilic and gynephilic men have little motivation to have sex with children. Thus, androphilic men are not disproportionately responsible for the sexual molestation of boys; homosexual pedophiles are.

Parent-child relationships. The idea that homosexuality resulted from pathological parent-child relationships became prominent because of psychoanalysis (Bayer, 1981). In general, psychoanalytic theorists came to blame a dysfunctional relationship between children and their parents for children’s homosexuality, which they saw as a pathological outcome. Culprits included emotionally distant fathers and overbearing mothers. These hypotheses had the empirical limitations of most psychoanalytic hypotheses (e.g., Grünbaum, 1986)—namely, that they stemmed from therapists’ observations filtered through the lens of highly speculative theory rather than from systematic scientific studies. The landmark study by Bell et al. (1981) seemingly disposed of the idea that homosexuality resulted from the quality of parent-child relationships. That study yielded relatively small correlations between retrospective ratings of parent-child relationship characteristics and the child’s eventual sexual orientation in adulthood. Furthermore, when other variables—especially childhood gender nonconformity—were covaried in path analyses, the causal paths between parent-child relationship characteristics and child’s sexual orientation were either nonsignificant or quite weak.

The idea that male homosexuality is caused by bad relationships with parents has been revived by the reparative therapist Joseph Nicolosi (1997; Nicolosi & Nicolosi, 2012). In particular, he has focused on the father-son relationship. According to Nicolosi, repairing that relationship and its alleged consequences can help change sexual orientation. We defer discussing therapy to change sexual orientation until later. For now, we note only that Nicolosi’s hypothesis is based on data no better than those of psychoanalysts.

What might account for the modest associations between retrospectively assessed parent-child relationship quality and adult sexual orientation? There are several alternative hypotheses to the possibility that parent-child relationship quality influences later sexual orientation. First, pre-homosexual children tend to be relatively gender nonconforming, and this may sometimes strain relationships with parents—especially fathers

(Kane, 2006). Second, on average, homosexual men score slightly higher than heterosexual men on trait neuroticism ($d = 0.20$; Lippa, 2005a). Assuming the neuroticism differences are apparent during childhood, they could contribute to differences in negative interactions between fathers and sons. Neuroticism is also related to biased recall of negative events (Larsen, 1992); thus, the retrospective differences in relationship quality could partly reflect memory biases. Third, on average, same-sex attraction in males is associated with elevated traits of separation anxiety in childhood (VanderLaan, Gothreau, Bartlett, & Vasey, 2011; Vasey et al., 2011; Zucker, Bradley, & Sullivan, 1996), and this could further strain father-and-son relationships. Of course, there are many other possibilities that are not causally related to sexual orientation, including the possibility that parents of pre-homosexual children are different from those of pre-heterosexual children in ways that affect the parent-child relationship.

The hypothesis that pathological parent-child relationships cause homosexuality has generated little scientific research, and almost no recent research. We believe that this is primarily because the hypothesis has little scientific promise.

Rearing by nonheterosexual parents. Two separable questions are of interest here regarding the outcome of children reared by nonheterosexual parents: First, do these children have an increased likelihood of becoming homosexual, and second, do they differ in other important ways from children reared by heterosexual families? In evaluating research on these questions, it is important to realize the very strong possibility of selection effects. The ideal study to investigate the influence of parental sexual orientation would involve randomly assigning children (via adoption) to heterosexual versus homosexual parents well matched on factors such as income. Adoption would be necessary to avoid confounding outcome due to rearing with that due to genetics. We would expect, for example, that homosexual parents should be more likely than heterosexual parents to have homosexual children on the basis of genetics alone. Matching parental characteristics is necessary if one wishes to exclude variables correlated with parental sexual orientation that may influence child outcome, regardless of whether parental sexual orientation does. Matching (or statistical control) is important but still imperfect, because there may be important but unrecognized differences between heterosexual and homosexual parents that are not caused by sexual orientation but contribute to children's outcomes.

For various reasons we will elucidate, studies of the effects of rearing by homosexual parents do not yet allow strong conclusions. These reasons include specific study limitations but also a general concern about parental

effects. An important, wide-ranging observation is that parents tend to have limited environmental effects on their children's behavioral traits. More specifically, resemblance between parents and offspring tends to be due to genes rather than environment, and, surprisingly, environment tends to make siblings reared together more different than similar (Harris, 1995; Plomin, 2011; Plomin & Daniels, 1987; Turkheimer, 2000). We know this through studies that use genetically informative designs, such as twin and adoption studies. (For an especially compelling adoption example, see Sacerdote, 2007.) To the extent that parents systematically and environmentally affect their children, the shared environment is important. The more important shared environment is for a trait, the more similar adoptive siblings (i.e., genetically unrelated children reared together) should be. In general, however, evidence indicates that adoptive siblings are quite dissimilar. Although some shared environmental effects exceed zero, these tend to be modest and to diminish with age (e.g., Buchanan, McGue, Keyes, & Iacono, 2009; Burt, 2009).

Researchers have increasingly recognized that accurately measuring the effect of parents on children requires genetically informative designs (Harris, 1995; Plomin, 2011; Plomin & Daniels, 1987). Other kinds of correlational studies—whether of resemblance between parents and children or of family characteristics predicting child outcomes—will generally and greatly overestimate the importance of the parental environment. One example of a variable whose effects have been exaggerated in non-genetically informative designs is parental divorce. People who divorce are different from those who do not. Personality, among other factors, is important—and partly heritable (Jockin, McGue, & Lykken, 1996). Indeed, the tendency to divorce one's spouse is strongly heritable (McGue & Lykken, 1992). Children of divorce share the experience of divorce as well as their parents' genes. This means that correlations between the experience of parental divorce and a child's eventual outcome will be inflated without controlling for genetics. Of course, in principle, parental sexual orientation could be different from other parental variables such as divorce and affect children's outcomes far more. But one cannot simply assume that it does; one must prove it with data. Unfortunately, collecting the requisite data is difficult, and no one has come close to doing so.

Parental "effects" in convenience samples. Most studies of children raised by nonheterosexual parents have depended on small convenience samples. Reviews of data from convenience samples have suggested that children reared by nonheterosexual parents have outcomes similar to those of children reared by heterosexual parents, with respect to both sexual orientation and quality of life

(Patterson, 2006; Tasker, 2005). These types of studies are not, however, without their limitations. Convenience samples are recruited nonsystematically, through techniques including advertisements and snowball sampling (i.e., having participants refer other potential participants they know). Participants recruited in such ways are likely to be unusual in some respects—having high motivation and curiosity, for example. Consequently, outcome differences between children of heterosexual and homosexual parents recruited nonsystematically may also be biased. Because most studies using convenience samples have been small, statistical power to detect small, or even moderate, differences has typically been low. Finally, by their very nature, convenience samples are not amenable to the kind of sophisticated quantitative analyses necessary to disentangle environmental from genetic parental effects. (That goal would require data from informative pairs of relatives, such as twins or adoptive siblings.)

Parental “effects” in a probability sample. In probability sampling, the attempt is made to recruit respondents in a representative way. To the extent that the attempt succeeds, numeric estimates will more accurately reflect population values compared with estimates obtained using convenience sampling. A recent large study using this approach (Regnerus, 2012a) has generated considerable controversy (Carey, 2012a; Cheng & Powell, 2015; Davidson, 2012; Gates et al., 2012; Oppenheimer, 2012; Regnerus, 2013), and we focus on it here.

The Regnerus (2012a) study used a sample of nearly 3,000 adults, including 175 who reported that their mother had ever had a same-sex romantic relationship and 73 who reported that their father had. Respondents provided information about a number of demographic characteristics, attitudes, behaviors, personality traits, and psychological symptoms. The main analyses compared variables between adult children raised in still-intact biological families (henceforth CIBFs) and other types, including those with homosexually experienced parents. Separate comparisons were made for those with homosexually experienced mothers (henceforth, CHEMs) and those with homosexually experienced fathers (CHEFs). Both CHEMs and CHEFs showed small to moderate statistically significant differences with CIBFs. Moreover, to the extent that the differences could be judged to be desirable or undesirable, they were generally in favor of the CIBFs. For CHEMs, these differences included, among others, higher rates of welfare assistance, unemployment, nonheterosexual identification, having experienced coercive sex, depression, marijuana use, tobacco smoking, and having been arrested and lower levels of education, income, and physical health. The smaller sample of CHEFs showed fewer statistically significant differences, with examples including higher rates of welfare

assistance, depression, and arrests and lower educational attainment. Most of these differences remained statistically significant after controlling for several demographic variables.

As has been widely noted by critics of the study, the families with homosexually experienced parents were almost all disrupted (e.g., because of parental divorce). Only 2 of the 248 children with homosexual mothers or fathers had lived with homosexually partnered parents for their entire childhoods (Regnerus, 2012b). Thus, parental homosexual experience was almost perfectly confounded with family disruption, and differences attributed to the former might be more accurately attributed to the latter. It is an important and controversial question why Regnerus's study was able to recruit so few intact families with two nonheterosexual parents. Assuming this was not due to sampling bias, there are at least two possibilities. First, stigmatization of homosexual relationships may make them more fragile; if so, their fragility will diminish with the ongoing decline of stigma, at least in the West. Second, other factors unrelated to stigma may cause the fragility. These could include, for example, characteristics of nonheterosexual people or characteristics of nonheterosexual relationships.

A recent reanalysis has raised serious questions about the validity of Regnerus's results, suggesting potential misclassification of respondents' family types (Cheng & Powell, 2015). Clearly, in order for us to take the aforementioned differences seriously, it is crucial that respondents' parents were accurately classified as heterosexual or not. Results of the reanalysis suggested that a high proportion of Regnerus's respondents classified as having nonheterosexual parents may have been misclassified. The basis for these concerns included inconsistencies in some respondents' answers, some extremely unlikely responses suggesting mischief, and evidence that some respondents did not live long with their nonheterosexual parents. When problematic cases were excluded, differences associated with family type largely vanished.

These recent concerns about Regnerus's family classifications appear to be sufficiently serious that no valid conclusions can be drawn about any association between having a homosexual parent and adult adjustment. But even ignoring those problems, causal attribution on the basis of the Regnerus study is inappropriate. Regnerus has correctly noted this, although his reason for doing so is not entirely correct. He has stated that the study “is not a longitudinal study, and therefore cannot attempt to broach questions of causation” (Regnerus, 2012a, p. 755). However interesting a longitudinal component might be, the lack of a genetically informative design, or of some other causally informative design such as the quasi-experimental instrumental-variables regression, remains problematic.²⁸ We simply cannot know from Regnerus's

study whether the differences he observed were caused by children's being reared by parents with or without homosexual experience, whether the differences were caused by the presence versus absence of family disruption, or whether rearing was mostly irrelevant to the observed differences. Based on what we know from studies of parental influence that have included the necessary designs, the latter possibility is most likely.

Therapy to change sexual orientation. *Conversion therapy* is the attempt to change homosexually oriented people to heterosexually oriented people via psychotherapy or behavioral therapy. *Reparative therapy* is a relatively recent form of conversion therapy associated with the psychologist Joseph Nicolosi (1997). Early forms of conversion therapy were often offered by conventional mental health professionals including psychiatrists and psychologists, because homosexuality was generally viewed as a form of psychopathology. Both that view and the practice of conversion therapy have changed. For example, both the American Psychiatric Association (2000) and the American Psychological Association (2009) oppose conversion/reparative therapy for both ethical and scientific reasons. Present-day conversion therapy, including reparative therapy, is most likely offered by, and to, the religiously observant. We use the term "conversion therapy" to refer to any therapy attempting to change sexual orientation.

Two important methodological concerns oppose all existing claims that conversion therapy can change sexual orientation: the likelihood of very strong selection bias and reliance on self-report data. Because nonheterosexual-oriented persons are not assigned randomly to either receive or not receive therapy to become heterosexual, those who receive therapy are likely to be unusual. Most obviously, they are especially motivated to change. This makes their data especially vulnerable to the second concern regarding self-report. Specifically, individuals who undergo conversion therapy may be especially susceptible to believing and reporting that therapy has succeeded regardless of its true effectiveness. Therefore, reliance on self-reported sexual feelings by such individuals renders even systematically collected data highly questionable as a gauge of sexual-orientation change.

The most notable study claiming that persistent, meaningful changes in sexual orientation are possible was conducted by Spitzer (2003), who later changed his mind about the validity of his findings (Carey, 2012b). Participants were 143 men and 57 women who had undergone reparative therapy and believed that they had shifted at least 10 points in the heterosexual direction on a 100-point scale of sexual orientation. On the basis of interviews, Spitzer initially concluded that the self-reported

changes were credible. Later, he came to believe that self-report data are simply inadequate, because such reports are often inaccurate, subject to both intentional deception and self-deception.

Designing a valid empirical study of the effectiveness of reparative therapy is straightforward, at least for men. Because an objective measure of male sexual orientation exists that is not easily manipulated, a study of sexual orientation in men need not rely on self-report: Measures of men's genital arousal patterns to a variety of male and female erotic stimuli, both before and after conversion therapy, would provide highly relevant evidence. Control groups of heterosexual and homosexual men not receiving conversion therapy would clarify the interpretation of results. For example, it appears easier to suppress genital arousal to arousing stimuli than it is to enhance arousal to non-arousing stimuli (H. E. Adams, Motsinger, McAnulty, & Moore, 1992). Thus, it would be important to look for increases in homosexual men's genital arousal to female stimuli and not just decreases in their arousal to male stimuli.

Data that might speak to this issue are meager. Freund (1960) found that clients' claims of sexual reorientation were not supported by phallometric assessments. Conrad and Wincze (1976) found that physiological arousal measurements did not support the positive reports of those who had participated in sexual-reorientation therapy.

Non-self-report measures also exist to measure women's sexual orientation—for example, relative viewing time for pictures of attractive men versus attractive women. But changes in these measures after conversion therapy would be more difficult to interpret than changes in male sexual arousal patterns. For example, conversion therapy might encourage the individual to avoid looking at same-sex targets and to look more at other-sex targets. If effective, this would change viewing-time patterns but not necessarily sexual orientation.

It is, of course, possible to change one's public sexual-orientation identity, and one can certainly make choices about whether one will or will not engage in same-sex or opposite-sex sexual behavior or become celibate. These sorts of choices likely explain claims by ex-gays and ex-lesbians that they are no longer leading a "homosexual lifestyle" (see Beckstead, 2001, pp. 92–109, for examples). There is no good evidence, however, that sexual orientation can be changed with therapy, and we strongly doubt it can be. Even many therapists sympathetic to the desire of some homosexual people to live heterosexual lives have shifted their efforts from changing sexual orientation to helping homosexual people live as they prefer under the unchangeable constraint of homosexual orientation (Schwartz, 2011; Throckmorton & Yarhouse, 2006).

The causes of sexual orientation: An interim summary

No specific theory of what causes people to be attracted to men, to women, or to both has received enough support to win the backing of all reasonable scientists, most of whom remain open-minded to a large extent. This does not mean, however, that any hypothesis is just as good as any other. In general, we know enough to conclude that most hypotheses are constrained, or at least not equally likely.

Two contrasting views of the development and causes of homosexuality tend to divide those with pro- and anti-homosexual attitudes. The first, associated with positive attitudes toward homosexuality, is that a small percentage of people are homosexual for so-far-unspecified reasons of nature rather than social nurture (Knauer, 2000). The second, associated with negative attitudes toward homosexuality, is that homosexuality is to some extent socially contagious and can spread either through sexual recruitment or through the relaxation of moral and legal prohibitions of homosexual behavior (Eskridge, 2005, 2008; Knauer, 2000). We believe scientific evidence supports the first view much more strongly than it does the second.

Several dependable findings of large effect are consistent with the former but not with the latter. Children who will become homosexual often differ in noticeable ways from those who will become heterosexual. These differences often emerge long before the children clearly have anything like a sexual orientation. Furthermore, these differences in childhood gender nonconformity emerge despite socialization, which works to enforce gender norms, not because of it. Homosexual attractions emerge prior to homosexual behavior in most people.²⁹ This should not be surprising because it follows the same pattern by which most heterosexual people's lives unfold. Perhaps the most extreme and plausibly effective social manipulation possible—changing boys into girls, socially and physically—has been attempted, with no apparent alteration of sexual orientation. These individuals—natal males changed into females—typically grow up to be attracted to women, based on limited available evidence. There is good evidence for both genetic and nonsocial environmental influences on sexual orientation. The limited evidence we have about the prevalence of nonheterosexuality across cultures and time suggests that homosexual orientation does not increase in frequency with social tolerance, although its expression (in behavior and in open identification) may do so.

In contrast, evidence that might be marshaled to support a socialization explanation is equally consistent with the alternative (nonsocial) view. For example, the fact that homosexual people are much more likely to have

early same-sex experiences, including experiences that are age-discrepant, is consistent with a recruitment hypothesis. But it is also consistent with the hypothesis that young people who already have homosexual attractions are more likely to have these experiences. The fact that the nonsocial hypothesis can explain several findings much better than the social hypothesis should affect our judgment of which is more likely.

The hypothesis that causal influences on sexual orientation are nonsocial rather than social is better supported for male than for female sexual orientation, for at least two reasons. First, the nonsocial fraternal-birth-order effect applies only to male sexual orientation. Second, the near-perfect quasi-experiment, in which seven infants were socially and physically reassigned to the other sex, involved only natal males. Indeed, sexual orientation may generally be better understood for males than for females (Bailey, 2009). We would be surprised if differences in social environment contributed to differences in male sexual orientation at all. We would be less surprised if the social environment affected the *expression* of male sexual orientation, including the likelihood that a homosexually oriented male would choose to act on his feelings. Although it would also be less surprising to us (and to others; see Baumeister, 2000) to discover that social environment affects female sexual orientation and related behavior, that possibility must be scientifically supported rather than assumed.

Policy Revisited

Because our article was initially motivated to help policymakers navigate the relevant science of sexual orientation, we concluded with an analysis of the likely effects of proposed policy changes. Our projections would apply, with appropriate adjustments, to any nation considering an increase in criminal or social sanctions against homosexual behavior. At the time of writing, such discussions were ongoing in various African, Asian, and Eastern European nations (Carroll & Itaborahy, 2015). For the purposes of this discussion, we will focus on recent, highly publicized policy proposals in Uganda.

Recent attempts to increase criminal penalties for homosexual behavior in Uganda, as well as in other countries, have been partly justified by the belief that the social environment is a powerful influence on sexual orientation. Specifically, President Museveni has said he believes that homosexual people recruit heterosexual people and that homosexuality can be successfully discouraged via social means, such as long prison sentences. In order to check his assumptions, he sought scientific support for—and subsequently rejected—the idea that homosexual orientation is inborn. Museveni believed that the inconclusive evidence he was presented showed that

sexual orientation is socially malleable (“President Museveni’s Full Speech,” 2014). We have taken considerable effort to show why this reasoning is erroneous.

Of course, justifying prison sentences based on the idea that they deter homosexuality also requires the assumption that homosexuality should be deterred, an assumption with which we disagree. But for now, let us set aside that objection and consider the likely implications of increasing criminal penalties for homosexuality. Assume that punitive legislation is passed and stays in place for a generation. What would change? No one knows for certain, of course. Certainty would require an experiment in which randomly assigned countries enacted laws varying in the severity of their penalties for homosexual behavior. Nothing like this randomized experiment will happen. But informed speculation is possible, based on the evidence we have discussed as well as the Western experience, with dramatic changes in attitudes toward homosexuality having occurred during less than a lifetime.

The following predictions follow from our review: There would be no change in the proportion of males strongly sexually attracted to other males, which would remain about 1 in 25 to 1 in 50. Although we are less certain that the same would be true for same-sex-attracted females, there is no scientific evidence that increasing criminal penalties would reduce the female prevalence of strong same-sex attraction. The average Ugandan household contains five people (Uganda National Household Survey Report, 2010). Approximately 1 in 5 to 1 in 10 of these households likely contains a nonheterosexual person. The typical Ugandan woman currently expects to give birth to approximately six children during her lifetime (Uganda Bureau of Statistics, 2011). Thus, approximately 1 in 4 to 1 in 8 women there gives birth to a nonheterosexual child. (This calculation assumes that homosexual children do not aggregate in certain families, which may not be strictly true, if genes or shared environment matter. These factors do not induce much aggregation, however.) Given their large family sizes, compared with those of their Western counterparts, it is likely that most Ugandan people will have a sibling, aunt or uncle, niece or nephew, or cousin who is nonheterosexually oriented. Our general point here is that the criminalization of homosexuality touches many—indeed, probably most—Ugandan families.

The requirement that no one may engage in homosexual activity has especially harsh implications for Ugandans with exclusively homosexual feelings. (It is useful for heterosexual people to imagine living in an analogous world, one that outlawed heterosexual relationships and sexual behavior.) Some of these individuals may live celibate lives, out of fear. Others—probably far more—will risk legal penalties in order to live in a way they find more fulfilling. Some may marry heterosexually, either

because they are genuinely trying to suppress their homosexuality or because they want to hide their true sexual orientation. Although some of these marriages will succeed, others will be unhappy. Regardless, the homosexual spouses’ sexual orientations are unlikely to change.

Beyond these basic predictions, things get more speculative. If the Western experience is a guide, enforcement of strictures against homosexuality is likely to be haphazard and dependent on local political situations (Eskridge, 2008). This has been especially true of consensual homosexual relationships conducted by adults in private, which were often tolerated if not embraced in the West even when they were illegal. Recent news from Uganda presents a harsher picture, however. According to Amnesty International, homosexual people in Uganda have experienced a marked increase in “arbitrary arrests, police abuse and extortion, loss of employment, evictions and homelessness” related to the punitive legislation (Amnesty International, 2014, para. 2). Physical attacks on homosexual people have also drastically increased (Bowcott, 2014). Aside from threats to their physical safety, nonheterosexual people in Uganda are subject to constant disapproval. This is likely to diminish their experience of self-worth, and increase feelings of shame, guilt, depression, and anxiety.

Researchers have begun to quantify the economic costs of anti-homosexual prejudice as a strategy to convince people that there are economic benefits associated with tolerance toward sexual-orientation and gender diversity. For example, a World Bank study suggested that discrimination on the basis of sexual orientation and gender identity costs India up to \$30 billion a year through lost wages, lower productivity associated with poor health caused by stress or curtailed education, and reduced tourism revenues, among other economic impacts (Patel, 2014). Another study of 39 countries conducted for the United States Agency for International Development (USAID) estimated the cost of anti-homosexual prejudice—as experienced through educational and workforce discrimination, police corruption, violence, and poor health care access—to be as much as 3% of a country’s gross domestic product (Badgett, Nezhad, Waaldijk, & van der Meulen Rodgers, 2014). Furthermore, reducing the scope of anti-homosexual policies and practices would have the benefit of saving many lives. For example, a study of the relative cost-effectiveness of different interventions against HIV transmission estimated that \$1 million devoted to HIV education in Kenya could avert nearly 3,000 deaths per year (i.e., \$272 per life saved; Beyrer et al., 2011).

For these reasons, we urge governments to reconsider the wisdom of legislation that criminalizes homosexual behavior. Furthermore, we invite members of governments considering such legislation to confer with us

about issues we have raised. Our expertise is theirs for the asking.

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Notes

1. Brunei is set to adopt anti-gay laws in 2016 that will allow stoning by death (Garcia, 2014; Mosbergen, 2015).

2. The terms “West” or “Western” are used here to refer to Euro-American cultures.

3. The Academy of Science of South Africa recently published a position statement on the science of sexual orientation and the implications of this science for legal policy (see Academy of Science of South Africa, 2015).

4. An important current controversy is whether to extend the term “sexual orientation” to include other stable patterns of sexual attraction, such as attractions to children (Seto, 2012) or even to nonhuman animals (Miletski, 2005). We use the term in the more restrictive sense—that is, to refer only to attraction to sexually mature human males or females. Both the causes and consequences of other stable patterns of sexual attraction likely differ considerably from those of sexual orientation in its usual sense (e.g., Cantor, 2012).

5. There has been movement to discontinue use of the word “homosexual,” given that this word was commonly used during historical periods when nonheterosexual people were generally

seen as deviant (J. W. Peters, 2014). We certainly do not believe that homosexual people are deviant (except in the statistical sense of rarity), but we have chosen to use the term “homosexual” (along with “heterosexual” and “bisexual”) for simplicity of communication. Yet we are sensitive to the importance of word choice when describing phenomena related to sexual orientation, and we recognize that all descriptors come with limitations.

6. Kinsey’s scale measured sexual feelings and behavior in combination. Nowadays, most researchers who employ Kinsey scales assess them separately.

7. Although several recent studies have found evidence for category-specific genital arousal in women using a variety of measures such as thermal imaging, laser Doppler imaging, and vaginal lubrication (Dawson, Sawatsky, & Lalumière, 2015; Kukkonen, Binik, Amsel, & Carrier, 2010; Waxman & Pukall, 2009), the studies were small, and none has yet been replicated.

8. Here, “homosexual” and “bisexual” mean with respect to natal sex, even among those males who have chosen to become transgender women.

9. Personality psychologists define neuroticism (emotional instability) as the predisposition to experience negative emotions such as anxiety. Individuals who are highly neurotic are emotionally reactive and vulnerable to stress (McCrae & John, 1992).

10. Sexual identity is more complicated, because it has both a public and a private component. Public sexual identity is how one presents oneself to others, and this is clearly chosen. Private sexual identity comprises beliefs about oneself, and these beliefs are sometimes chosen and sometimes not. For example, if a woman is consciously aware of her same-sex attractions, then she may have no choice but to believe that she is lesbian or bisexual. However, some individuals may intentionally adopt alternative beliefs about their same-sex attractions—for example, that they are signs of confusion or mental distress—and may therefore *choose* to believe that they are heterosexual despite their same-sex sexuality. It is because of such complications that questions of choice have no clear interpretation with respect to sexual identity.

11. We are aware that there are religious objections to tolerance of homosexuality and that these will need to be factored into political responses to the issues. For the purposes of this report, however, we ignore such religious objections. To the extent that someone believes religious doctrine trumps rationality and science, we simply disagree.

12. A common additional understanding of “innate” is “determined prior to birth.” Although it is simpler here to use the understanding we have provided, in fact all influential scientific hypotheses that sexual orientation is innate emphasize the importance of the prenatal element.

13. “Cisgender” refers to individuals whose gender identity matches the one they were assigned at birth.

14. “Transgender” refers to individuals whose gender identity is different from the one they were assigned at birth.

15. In egalitarian relationships, both partners are postpubertal, and if age differences exist, they generally do not exceed one generation.

16. This effect size is highly variable across different samples in relation to ethnicity, among other characteristics.

17. The presumed heterosexual subjects were likely heterosexual given what was known about them. In any case, classification errors would not create spurious findings.

18. Although we agree with Byne's argument and would support renaming the INAH-3 as the human SDN-POA, we continue to refer to INAH-3 here.

19. How unexpected is this result under a hypothesis of "nurture?" Our review of sexual-orientation prevalence suggests that 1.1% of women are predominately attracted to other women (Fig. 1). That is the rate we should expect in our near-perfect quasi-experiment, under the hypothesis that only nurture (i.e., sex of rearing) matters. If the fact that these individuals had prenatal male biology were irrelevant, then the number expected to be strongly attracted to women would equal $0.011 \times 7 = 0.077$; this is a much smaller number than the seven who were actually strongly attracted to women. The chances that all seven of these individuals would be strongly attracted to women, again under the nurture-only hypothesis, would be .011⁷, or .0000000000000195. The nurture-only hypothesis is clearly untenable. Results of the near-perfect quasi-experiment are exactly as expected via the opposite, alternative, nature-only hypothesis: seven of seven strongly attracted to women. Of course, the non-opposite alternative—that both nature and nurture matter—must also be considered. Because of the small number of individuals studied ($N = 7$), fairly sizable sex-of-rearing influences cannot be statistically excluded. Although none of the seven individuals had a sexual orientation consistent with a sex-of-rearing hypothesis, the 95% confidence interval of the proportion $0/7$ has an upper bound of .44. This is nearly 15 times the expected rate assuming that sex of rearing has no effect (.0295, based on the likelihood that someone born male will be attracted to males; see Fig. 1). That is, using these data alone, we cannot statistically exclude the possibility that rearing someone as female increases the likelihood that she will be attracted to males by almost fifteen-fold.

20. More accurately, half of their DNA regions are identical by descent from the same parent, on average. Humans have more than 99% of their DNA in common on a base-pair level, and so the half of these variant base pairs that are identical by descent among DZ twins is an index of their similarity with respect to DNA (some of which is in or affects genes) that varies among humans.

21. For a trait measured categorically, as sexual orientation usually is, the correlation is best estimated using the MZ and DZ twin concordances (the proportion of MZ and DZ homosexual index subjects whose twins are also homosexual), using the multifactorial threshold model, under the assumption that a normally distributed trait propensity underlies the observed trait (Falconer & Mackay, 1996). This is a tetrachoric, rather than a Pearson, correlation. To ensure the accuracy of heritability and other estimates, it is crucial that twins are randomly—or at least representatively—sampled with respect to concordance status (i.e., whether both twins are homosexual or only one is). Finally, the logic of the classical twin study requires the assumption that the trait-relevant environment be equally similar among members of MZ and DZ pairs. This "equal environments" assumption has generally been supported for other behavioral traits (Flint, Greenspan, & Kendler, 2010).

22. Several published studies were omitted for the following reasons:

Study	Reason
Bailey, Dunne, and Martin (2000)	Likely considerable sample overlap with Zietsch et al. (2012)
Bearman and Brückner (2002)	Twins not yet adults with stable sexual orientations
Burich, Bailey, and Martin (1991)	Likely considerable sample overlap with Zietsch et al. (2012)
Burri, Cherkas, Spector, and Rahman (2011)	Unable to obtain concordance data
Eckert, Bouchard, Bohlen, and Heston (1986)	Too few twin pairs
Heston and Shields (1968)	Too few twin pairs
Kirk, Bailey, Dunne, and Martin (2000)	Likely considerable sample overlap with Zietsch et al. (2012)
Whitam, Diamond, and Martin (1993), female twin pairs	Too few female pairs

23. In general, estimates of heritability and shared environmentality are much less stable than those of nonshared environmentality, because the former depend on the difference between two correlations and the latter depend on the difference between one correlation and unity.

24. The indirect molecular evidence includes findings that mothers of homosexual men had a pattern of skewed inactivation of the X chromosome (Bocklandt, Horvath, Vilain, & Hamer, 2006) and that a region of chromosome 10 tended to be linked with male sexual orientation if transmitted through the mother (Mustanski et al., 2005).

25. Although MZ twins can differ genetically, such differences are too rare to account for the high rate of sexual-orientation discordance.

26. As usual, our use of medical examples has no implications for how we view any sexual orientation; it simply reflects the availability of such examples.

27. Technically, homosexual pedophilia is sexual attraction to prepubescent males (i.e., pubertal Tanner stage 1; typical ages = 5–10), and homosexual hebephilia is attraction to pubescent males (i.e., Tanner stages 2 or 3; typical ages = 11–14). Androphilic men, in contrast, are most sexually attracted to males at Tanner stages 5 and, to a lesser degree, 4 (typical ages = 15 and older). For the sake of simplicity and convention, we refer to both hebephilic and pedophilic men as "pedophilic."

28. In general, quasi-experimental designs aim to provide more rigorous tests of causal hypothesis compared with mere tests of association (Shadish, Cook, & Campbell, 2001).

29. Moreover, because this evidence is retrospective and based on self-report, there is reason to doubt the accuracy of the exceptions to this pattern, because such individuals may misremember the sequence of events or be prone to blaming their stigmatized feelings on experiences initiated by others.

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