

According to parental investment theory (Trivers 1972) there are differences between men and women with respect to the amount of time and energy invested in their offspring. Consequently, it is supposed that the lesser-investing sex is usually more unrestricted in sociosexual orientation than the more-investing sex. Men should therefore demonstrate more unrestricted sociosexual orientation than women across human cultures. Schmitt suggests that the robustness of such a sex difference forms strong support for parental investment theory. He further notes that to date there is no study that has carefully examined environmental influences on sociosexuality, though the impact might be high, especially in light of theories concerning sex ratio.

Sex ratio is defined by the relative balance of marriage-age men to marriage-age women in a mating pool. It is considered high when men significantly outnumber women and is considered low when there are relatively more women than men in the mating market. According to Daly and Wilson (1988), in most cultures women typically slightly outnumber men because of a higher male mortality rate. Pedersen (1991) consequently argued that when sex ratios are low and there are more women than men, males become an especially scarce resource that women must compete for. Accordingly, Schmitt hypothesizes that cultures with lower sex ratios should possess higher levels of sociosexuality when men tend to desire promiscuous sex. In contrast, in cultures with higher sex ratios, lower levels of sociosexuality should be observed. The International Sexuality Description Project (ISDP) project found, as predicted, that sex ratios were significantly negatively correlated with national sociosexuality, and this finding is consistent with the view that cultures with more women than men possess mating systems driven by men's evolved desires for unrestricted promiscuous sex. However, in some cultures with more men than women, sociosexuality was found to be low, and the mating system is therefore supposed to be driven by women's desires for monogamous mating. But what might be the driving force of these remarkably stable effects across nations, and what might explain the variance between cultures?

Although the results reported by Schmitt are basically consistent with the sex ratio theory, it seems that the ISDP so far provides only limited explanations. For example, Schmitt argues that an alternative explanation could be that a low sex ratio in a culture may lead men to engage in greater intrasexual competition and mating efforts.

We suggest that (1) the variation in sex ratio across nations may be at least partly explained by prenatal androgen levels causing intrauterine stress and (2) the study of a potential hormonal basis would provide a more detailed picture about the variation of male-male competition across different cultures. James (1996; 1997; 2000) has presented evidence that high testosterone, in both male and female parents, at conception is associated with an increased sex ratio. Elevated levels of testosterone might be a result of intrauterine stress. However, the study of prenatal androgen action with respect to sex ratio theory across nations in a large-scale project such as the ISDP appears to be a difficult undertaking. There is now considerable evidence that the relative length of the second (the index finger) to fourth finger (the ring finger) (2D:4D) is a pointer to prenatal testosterone levels and may thus serve as a window to the prenatal hormonal environment (for a review, see Manning 2002). We propose that the study of 2D:4D ratio may provide a proxy to early androgen action and its implications for sex ratio theory.

There is evidence that this 2D:4D ratio is sexually dimorphic and is largely determined prenatally (Manning 2002). Males tend to show lower values of 2D:4D than do females; that is, males have on average longer fourth digits relative to their second than do females (Phelps 1952; Manning et al. 1998). Relative finger lengths are determined before birth (Garn et al. 1975), and the sex difference in 2D:4D seems to be present in children as young as 2 years (Manning et al. 1998). This sex difference in 2D:4D appears to be robust across a number of ethnic groups and races (Manning 2002; Manning et al. 2000; Peters et al. 2002). The sexual dimor-

phism in 2D:4D has been known for many years (e.g. Baker 1888), although it has only recently been suggested that sex differences in 2D:4D arise from in utero concentrations of sex steroids, with 2D:4D negatively related to prenatal testosterone and positively associated with prenatal estrogen (Manning et al. 1998). There is accumulating evidence for these relationships with sex hormones and sex-dependent behavior. For example, some sexually dimorphic traits favouring males are associated with low 2D:4D ratios such as left-handedness, autism, good visuospatial ability, and fast running speed. Other dimorphic traits favouring females are associated with high 2D:4D ratios – good verbal fluency and breast cancer (for review, see Manning 2002). Further, mothers with high waist-to-hip ratio (WHR), which is associated with high testosterone and low estrogen, tend to have children with low 2D:4D ratios (Manning et al. 1999). Children with congenital adrenal hyperplasia (CAH), a condition associated with high prenatal androgens, have lower 2D:4D ratios than do controls (Okten et al. 2002); and mothers with low 2D:4D tend to have children with low 2D:4D ratio, and their children possess high concentrations of testosterone in their amniotic fluid (Manning 2002).

Manning et al. (2002) hypothesized that if the suggestion by James (1996, 1997, 2000) were true, 2D:4D ratios of adults might be negatively related to the sex ratio of their children. This was tested in samples from English, Spanish, and Jamaican populations, and a negative relationship between sex ratio and 2D:4D ratio independent of sex and ethnicity of the parent was found. Manning et al. (2002) suggested that low 2D:4D individuals are more likely to have male offspring than those with a high 2D:4D ratio. These findings are consistent with James' (1996, 1997, 2000) suggestion that sex ratio varies according to exposure to environmental stress. We suggest that the study of associations among 2D:4D ratios across nations may provide further insight into sex ratio theory and its consequences for sociosexual orientation because of its nature as proxy to prenatal and adult levels of sex steroids. We argue that the variance in sex ratio is caused by exposure to early androgen levels and also suggest that sex-dependent behaviors and aspects of sociosexuality may correlate with 2D:4D ratio. Given that the sexual dimorphism in 2D:4D ratios appears to be a relatively robust trait across various human populations, 2D:4D is likely to be a valuable trait to study the hormonal basis of sociosexuality regardless of particular social influences.

Ethnography, cultural context, and assessments of reproductive success matter when discussing human mating strategies

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Abstract: The target article effectively assesses multiple hypotheses for human sexuality, demonstrating support for a complex, integrated perspective. However, care must be taken when extrapolating human universal patterns from specific cultural subsets without appropriate ethnographic contexts. Although it makes a strong contribution to the investigation of human sexuality, the basal reliance on a reductionist perspective constrains the full efficacy of this research.

In the target article, Schmitt tackles an extremely complex subject with an eye toward identifying mating strategies by using the Sociosexual Orientation Inventory (SOI) in a broad cross-cultural survey. Schmitt's conclusion that sociosexual differences "are predictable from several theoretical perspectives, none of which is conspicuously superior to the others" (sect. 7.5) is an important statement that clearly lays out an appeal for a broad, complexities-based approach to the topic. The application of this data set to hypotheses for human mating patterns and sexuality results in one of the strongest assessments of these hypotheses to date. The data

presented in the target article argue not for a specific focus on single perspectives in attempting to model and understand human sociosexuality but rather seem to suggest that a holistic meta-approach, inclusive of ethnographic, psychological, sociological, and biological perspectives, although difficult, will produce the most comprehensive and effective results.

Although I wholeheartedly agree with many of Schmitt's conclusions, aspects of the analyses remain rooted in a reductionist perspective that can inhibit further elaboration of trends and patterns in human sexuality. It is on this point that I will focus my commentary, not in derision of the overall contribution of the target article but as a consistent reminder of the importance of including anthropological contexts and complex evolutionary perspectives.

Like many studies of sexuality, this one is focused primarily on one subculture (college students) and thus should also include other correlates of these specific populations, such as type of education, media exposure, integration with other generations in the same society, general and specific health issues/status, and economic status, for example. Schmitt uses United Nations reports and psychological surveys of sex roles and sexism as cultural variables. However, using these statistical data sets does not actually provide ethnographic measures as much as it provides broad demographic and nation-level sociological ones (such as gross domestic product [GDP], mean age at marriage, or percentage of women in parliament). Using the International Sexuality Description Project (ISDP) SOI data set as partial support for some very broad adaptive hypotheses regarding human mating strategies can miss the power of the data set and paint an incomplete picture. The data presented here are not truly a study of evolutionary strategies (because measures of reproductive success are not included) but rather one of SOI responses. In this sense the title of the target article could have been "the sociosexuality of college students: a 48-nation study of the SOI measure of sexuality" and remain a substantial contribution to the study of sexuality.

Schmitt refers to Wood and Eagly (2002) frequently but does not fully include an important aspect of that source's methodology: the inclusion of anthropological databases (ethnographic sets) to contextualize the differences and similarities in human sexualities. Providing an ethnographic context facilitates attempts to uncover patterns of behavior that may reflect adaptive mating strategies in humans. Without ethnographic inclusions, the data set rests outside the complex interconnective biocultural web of humanity and thus may present a functionally incomplete picture of actual behavioral patterns.

Schmitt states that "culture has an important influence on sociosexuality, but biological sex is the larger and stronger predictor of human mating strategies across the nations of the ISDP" (sect. 6.6). Here, answers to the SOI questions made by primarily urban, educated individuals are taken first as accurate indicators of their sociosexuality and then translated into representations of mating strategies. This leap is arguably justified by the fact that many of the responses are statistically similar across samples used. However, it is not clear to me that, for example, the measure of "nation" defined as half the partial η^2 -effect size of "sex" adequately addresses actual cultural and biological complexities. Neither the target article nor the other SOI reports clearly link the sociosexuality indicators as measured by the SOI to actual reproductive success or even actual mating patterns or behavior by individuals. Therefore, the leap from SOI answers to adaptive patterns of human behavior remains tenuous at best. The use of proxy measures for reproductive success (even if they are internally valid in the sample) remains highly speculative as evidenced from the primatological and animal behavior literatures. Proxy measures on generally young individuals (as in this study) may result in missing substantial components of their lifetime strategies. Experience affects behavior, and a focus on mainly reproductively young individuals can produce incomplete or artificial results.

The target article would have benefited from inclusion of the discourse arguing for less dramatic differences in male and fe-

males attitudes towards partner number and mating patterns (Miller et al. 2002; Pederson et al. 2002). Also, in an overview of mating strategies theory, one should be careful about heavy reliance on simplistic interpretations of the Trivers' model for obligatory parental investment and subsequent differences in sociosexual strategies, given the substantial complexities in the actual impacts of sexual selection, choice, and mating strategies reviewed in recent literature in evolutionary and ecological studies (Borg-erhoff-Moulder 2004; Kokko & Jennions 2003; Tang-Martinez 2000).

Finally, the use of unrealistic figures of potential male reproductive success is counterproductive because there is no evidence that in humans or other primates such a dramatic lifetime reproductive skew occurs with any regularity in any population studied. Using such assumptions as a jumping off point, even if hypothetical, lays an unrealistic baseline that can then be used to create a variety of scenarios, all of which are faulty given the erroneous basal assumption. True potential reproductive success in a human society is dependant on much more than whether that society practices polygyny or monogamy as its primary marriage system. Marriage systems should not be seen simply as proxies for mating systems, nor should they necessarily be seen as reflective of adaptive strategies. This again stresses the need for a cultural context in which to place interview data on sexuality in humans.

Despite my criticisms, it is important to note the Schmitt is very aware of the limitations of the data set and explicitly points them out in section 7.1, entitled "Sociosexuality and psychometrics." He explicitly states that the current findings are "tentative until more sophisticated sampling techniques can be employed" (sect. 7.1), but this does not dissuade him from making some broad claims about adaptations and strategies throughout the target article.

In all, this is an extremely important contribution to the study of human sexuality, and Schmitt and his colleagues are to be congratulated on the ISDP and its far-reaching implications. The diverse sets of data produced from the project, especially those discussed in the target article, will provide substantial fodder for multiple theoretical and practical innovations in sexuality theory, as Schmitt clearly outlines in his discussion and conclusion.

Sperm competition theory offers additional insight into cultural variation in sexual behavior

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Abstract: Schmitt recognized that research is needed to identify other factors associated with sex ratio and with sociosexuality that may explain cross-cultural variation in sexual behavior. One such factor may be the risk of sperm competition. Sperm competition theory may lead us to a more complete explanation of cultural variation in sexual behavior.

Schmitt found that sex ratio, as predicted by Pedersen (1991), is correlated negatively with sociosexuality. That is, in those nations where women outnumber men (low sex ratio), individuals tend to be more sexually promiscuous. It is not yet known whether the sex ratio in a population causes a shift in sociosexuality, and Schmitt acknowledged appropriately that future research will identify other factors associated with sex ratio and with sociosexuality that may help to provide a more complete theory of cross-cultural variation in sexual behavior.

One such factor likely related to sex ratio and to sociosexuality that warrants future investigation is sperm competition, defined as the competition between the sperm of two or more males for fertilization of a female's eggs (Parker 1970). In humans, sperm competition is a consequence of female sexual infidelity and fe-