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Biased Sex Ratios Influence Fundamental Aspects of Human Mating

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Abstract

The operational sex ratio—the ratio of men to women in a given population—affects a range of social processes. The current research demonstrates that biased sex ratios (greater numbers of one sex than the other) influence fundamental aspects of people's mating strategy. When the sex ratio was favorable (one's own sex was in the minority), both sexes adopted strong sex-typical sociosexual orientations (relatively restricted for women; relatively unrestricted for men). When the sex ratio was unfavorable (one's own sex was in the majority), both sexes shifted toward the orientation typically favored by the other sex: Women became more unrestricted and men became more restricted (Experiment 1). When the sex ratio was unfavorable (relative to favorable), participants also displayed greater aggression toward a romantically desirable (but not undesirable) same-sex partner (Experiment 2). Exploratory analyses suggested that the sex ratio effect was present for unprovoked aggression but not provoked aggression (given the exploratory nature of that analysis, the aggression effect should be considered with some caution). Findings suggest that people's mating strategies are adaptively calibrated to contingencies within the local mating ecology.

Keywords

sex ratio, sociosexual orientation, intrasexual aggression, evolutionary psychology

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When people approach challenges associated with attracting and retaining potential romantic partners, they do so in ways that are adaptively calibrated to pressures that exist within the local social ecology (Gangestad, Haselton, & Buss, 2006). Men and women respond to contingencies in the environment by deploying adaptive strategies designed to maximize reproductive success. One important ecological factor that may affect people's mating strategies is the ratio of men to women in the local environment (Guttentag & Secord, 1983; Griskevicius et al., 2012). The current research advances the human mating literature by testing the hypothesis that being in an environment marked by a biased sex ratio (greater prevalence of one sex than the other) influences fundamental aspects of people's mating strategies, including both their orientation toward engaging in casual sex and the level of aggression they display toward same-sex competitors.

Sex ratio theory (Charnov, 1982; Guttentag & Secord, 1983; see also Baumeister & Vohs, 2004) implies that as the sex ratio within a population becomes biased toward one sex over the other, the more prevalent sex will compete vigorously with same-sex rivals for access to the relatively scarce number of potential partners. Consequently, the less prevalent sex can become choosier in selecting potential partners and can afford to prioritize potential partners who adhere to the preferred mating style of the less prevalent sex. Although sex ratio theory has received correlational support (e.g., Barber, 2001; Bien, Cai, Emch, Parish, & Tucker, 2013), experimental tests are rare. Recent experiments have examined sex ratio effects on men's financial decisions (Griskevicius et al., 2012) and women's career choices (Durante, Griskevicius, Simpson, Cantãš, & Tybur, 2012), both of which reflect cognitively downstream aspects of people's mating strategies. The current research provides the first rigorous test of whether biased sex ratios affect two central aspects of people's mating strategy: their sociosexual orientation and their level of intrasexual aggression.

Sex Ratios and Sociosexuality

One of the most fundamental aspects of people's mating strategy is their sociosexual orientation; that is, their willingness to engage in casual sexual activity without requiring a

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high degree of commitment (Simpson & Gangestad, 1991). Being inclined to seek casual sex (unrestricted sociosexual orientation) versus avoid it (restricted sociosexual orientation) reflects a key difference between mating strategies designed to facilitate short- versus long-term relationships, respectively.

Consistent with parental investment theory (Trivers, 1972), which emphasizes sex differences in initial obligatory levels of parental investment, men tend to be more sexually unrestricted than women are, a sex difference that has been observed across diverse cultures (Buss & Schmitt, 1993; Buss, 1989; Schmitt, 2015). Despite the general existence of sex differences, however, each individual's sociosexual orientation can be influenced by the presence of other men and women in the local environment (Kenrick, Li, & Butner, 2003). For example, environments with more women than men are associated with high rates of female promiscuity (Schmitt, 2005; also Barber, 2001), providing correlational evidence that when men are scarce, women compete with each other by offering sex without requiring high levels of commitment (Baumeister & Vohs, 2004).

When people are faced with a favorable sex ratio (they are in the minority sex), they can afford to adopt a strong orientation toward their preferred mating strategy. Based on sex differences in sociosexuality, one might predict that given a favorable sex ratio, men would adopt a strong unrestricted sociosexual orientation, whereas women would adopt a strong restricted sociosexual orientation. Although men are generally less sexually restricted than women, we predicted that men would become more restricted when presented with an unfavorable sex ratio (fewer women than men) compared with a favorable sex ratio (fewer men than women). In such environments, women can be more selective and require higher levels of commitment. Thus, men might become more restricted to bring their own mating strategy in line with the preferred strategy of women. Conversely, we predicted that women would be more unrestricted when presented with an unfavorable sex ratio (fewer men) compared with a favorable sex ratio (fewer women). When there is an abundance of women, women might lower their commitment requirements to be selected by the relatively scarce number of men. We tested these hypotheses in Experiment 1.

Sex Ratios and Intrasexual Aggression

Another strategy that men and women use to attract and secure potential romantic partners involves aggression toward same-sex rivals (Ainsworth & Maner, 2012). From an evolutionary perspective, people use aggression as a way of competing with same-sex rivals, thereby increasing their access to mating opportunities (Archer, 2009; Wilson & Daly, 1985). Aggression can be used by both sexes to decrease the number and efficacy of potential rivals with whom one has to compete over access to potential mates. Furthermore, aggression can be used to signal that one possesses qualities that are desired by the other sex. For example, men may use aggression to increase their level of social dominance. Women tend to be attracted to socially dominant men, and socially dominant men tend to be more successful in attracting potential mates (Sadalla, Kenrick, & Vershure, 1987). Conversely, men who score low on social dominance tend to be overlooked by women seeking potential mates (Buss & Schmitt, 1993).

There is suggestive evidence supporting the hypothesis that the operational sex ratio may influence same-sex aggression. For example, there are higher levels of male aggression in male-prevalent environments, presumably because men must compete more vigorously with each other over access to potential mates (Barber, 2003; Hudson & Den Boer, 2002). There is less research on the effect of sex ratios on female aggression. This lack of evidence could reflect a tendency for researchers to focus more on direct aggression (which is more prevalent among men) than indirect aggression (which is more prevalent among women; Bjorkqvist, 1994). However, there is some evidence that women are more aggressive in female-prevalent environments than in male-prevalent environments (Campbell, 2013). Nevertheless, this body of evidence is based on correlational data and thus falls short of clearly identifying the role sex ratio plays in intrasexual aggression. Such studies have failed to assess whether the sex ratio causes aggression toward same-sex rivals. In the current research, we predicted that being in an environment marked by an unfavorable sex ratio (as compared with a favorable sex ratio) would cause people to display higher levels of aggression toward a same-sex rival.

Because there are potential risks associated with the use of aggression, such as retaliation and injury, the use of aggression as a mating tactic should be used selectively (Ainsworth & Maner, 2014). In particular, aggression should be displayed primarily toward those individuals who possess traits and characteristics that serve as threats to one's own success in the mating market. The most threatening individuals in the mating market are those who possess high levels of physical attractiveness and social status because such individuals are typically seen as highly desirable by the other sex (Griskevicius, Haselton, & Ackerman, 2014; Maner & Ackerman, 2013). Thus, although we expected that being in an unfavorable sex ratio (relative to a favorable sex ratio) would lead to higher levels of aggression toward a same-sex target, we also expected that this pattern would be moderated by the desirability of the target person. Specifically, we predicted that the effect would be stronger for desirable targets (those who are attractive and possess high social status) than for undesirable targets (those who are relatively less attractive and who lack social status). That is, we predicted that being in an unfavorable sex ratio (relative to a favorable sex ratio) would elicit increases in aggression more strongly toward a highly desirable rival than toward a rival who lacks socially desirable characteristics. We tested these hypotheses in Experiment 2. In addition to these primary hypotheses, we also explored whether exposure to an unfavorable sex ratio

would increase unprovoked aggression, aggression that was provoked by the actions of one's partner, or both types of aggression.

Experiment 1

Method

Participants. One hundred twenty-nine heterosexual undergraduate students (82 women, 47 men) at Florida State University who described themselves as single participated for course credit. We computed an a priori required sample size using a two-tailed test, $d = 0.50$, $\alpha = .05$, and power = .80 with an allocation ratio (N2 / N1) = 1 to yield a sample size of 128 participants. Our estimated effect size was obtained from a combination of effect sizes from Griskevicius et al. (2012) and Durante et al. (2012), the two main experimental studies on sex ratio effects available in the literature. The sample was limited to single participants because this study focused on a person's interest in casual sex (sociosexuality) so inclusion of those in long-term committed relationships would likely obscure the predicted effects; the romantic goals of people in a committed romantic relationship are already being satisfied to some extent, and thus they might be less affected by the sex ratio manipulations. Thus, the exclusion criterion of people in a committed relationship was instituted at the level of data collection, not data analysis. All participants provided informed consent prior to participating. Age ranged from 18 to 22 years old ($M = 19.35$, $SD = 1.28$ years).

Procedure. Participants read one of two short news articles about the prevalence of male and female students on campuses across their college institution's conference (the Atlantic Coast Conference). The news articles were adapted from previous research (Griskevicius et al., 2012) and were ostensibly taken from the *Tallahassee Democrat* (a reputable newspaper located near their local university). One article highlighted that the sex ratios on campuses were becoming more female-prevalent, whereas the other article noted that sex ratios were becoming more male-prevalent. Fifty-eight participants (36 female, 22 male) were randomly assigned to the unfavorable sex ratio condition (participants were in the majority sex) while 71 (46 female, 25 male) participants were randomly assigned to the favorable sex ratio condition (participants were in the minority sex). To minimize suspicion and enhance attention to the manipulation, we informed participants that the session involved multiple studies, the first of which concerned memory for news material. In sum, the study used a 2 (participant sex) × 2 (favorable sex ratio vs. unfavorable sex ratio) between-subjects design.

Following the sex ratio manipulation, participants completed the multidimensional Sociosexual Orientation Inventory (SOI; Jackson & Kirkpatrick, 2007). This scale provides a measure of people's willingness to engage in uncommitted sex. People with a restricted sociosexual orientation require a high degree of closeness and commitment before engaging in sex with a romantic partner. In contrast, people with an unrestricted sociosexual orientation are more comfortable engaging in casual sex. Restricted versus unrestricted sociosexual orientations reflect a key difference between strategies designed to facilitate committed long-term versus uncommitted short-term mating relationships, respectively. The multidimensional inventory assesses people's attitudes and desires toward casual sex, as well as their previous sexual behavior. It is important to distinguish between these components because attitudes and desires can momentarily shift whereas the current environment cannot change people's previous sexual behavior. In this study, therefore, we focused on the Attitude and Desire subscales in our primary analyses. Sample items included "Sex without love is ok"; "I could easily imagine myself enjoying one night of sex with someone I would never see again"; and "I could enjoy sex with someone I find highly desirable even if that person does not have long-term potential." Items are scored on a 7-point Likert-type scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Higher numbers reflect a more unrestricted sociosexual orientation whereas lower numbers reflect a more restricted sociosexual orientation ($M = 3.64$, $SD = 2.06$, $\alpha = .77$).

The Behavior subscale was used in supplemental analyses to assess whether the sex ratio effects on sociosexual orientation were specific to people's current attitudes and desires toward casual sex or whether they extended to the measure of previous sexual behavior. Sample items included "During your entire life, with how many partners of the opposite sex have you had sexual intercourse?" ($M = 3.28$, $SD = 1.92$) and "With how many partners of the opposite sex have you had sexual intercourse within the past year?" ($M = 3.98$, $SD = 5.65$). If the sex ratio primes affect people's self-presentational strategy, then people might use their reports of previous sexual behavior to present themselves in a light that would make them appear more desirable to the other sex. Men might report that they have engaged in less previous sexual behavior to communicate high levels of commitment, whereas women might report that they have engaged in more previous sexual behavior to communicate high levels of sexual accessibility.

After completing the SOI, participants responded to an attention check. Participants answered a single question that assessed whether the article they read said college campuses were becoming more male-prevalent or more female-prevalent. Seven participants answered this question incorrectly and were removed from analyses. After the attention check, participants were debriefed and dismissed from the experiment. In an effort to contribute to an open and transparent science, we have reported all measures, manipulations, and data exclusions along with all studies that test these hypotheses.

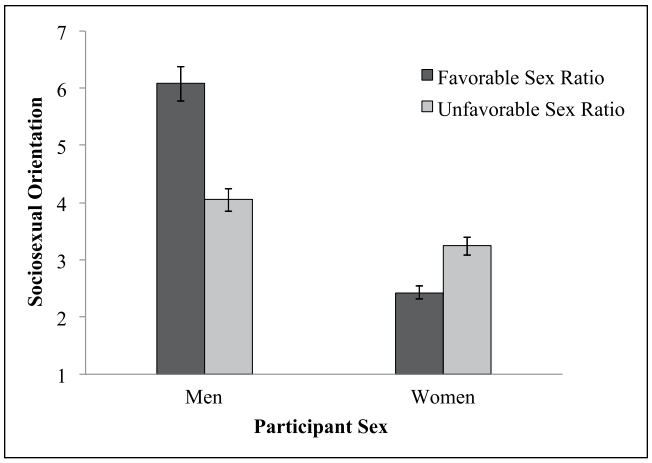

Figure 1. The effect of sex ratio on sociosexual orientation by participant sex.
Note. Higher numbers reflect more unrestricted sociosexual orientations. Error bars represent standard errors.

Results

We used a general linear-model ANOVA to predict participants' sociosexual orientation from participant sex, experimental condition (favorable vs. unfavorable sex ratio), and their interaction. We observed the predicted two-way interaction between experimental condition and participant sex, $F(1, 125) = 23.60$, $p < .001$; $d = 0.87$ (see Figure 1). We also found a main effect of participant sex, $F(1, 125) = 58.76$, $p < .001$; $d = 1.37$, such that men were more unrestricted than women.

We followed up the significant interaction by assessing the simple effect of the sex ratio manipulation in men and women. Men displayed a more unrestricted sociosexual orientation when there was a favorable female-prevalent sex ratio ($M = 6.08$, $SD = .95$) than when there was an unfavorable male-prevalent sex ratio ($M = 4.05$, $SD = 1.86$), $F(1, 125) = 19.13$, $p < .001$; $d = 0.77$. Conversely, women displayed a more unrestricted sociosexual orientation when there was an unfavorable female-prevalent sex ratio ($M = 3.24$, $SD = 1.86$) than when there was a favorable male-prevalent sex ratio ($M = 2.43$, $SD = 1.49$), $F(1, 125) = 5.18$, $p = .03$; $d = 0.41$.

To provide additional context for these findings, we summarized data from our lab's previous research measuring SOI in this same population to provide baseline measures of men's ($M = 4.56$, $n = 293$) and women's ($M = 2.75$, $n = 581$) sociosexual orientations. These averages reflected sociosexual orientations that were intermediate to those observed in the current study. That is, whereas men and women were relatively more unrestricted than normal in the female-prevalent condition, they were relatively more restricted than normal in the male-prevalent condition.

We considered the possibility that changes in people's sociosexual orientations might reflect some element of self-presentation. When exposed to unfavorable sex ratios, people may report their previous sexual behavior in a way that signals to the other sex that one's previous sexual behavior is consistent with what they think members of the minority sex prefer. To assess that possibility, supplemental analyses focused on the Behavior subscale of the SOI. There was no interaction between sex ratio and participant sex on reports of total previous sexual behavior, $F(1, 125) = 0.00$, $p = .99$, or sexual behavior within the last year, $F(1, 125) = .001$, $p = .98$. Nor was there any main effect of the sex ratio manipulation on total previous sexual behavior, $F(1, 125) = .94$, $p = .33$, or sexual behavior within the last year, $F(1, 125) = 1.02$, $p = .31$. Thus, there were no differences in reported previous sexual behavior for participants exposed to a favorable versus unfavorable sex ratio. The only effect we observed was a marginally significant main effect of participant sex on previous sexual behavior within the last year, $F(1,125) = 3.00$, $p = .09$, such that men reported engaging in more previous sexual behavior than did women. Thus, in sum and consistent with our predictions, the sex ratio primes affected only people's current attitudes and desires toward casual sex, but did not affect people's reports of previous sexual behavior.

Discussion

Men and women adaptively calibrated their attitudes and desires toward casual sex based on whether they were exposed to a favorable or unfavorable sex ratio. When in the minority, participants strongly adopted the orientation typically preferred by their sex. When in the majority, participants shifted toward the preferred orientation of the other sex, presumably to increase their likelihood of being selected by the relatively scarce number of potential partners. Thus, the manipulation caused both sexes to shift their mating strategy to maximize mating opportunities within the local ecology.

Experiment 2

Method

Participants. One hundred seventy-seven heterosexual undergraduates (104 men, 73 women) at Florida State University participated in this study for course credit. Using GPower, we computed an a priori required sample size using a two-tailed test, $d = 0.50$, $\alpha = .05$, and power = .90 with an allocation ratio (N2 / N1) = 1 to yield a sample size of 172 participants. Our estimated effect size was obtained from a combination of effect sizes from Griskevicius et al. (2012) and Durante et al. (2012). Unlike Experiment 1, this experiment included participants who were in a committed romantic relationship ($N = 58$) along with single participants, because same-sex aggression is relevant to both competitions over new mates and efforts to guard existing mates. All participants provided informed consent prior to participating. Age ranged from 18 to 22 years old ($M = 19.29$, $SD = 1.35$ years).

Procedure. Participants were told that they would be completing a series of studies with two same-sex partners who were ostensibly located in other lab rooms. One of these partners was presented as being highly desirable whereas the other partner was presented as being less desirable (see below for details). Participants began the experiment by writing a short introductory paragraph about themselves and posing for a photograph to be shared with their ostensible same-sex partners. Participants then read a short news article about male and female students on college campuses. Those articles contained the sex ratio manipulations and were identical to the articles used in Experiment 1. Ninety-two participants (55 male, 37 female) were randomly assigned to the unfavorable sex ratio condition while 85 (49 male, 36 female) participants were randomly assigned to the favorable sex ratio condition. Participants were told that the news article was part of a memory study and that they should pay close attention to the details of the article, as they would be asked to recall information from the article at a later time.

Following the priming procedure, participants were told that they would be competing against their first partner. We counterbalanced the order of presentation of desirable and undesirable partners (partner desirability was included as a within-subjects variable to maximize statistical power). Participants read the introductory paragraph that was (ostensibly) written by their first partner and viewed a photograph of the first partner. For the highly desirable partner, participants viewed a picture of a same-sex individual who was pretested by an independent sample ($n = 32$) to be relatively attractive (male, $M = 6.44$; female, $M = 7.41$ on a 9-point scale). For the undesirable partner, participants viewed a picture of a same-sex individual who was pretested to be relatively less attractive (male, $M = 4.75$; female, $M = 5.50$ on a 9-point scale).

The introductory paragraph for the desirable partner communicated a high level of social status:

> Hey my name is Chris and I'm a junior who is double majoring here at FSU. In my free time, I play intramural sports for my fraternity [sorority]. I also currently have an internship at the state Capitol. I also like to go out a lot to parties and bars, trying to meet new people and I date whenever I can. I have a great group of friends and we have a lot of fun together.

The introductory paragraph for undesirable partner communicated a lower level of social status:

> I'm Jamie and I'm a sophomore. I spend a lot of my time as President of Mu Alpha Theta, the math honors society on campus. I also volunteer at the FSU radio station WVFS 89.7. When I'm not in class or working, I like to stay in and play video games whenever I can. I'm not really that into going out. I just got a new cat so I've been playing with her a lot lately.

Thus, the partner desirability manipulation coupled physical attractiveness with social status.

After reading the introductory paragraph and viewing the picture of the first partner, participants completed a noise-blast task against that same-sex partner. The task provided a behavioral measure of aggression (see below for details about the task). Following completion of the noise-blast task with the first partner, participants were told that they would be completing the same noise-blast task against the second partner, but it would take a few moments for the experimenter to set up. In the meantime, participants answered a single question that assessed whether the article they read earlier said that college campuses were becoming more male-prevalent or more female-prevalent. This question served as an attention check to assess whether participants were paying attention to the sex ratio prime. Three participants answered this question incorrectly and were removed from analyses. The questionnaire also served as a booster manipulation for the next phase of the study because the details of the sex ratio manipulation were again made salient.

After participants answered the question about the article, they were told that the second partner was ready to participate and that the final phase of the experiment would commence. Participants then read the introductory paragraph and were shown the picture of the second partner. Participants then completed the noise-blast task against the second partner. Finally, participants were debriefed and dismissed from the experiment. Thus, the study used a 2 (participant sex) × 2 (sex ratio: Favorable vs. unfavorable, between-subjects) × 2 (highly desirable partner vs. less desirable partner, within-subjects) mixed design.

Noise-blast task. Participants were told that they were completing an auditory reaction-time task with their same-sex partner, who ostensibly was located in another room. This reaction-time task has been used in other experiments to measure aggression (Bushman & Baumeister, 1998; Ainsworth & Maner, 2012). Participants completed 15 trials and reacted as quickly as possible to a tone played through headphones by clicking a button on the computer screen. The loser of each trial was forced to listen to a painful blast of white noise that their partner dictated. Before each trial, each person chose the volume and duration (both on 0-10 scales) of the blast. The task was set up so that the participant would lose approximately half of the trials and the noise would become incrementally more painful over time. The task was rigged so that the participant would win the first three trials. Thus, on all but the first three trials, participants were reacting to noise blasts by their partner. This procedure allowed us to measure two different types of aggression: unprovoked aggression, which was the amount of aggression on the first three trials, and provoked aggression, which was the amount of aggression on the subsequent trials. The volume and duration of the blasts were averaged to create a composite measure of aggression. Higher numbers reflect higher levels of aggression toward the same-sex partner (see Table 1 for distribution of aggression scores).

Results

We used a mixed-model ANOVA to predict unprovoked and provoked aggression toward same-sex partners from

Table 1. Means and Standard Deviations for Unprovoked and Provoked Aggression Toward Desirable and Undesirable Targets.

	Desirable targets	Undesirable targets
Unprovoked	4.16 (1.90)	3.66 (1.61)
Provoked	4.64 (1.64)	4.49 (1.51)

experimental condition (favorable vs. unfavorable sex ratio), participant sex, partner type (high vs. low social status), and their interactions. From the outset of this investigation, we had no a priori predictions regarding provoked and unprovoked aggression; both have been the focus of previous aggression research (e.g., Ainsworth & Maner, 2014) and there were reasons to think that one or the other might be responsive to the sex ratio primes. Thus, this aspect of the investigation was exploratory, and we report results for both types of aggression. We observed a two-way interaction between sex ratio condition and partner type for unprovoked aggression, $F(1, 173) = 5.80$, $p = .02$; $d = 0.37$ (see Figure 2). This same interaction only approached significance for provoked aggression, $F(1, 173) = 2.55$, $p = .11$; $d = 0.24$.

There were reasons to think that both men's and women's aggressive tendencies would depend on sex ratio, and so we did not anticipate moderating effects of sex in this study. However, we included participant sex in our statistical models because we wanted to account for possible main effects of sex and because we suspected that readers would want to know about possible sex differences. The three-way interaction between condition, participant sex, and partner type was not significant for unprovoked aggression, $F(1, 173) = 2.11$, $p = .15$; $d = 0.22$, or for provoked aggression, $F(1, 173) = 0.17$, $p = .69$; $d = 0.06$. We also found a main effect for partner type for unprovoked aggression, $F(1, 173) = 15.88$, $p < .001$, such that people displayed more unprovoked aggression toward desirable partners than less desirable partners. The main effect for partner type only approached significance for provoked aggression, $F(1, 173) = 3.01$, $p = .09$, but it was in the same direction as the effect for unprovoked aggression.

To interpret the interaction between sex ratio condition and partner type, we tested the simple effects of experimental condition on aggression toward desirable and undesirable partners. We found a significant effect of the sex ratio manipulation on unprovoked aggression toward desirable partners, such that participants displayed more unprovoked aggression toward desirable partners when they were in an unfavorable sex ratio environment ($M = 4.45$, $SD = 1.97$) than when they were in a favorable sex ratio environment ($M = 3.83$, $SD = 1.78$), $F(1, 173) = 3.99$, $p = .05$; $d = 0.30$ (see left side, Figure 2). There was no difference in the amount of unprovoked aggression displayed toward undesirable partners when participants were in an unfavorable sex ratio environment ($M = 3.66$, $SD = 1.56$) as compared with a favorable sex ratio environment ($M = 3.66$, $SD = 1.67$), $F(1, 173) = 0.00$, $p = .98$; $d = 0.00$ (see right side, Figure 2).

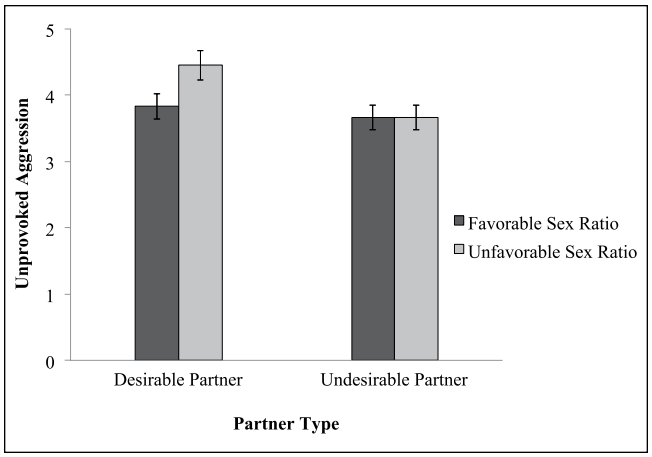

Figure 2. The effect of sex ratio on unprovoked aggression by partner type.
Note. Higher numbers reflect more unprovoked aggression (scale ranges from 0-10). Error bars represent standard errors.

We observed no significant effect of experimental condition for provoked aggression directed toward desirable or undesirable partners. There was no difference in the amount of provoked aggression displayed toward desirable partners when participants were in an unfavorable sex ratio environment ($M = 4.75$, $SD = 1.55$) as compared with a favorable sex ratio environment ($M = 4.52$, $SD = 1.74$), $F(1, 173) = 0.70$, $p = .40$; $d = 0.13$. Similarly, there was no difference in the amount of provoked aggression displayed toward undesirable partners when participants were in an unfavorable sex ratio environment ($M = 4.46$, $SD = 1.41$) as compared with a favorable sex ratio environment ($M = 4.52$, $SD = 1.63$), $F(1, 173) = 0.08$, $p = .77$; $d = 0.04$.

Discussion

Participants displayed greater levels of unprovoked aggression toward a desirable same-sex partner when exposed to an unfavorable sex ratio compared with a favorable sex ratio. Results did not extend to provoked aggression. Because we had no a priori predictions about sex ratio effects on provoked versus unprovoked aggression, that aspect of the investigation should be considered exploratory and, more broadly, results from this experiment should be considered with some caution. Further research is needed before drawing strong conclusions about the effects of sex ratio on aggressive behavior. Nevertheless, consistent with our primary hypothesis, being in the majority sex (relative to the minority sex), and thus facing greater intrasexual competition, led participants to display greater aggressive behavior toward a desirable same-sex rival. Moreover, consistent with the hypothesis that aggression can be costly and thus should be deployed selectively, the sex ratio manipulation influenced aggressive behavior only toward a highly desirable same-sex target who reflected a potent and potentially threatening romantic competitor. No effects were

observed for relatively less desirable targets, who lacked attractive social and physical qualities and who therefore posed a lower level of reproductive threat. This is consistent with previous evidence that intrasexual aggression as a mating strategy is deployed selectively toward targets who are highly desirable and thus who are most likely to endanger one's access to potential mating opportunities (Ainsworth & Maner, 2014). Thus, participants facing a reproductively unfavorable sex ratio responded by aggressing strategically toward those individuals who pose the greatest threats to their mating success.

General Discussion

The current findings suggest that local sex ratios influence central aspects of human mating strategies. Whether they were in an environment marked by a favorable versus unfavorable sex ratio affected the amount of commitment people required before engaging in sex (their sociosexual orientation) and the level of aggression they displayed toward a desirable intrasexual rival.

Being in the minority sex affords greater ability to be selective in shaping one's general mating strategy and reduces the need to compete with other members of one's own sex over access to potential partners. Indeed, when they were in the minority sex, both men and women gravitated toward more strongly espousing their own sex's preferred orientation toward short- versus long-term relationships. Men became especially interested in casual sexual relationships, whereas women eschewed such relationships in favor of greater commitment. Members of both sexes also responded to being in the minority sex by displaying relatively low levels of aggression, presumably because there was less need to compete with others over access to potential mates.

In contrast, being a member of the majority sex might mean having to cater to the desires of the other sex and competing more vigorously with members of one's own sex. Consistent with this hypothesis, participants responded to being in the majority by shifting away from their own sex's preferred orientation toward casual sex and moving toward the orientation typically preferred by the other sex. Participants also displayed greater unprovoked aggression toward a same-sex partner, particularly one who displayed desirable qualities and who therefore reflected a potent rival. Notably, participants did not aggress toward a relatively undesirable partner. Indeed, the strategic nature of this effect underscores its function—to harm someone who poses a potent reproductive threat when the mating ecology is unfavorable.

Although no moderating effects of sex were observed in this research, other studies in this literature suggest the presence of sex differences. For example, the males of many species tend to display greater intrasexual competition and aggression than the females (Archer, 2004; Wilson & Daly, 1985), a tendency that in other species is heightened during mating season (Wingfield, Hegner, Dufty, & Ball, 1990). Although we had no predictions about whether participant sex would moderate the effect of the sex ratio manipulations, the experiments may not have been adequately powered to detect possible sex differences. Therefore, this aspect of the investigation should be interpreted with caution, and further research is needed to assess whether sex ratio effects might differ for men versus women.

Implications of the Current Research

Most research on sex ratio in humans has been correlational in nature (for exceptions, see Durante et al., 2012, Griskevicius et al., 2012). In contrast, the current studies provide experimental evidence that variations in sex ratio cause people to adaptively calibrate key aspects of their mating strategy to maximize reproductive success. The current research represents one of the first lines of research to establish the causal link between sex ratios and central aspects of human mating.

In addition to advancing the literature on mating, these findings also contribute to the aggression literature by identifying a situational factor that may promote aggressive behavior (cf. Anderson & Bushman, 2002). Evolutionary perspectives highlight the functional role that aggression plays in mating and intrasexual competition (Ainsworth & Maner, 2012, 2014; Archer, 2004; Griskevicius et al., 2009; Wilson and Daly, 1985). The current research extends this literature by identifying an environmental contingency that determines when and why aggression is deployed. Consistent with evolutionary theories emphasizing the link between mating and aggression, the current findings illustrate that people are especially likely to use aggression in unfavorable mating environments and toward same-sex rivals who are perceived to pose the biggest threats to one's mating success.

Although this research did not yield definitive conclusions regarding sex ratio effects on unprovoked versus provoked aggression, the distinction between the two types of aggression may be important for theories of mating. On one hand, unprovoked aggression provides an initial means of asserting oneself over potential competitors, and so, it could be used strategically to increase one's reproductive success. On the other hand, provoked aggression could serve the same purpose, in the sense that it helps preserve one's reputation in the face of an aggressive competitor. Future research would benefit from examining more closely the role provocation plays in mating-related aggression.

Implications of the current work extend beyond the laboratory. Many large-scale problems faced by society, such as high teen-pregnancy rates, risky sexual behavior, and violent crime, are influenced by situational factors (e.g., Wilson & Daly, 1985). The current research identifies one factor that could underlie such problems and, consequently, provides

potential pathways toward combating them. Indeed, one implication of the current research is that balanced sex ratios—or building safeguards when the sex ratio is imbalanced—could undercut dysfunctional patterns of sexuality and violence (cf. Barber, 2001; Bien et al., 2013).

Limitations and Future Directions

Limitations of these studies provide valuable avenues for future research. First, the sex ratio manipulation was highly conscious and explicit. Outside the lab, sex ratios may be perceived at a more implicit level. Future investigations should vary the subtlety of sex ratio primes (e.g., having participants view images of varied sex ratios or engage in a group interaction that varies the sex ratio within the group; cf. Griskevicius et al., 2012; Durante et al., 2012). Such approaches would extend the ecological validity of this research.

Future research could profitably explore individual differences that moderate effects of biased sex ratios, such as the desirability of the participant. Highly desirable people possess a larger pool of potential partners, so they may not need to cater to the preferences of the other sex or use aggression as a mating tactic to the same extent that less desirable people do. Consequently, highly desirable people may be relatively immune to the effects of unfavorable sex ratios. Future research would benefit from evaluating this hypothesis and investigating additional moderating variables in the person and the social context (e.g., cultural norms pertaining to sexuality or aggression).

Concluding Remarks

This article presents rigorous experimental evidence that biased sex ratios change fundamental aspects of people's mating strategies, including both their orientation toward casual sex and the extent to which they use aggression as a mating tactic. These findings suggest that people's mating psychology is adaptively calibrated to proximate environmental pressures and provide support for an ecologically contingent view of human mating. More broadly, this investigation illustrates the value of testing theories from evolutionary biology using rigorous experimental methods from social psychology. The integration of these approaches provides a useful framework for understanding a vast range of social processes.

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References

Ainsworth, S. E., & Maner, J. K. (2012). Sex begets violence: Mating motives, social dominance, and physical aggression in men. *Journal of Personality and Social Psychology*, *103*, 819-829.

Ainsworth, S. E., & Maner, J. K. (2014). Assailing the competition: Sexual selection, proximate mating motives, and aggressive behavior in men. *Personality and Social Psychology Bulletin*, *40*, 1648-1658.

Anderson, C. A., & Bushman, B. J. (2002). Human aggression. *Psychology*, *53*, 27-51.

Archer, J. (2004). Sex differences in aggression in real-world settings: A meta-analytic review. *Review of General Psychology*, *8*, 291-322.

Archer, J. (2009). Does sexual selection explain human sex difference in aggression? *Behavioral and Brain Sciences*, *32*, 249-266.

Barber, N. (2001). On the relationship between marital opportunity and teen pregnancy: The sex ratio question. *Journal of Cross-Cultural Psychology*, *32*, 259-267.

Barber, N. (2003). The sex ratio and female marital opportunity as historical predictors of violent crime in England, Scotland, and the United States. *Cross-Cultural Research*, *37*, 373-391.

Baumeister, R. F., & Vohs, K. D. (2004). Sexual economics: Sex as female resource for social exchange in heterosexual interactions. *Personality and Social Psychology Review*, *8*, 339-363.

Bien, C. H., Cai, Y., Emch, M. E., Parish, W., & Tucker, J. D. (2013). High adult sex ratios and risky sexual behaviors: A systematic review. *PLoS ONE*, *8*, e71580.

Bjorkqvist, K. (1994). Sex differences in physical, verbal, and indirect aggression: A review of recent research. *Sex Roles*, *30*, 177-188.

Bushman, B. J., & Baumeister, R. F. (1998). Threatened egotism, narcissism, self-esteem, and direct and displaced aggression: Does self-love or self-hate lead to violence? *Journal of Personality and Social Psychology*, *75*, 219-229.

Buss, D. M. (1989). Sex differences in human mate preferences: Evolutionary hypotheses tested in 37 cultures. *Behavioral and Brain Sciences*, *12*, 1-49.

Buss, D. M., & Schmitt, D. P. (1993). Sexual strategies theory: An evolutionary perspective on human mating. *Psychological Review*, *100*, 204-232.

Campbell, A. (2013). The evolutionary psychology of women's aggression. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *368*, 20130078.

Charnov, E. L. (1982). *The theory of sex allocation*. Princeton, NJ: Princeton University Press.

Durante, K. M., Griskevicius, V., Simpson, J. A., Cantãš, S. M., & Tybur, J. M. (2012). Sex ratio and women's career choice: Does a scarcity of men lead women to choose briefcase over baby? *Journal of Personality and Social Psychology*, *103*, 121-134.

Gangestad, S. W., Haselton, M. G., & Buss, D. M. (2006). Evolutionary foundations of cultural variation: Evoked culture and mate preferences. *Psychological Inquiry*, *17*, 75-95.

Griskevicius, V., Haselton, M. G., & Ackerman, J. A. (2014). Evolution and relationships. In J. A. Simpson & J. F. Dovidio (Eds.), *The handbook of personality and social psychology: Interpersonal relations and group processes* (pp. 3-32). Washington, DC: American Psychological Association.

Griskevicius, V., Tybur, J. M., Ackerman, A. J., Delton, A. W., Robertson, T. E., & White, A. E. (2012). The financial consequences of too many men: Sex ratio effects on saving, borrowing, and spending. *Journal of Personality and Social Psychology*, *102*, 69-80.

Griskevicius, V., Tybur, J. M., Gangestad, S. W., Perea, E. F., Shapiro, J. R., & Kenrick, D. T. (2009). Aggress to impress: Hostility as an evolved context-dependent strategy. *Journal of Personality and Social Psychology*, *96*, 980-994.

Guttentag, M., & Secord, P. (1983). *Too many women?* Beverly Hills, CA: SAGE.

Hudson, V., & Den Boer, A. (2002). A surplus of men, a deficit of peace: Security and sex ratios in Asia's largest states. *International Security*, *26*, 5-38.

Jackson, J. J., & Kirkpatrick, L. A. (2007). The structure and measurement of human mating strategies: Toward a multidimensional model of sociosexuality. *Evolution & Human Behavior*, *28*, 382-391.

Kenrick, D. T., Li, N. P., & Butner, J. (2003). Dynamical evolutionary psychology: Individual decision-rules and emergent social norms. *Psychological Review*, *110*, 3-28.

Maner, J. K., & Ackerman, J. M. (2013). Love is a battlefield: Romantic attraction, intrasexual competition, and conflict between the sexes. In J. A. Simpson & L. Campbell (Eds.), *Oxford handbook of close relationships* (pp. 137-160). New York, NY: Oxford University Press.

Sadalla, E. K., Kenrick, D. T., & Vershure, B. (1987). Dominance and heterosexual attraction. *Journal of Personality and Social Psychology*, *52*, 730-738.

Schmitt, D. P. (2005). Sociosexuality from Argentina to Zimbabwe: A 48-nation study of sex, culture, and strategies of human mating. *Behavioral and Brain Sciences*, *28*, 247-311.

Schmitt, D. P. (2015). The evolution of culturally-variable sex differences: Men and women are not always different, but when they are . . . it appears not to result from patriarchy or sex role socialization. In V. A. Weekes-Shackelford & T. K. Shackelford (Eds.), *The evolution of sexuality* (pp. 221-256). New York, NY: Springer.

Simpson, J. A., & Gangestad, S. W. (1991). Individual differences in sociosexuality: Evidence for convergent and discriminant validity. *Journal of Personality and Social Psychology*, *60*, 870-883.

Trivers, R. (1972). Parental investment and sexual selection. In B. Campbell (Ed.), *Sexual selection and the descent of man* (pp. 136-179). Chicago, IL: Aldine-Atherton.

Wilson, M., & Daly, M. (1985). Competitiveness, risk-taking, and violence: The young male syndrome. *Ethology and Sociobiology*, *6*, 59-73.

Wingfield, J. C., Hegner, R. E., Dufty, A. M., & Ball, G. F. (1990). The challenge hypothesis: "Theoretical implications" for patterns of testosterone secretion, mating systems, and breeding strategies. *The American Naturalist*, *136*, 829-846.