

This is an awesome title

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Abstract

1 Introduction

Gender differences in sexual behaviors, especially short-term mating behaviors, have been a well-documented phenomenon in human sexuality research. For example, research has found that heterosexual men, as compared to heterosexual women, have a higher average number of past short-term sexual partners (Oliver & Hyde, 1993; Petersen & Hyde, 2010; Rissel et al., 2014), have short-term mating more frequently (Petersen & Hyde, 2010), and engage in extramarital sex more often (Petersen & Hyde, 2010). These gender differences have also been observed between gay men and lesbian women (Bailey et al., 1994; Bryant & Demian, 1994; Peplau et al., 1997, 2004).

In the existing literature, gender differences in sexual behaviors are not usually distinguished from those in attitudes towards or preferences for short-term mating. Some researchers study gender differences on the two levels simultaneously without a conceptual distinction (e.g., Petersen & Hyde, 2010), whereas some implicitly equate the two, assuming that behavioral differences are a direct expression of the psychological ones (e.g., Schmitt et al., 2001).

Intuitive as this line of reasoning is, there are good reasons to doubt its soundness. This is because any heterosexual sexual encounter involves both a man and a woman (the frequency of encounters involving more than two persons is negligible, (e.g., Herbenick et al., 2017). A new short-term mating experience for a man is, therefore, also a new experience for a woman, and the same logic applies to counting a new short-term mate. As a result, the psychological differences in short-term mating preferences may not result in behavioral ones in the heterosexual case (Archer, 2019).

The present study took gender differences in mating preferences as an assumption, which was proposed by sexual strategy theory (Buss & Schmitt, 1993) and repeatedly found support by empirical studies (e.g., Schmitt, 2003; Walter et al., 2020). Using an agent-based model, we investigated whether men and women's different mating preferences resulted in any gender differences in short-term mating behaviors, specifically, in the number of short-term mating experiences and short-term mates, and if they did, under what circumstances.

1.1 Gender differences in short-term mating preferences

Gender differences in mating strategies have been studied in the light of sexual strategy theory (Buss & Schmitt, 1993). It posits that since the minimum investment that men devote to their offspring (contribution of sperm through one sexual act) is lower than that of women (gestation, labor, and lactation), men tend to have short-term mating as a larger part of their mating strategy than women do. This is because women's high minimum investment leads to higher opportunity cost (vs. men) if they have sex with a suboptimal partner and give birth to offspring with a low survival chance. As a result, men may have a greater interest in short-term mating, desire a larger number of short-term mates in a given period, and be less selective with respect to accepting a potential mate (Buss & Schmitt, 1993).

The hypotheses derived from sexual strategy theory have received extensive support from empirical studies. For example, men reported to be currently seeking short-term mates to a larger extent than women did (Buss & Schmitt, 1993; Schmitt et al., 2001; Schmitt, 2003), and a larger proportion of them were in any way seeking short-term mates (vs. not seeking) (Schmitt, 2003). These have been found among U.S. college students (Buss & Schmitt, 1993; Schmitt et al., 2001) as well as in ten world regions in a cross-cultural study (Schmitt, 2003). Similarly, men across the world also reported to desire more short-term sexual partners compared to women for a number of given time periods (e.g., a month, a year) (Buss & Schmitt, 1993; McBurney et al., 2005; Schmitt, 2003). The gender differences were significant regardless of whether they were estimated by mean (Buss & Schmitt, 1993; Schmitt et al., 2001; Schmitt, 2003), median (Schmitt et al., 2001; Schmitt, 2003), or percentage (Schmitt, 2003) statistics.

As for mating standards, men are more likely to accept someone as a potential short-term mate. For example, studies using U.S. college samples found that the minimum percentile ranks that men found acceptable for a potential short-term sexual partner were lower than for women both overall and on individual traits (e.g., social status, attractiveness) (Kenrick et al., 1990; Regan, 1998). A study also found that when presented with identical descriptions of potential mates, men on average rated them as more desirable than women did (Wiederman & Dubois, 1998).

Some evidence shows that sexual strategy theory also predicts mating preferences among gay

men and lesbian women. A survey study using a community sample from the U.S. found that gay men were more interested in short-term mating than lesbian women and that this gender difference was comparable to that existing among heterosexual individuals (Bailey et al., 1994). An indirect piece of evidence on differential standards for short-term mates comes from a recent study finding that significantly more gay men than lesbian women reported to have accepted a casual sexual offer from a same-gender person (Matsick et al., 2021). Past studies suggest that the gender difference in the acceptance rate of casual sexual offers may originate from men and women's differential standards for short-term mates (Conley et al., 2011; Hald & Høgh-Olesen, 2010). Thus, as a postulation, gay men and lesbian women may also have different standards for short-term mates.

1.2 Constraints on men's preferences for short-term mating

Since heterosexual sex involves both a man and a woman in most cases, men's interest in short-term mating can be constrained by women's preference for long-term relationships (Archer, 2019; Symons, 1979). This is because men's short-term mating preferences can only translate into behaviors when there are women willing to have sex with them. When short-term mating occurs, the number of short-term mating encounters and short-term mates is essentially the same for men and women (although this does not necessarily mean that the total number of men and women who have ever had short-term mating must be equal). Therefore, we would expect to observe no gender difference in short-term mating behaviors among heterosexual individuals even when there were gender differences in mating preferences.

As a comparison, in the cases of gay men and lesbian women, men's preferences are not constrained by women's, but only by those of other men, who, arguably, have more similar preferences. This would allow for a more direct behavioral expression of men's mating preferences. The notion that gay men have less restricted preferences was borne out in the proportion of individuals who have engaged in extradyadic sex (Peplau et al., 2004). A study showed that the proportions of heterosexual men and women who have engaged in extradyadic sex were 26% and 21%, respectively, while the statistics among gay men and lesbian women were 82% and 28%, respectively (Peplau et al., 2004). Therefore, we would theoretically expect to observe gender differences in

short-term mating behaviors among gay men and lesbians. Moreover, we would also expect to find that gay men, as compared to heterosexual men, engaged in more short-term mating behaviors due to the lessened constraint on their mating preferences.

1.3 A simple model of short-term mating behaviors

By using a spatial agent-based model, the present study investigated whether men and women's different mating preferences resulted in any gender differences in short-term mating behaviors, and if they did, under what circumstances. The interest in short-term mating was modeled as an individual's likelihood of deciding to have short-term mating at each time step. The standards for short-term mates were modeled as the minimum desirability of a potential mate with whom an individual was willing to have sex. Short-term mating behaviors were operationally defined as the number of short-term mating experiences and the number of past short-term mates.

We modeled this process among both heterosexual individuals and gay men and lesbian women to examine whether constraints set by the opposite sex's preferences would make a difference in short-term mating behaviors. Individuals' sexual orientation was conceptualized in terms of behaviors only in our model. Heterosexual men had short-term mating or formed a long-term relationship with women, while gay men only with other men, and vice versa for women.

We raised the following hypotheses in the present study: when there were gender differences in preferences for short-term mating, 1) there would be gender differences in short-term mating behaviors among gay men and lesbian women, with gay men being engaged in more such behaviors, and 2) gay men would engage in more short-term mating behaviors as compared to heterosexual men.

2 Material and methods

2.1 Model Design

We developed an agent-based model to represent a simplified environment where men and women can move around, search for mates, and form long-term and/or short-term relationships.

Space and time are modeled as discrete variables. Space was represented as discrete locations on a two-dimensional 33*33 lattice. Agents' movement in the space was not meant to simulate physical movement but a state of encountering potential mates. Staying at one location represented being committed to a long-term relationship.

The model measured **three** outcomes: (1) the number of men and women who had ever engaged in short-term mating **put this to the end**; (2) the number of short-term mating experiences of men and women; (3) the number of short-term mates of men and women. The number of short-term mating experienced and short-term mates were calculated by taking the average among the whole men/women population and among those who had engaged in short-term mating.

See the Supplemental Materials for the overview, design concepts, and details (ODD) protocol of the model, which includes detailed scheduling and parameterization. The model can be downloaded from the Github online repository [link masked for peer review]. The model was programmed in Netlogo 6.2.1 (Wilensky, 1999).

2.2 Experiment Design

Using the agent-based model, the present study conducted two 2 (gender difference vs. no difference in short-term mating likelihood) x 2 (gender difference vs. no difference in mating standard) experiments. Experiment 1 was run among heterosexual agents who only engaged in short-term or long-term relationships with agents of the opposite gender. Experiment 2 was run among gay men and lesbian women who only engaged in short-term or long-term relationships with agents of the same gender.

Gender differences were modeled in agents' likelihood of engaging in short-term mating and the standard for short-term mates. The values of these parameters were set based on empirical findings in human mating psychology. We compared the conditions where there were gender differences in mating preferences with counterfactual conditions where gender differences were missing. When there was a gender difference in short-term mating likelihood, men had a 40% likelihood of deciding to engage in short-term mating upon meeting a potential mate, while women had a likelihood of 25% (Buss & Schmitt, 1993; Schmitt et al., 2001; Schmitt, 2003). When there

was no gender difference in short-term mating likelihood, both women and men had a likelihood of 25%. When there was a gender difference in mating standards, men had a mating standard of 3 (the minimum mate value of a potential partner with whom an agent is willing to have short-term mating, highest possible value = 10), while women had a standard of 5 (Kenrick et al., 1990; Regan, 1998). When there was no gender difference in mating standards, both men and women had a standard of 5.

2.3 Model Schedule

2.3.1 Initial setup

In total, 150 women and 150 men were created on the lattice at random locations. All agents were initialized with (1) a three-unit maximum distance by which agents can move away from their birthplace (movement range); (2) a 10% likelihood of two agents forming a long-term relationship upon meeting; (3) single status and no long-term partner; (4) a mate value, sampled from a Gaussian distribution ($M = 5$, $SD = 1.5$); (5) no short-term mate or short-term mating history.

The likelihood of engaging in short-term mating and the standard for short-term mates were initialized either the same or differently for men and women, depending on the experimental conditions.

2.3.2 Procedures

2.3.2.1 Heterosexual procedures. At each time step, agents first checked whether they were in a long-term relationship. If they were not in a long-term relationship, they set their heading randomly (if they were within the movement range from the birthplace) or faced the birthplace (if they were out of the movement range from the birthplace) and moved by a random distance. The random distance was less than half of the movement range. If they were in a long-term relationship, they did not move. Then, the agents decided on whether to engage in short-term mating by a chance of the chosen likelihood (either 25% or 40%).

Women checked to see if any men were at the same location. If there were, they randomly chose one of them as their potential short-term mate. If both men and women met each other's mating

standards and both of them decided to engage in short-term mating, they had sex. This would result in increasing both parties' number of short-term mating experiences by one. They also recorded each other on their lists of past short-term mates if they were not on the lists yet.

Then, women randomly selected one man at the same location as their potential long-term partner. There was a 10% of chance that a pair would form a long-term relationship. After forming a long-term relationship, both men and women changed to coupled status and register each other as the long-term partner.

2.3.2.2 Gay men and lesbian women procedures. At each time step, men and women moved and decided on short-term mating as the agents did in the heterosexual procedures. Half of the agents (an equal number of men and women) were also given the initiator status. The initiators checked to see whether there were other agents at the same location. The rest of the procedures were identical to the heterosexual procedures, except that the agents only chose those with the same gender as themselves as potential short-term mates or long-term partners.

2.4 Simulations

The model was run for 1,000 time steps in each simulation. We ran 10,000 simulations for each experiment, and 2,500 simulations for each condition. We controlled for initializing random seeds in the model runs. All simulations were run using Netlogo 6.2.1 (Wilensky, 1999).

2.5 Statistical analysis

Statistical analyses were conducted using R version 4.1.3 (R Core Team, 2022) and the figures were generated by the ggplot2 package (Wickham, 2016). Two-tailed independent samples *t*-tests were used for all statistical comparisons. The data were assumed to be normally distributed within each condition but was not formally tested.

3 Results

3.1 Gender differences in short-term mating behaviors in each experiment

The results from Experiment 1 showed that when there were gender differences in preferences for short-term mating, there was no gender difference in the average number of short-term mating experiences among heterosexual individuals ($M_m = 1.43$, $SD_m = 0.24$; $M_w = 1.43$, $SD_w = 0.24$), Cohen's $d = 0$. Nor was there a difference in the average number of short-term mates ($M_m = 0.80$, $SD_m = 0.11$; $M_w = 0.80$, $SD_w = 0.11$), Cohen's $d = 0$ (Figure 1).

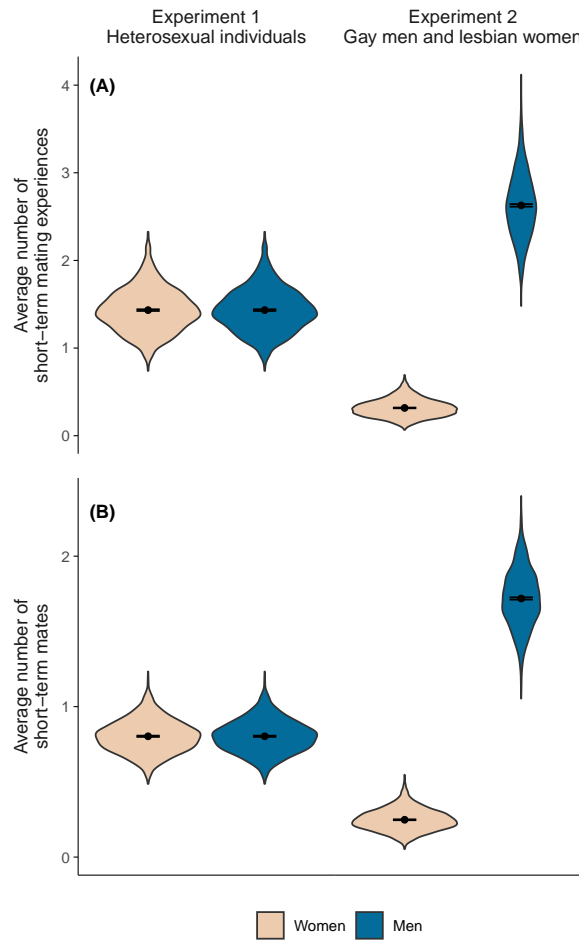


Figure 1: Short-term mating behaviors of men and women after 1,000 time steps in the model when gender differences existed in mating preferences. Violin plots summarizing the outcome variables separately for heterosexual individuals and gay men and lesbian women. Plot (A) shows the average number of short-term mating experiences, and plot (B) shows the average number of short-term mates. Central points show mean values and whiskers represent standard errors, but the standard errors are small and overlap to form a single bar. Statistics were calculated using the full population of men and women in the model ($N_m = N_w = 150$).

The results from Experiment 2 showed that when there were gender differences in preferences for short-term mating, there were gender differences in short-term mating behaviors between gay men and lesbian women (Figure 1). The average number of short-term mating experiences was higher among gay men ($M = 2.63$, $SD = 0.37$) than among lesbian women ($M = 0.32$, $SD = 0.10$), $t(4,998) = -301.78$, $p < .001$, Cohen's $d = 8.54$. Similarly, the average number of short-term mates was higher among gay men ($M = 1.72$, $SD = 0.19$) than among lesbian women ($M = 0.25$, $SD = 0.07$), $t(4,998) = -357.69$, $p < .001$, Cohen's $d = 10.12$.

In Experiment 1, however, when the means of the outcome variables were calculated among men and women who were in the mating pool (i.e., those with a non-zero number of short-term mating experiences) (**the number of individuals in the mating pool: M_m , SD_m ; M_w , SD_w**), there were gender differences in short-term mating behaviors when there were gender differences in mating preferences. The average number of short-term mating experiences was higher among heterosexual men ($M = 3.78$, $SD = 0.50$) than among heterosexual women ($M = 2.79$, $SD = 0.35$), $t(4,998) = -81.53$, $p < .001$, Cohen's $d = 2.31$. Likewise, the average number of short-term mates was higher among heterosexual men ($M = 2.12$, $SD = 0.17$) than among heterosexual women ($M = 1.56$, $SD = 0.11$), $t(4,998) = -135.85$, $p < .001$, Cohen's $d = 3.84$.

3.2 Comparing short-term mating behaviors of heterosexual and gay men

The results comparing across the two experiments revealed that gay men engaged in short-term mating behaviors more than heterosexual men did (Figure 2). The average number of short-term mating experiences was higher among gay men ($M = 2.63$, $SD = 0.37$) than among heterosexual men ($M = 1.43$, $SD = 0.24$), $t(4,998) = -134.87$, $p < .001$, Cohen's $d = 3.81$. Similarly, the average number of short-term mates was higher among gay men ($M = 1.72$, $SD = 0.19$) than among heterosexual men ($M = 0.80$, $SD = 0.11$), $t(4,998) = -206.91$, $p < .001$, Cohen's $d = 5.85$.

3.3 Comparing across conditions

In an exploratory manner, we also compared across conditions to see which of the two dimensions of preferences for short-term mating contributed to gender differences in sexual behaviors.

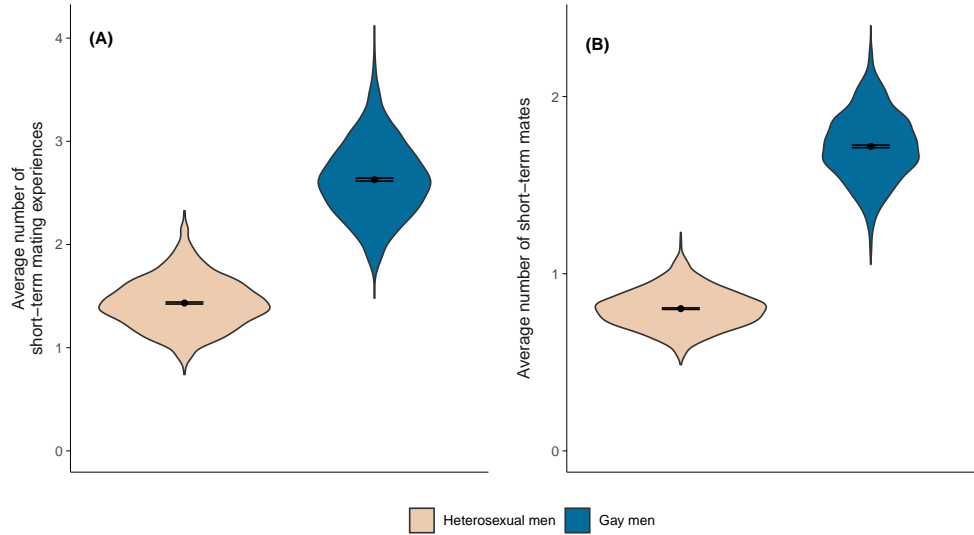


Figure 2: Short-term mating behaviors of heterosexual and gay men after 1,000 time steps in the model when gender differences existed in mating preferences. Violin plots summarizing the outcome variables. Plot (A) shows the average number of short-term mating experiences, and plot (B) shows the average number of short-term mates. Central points show mean values and whiskers represent standard errors, but the standard errors are small and overlap to form a single bar. Statistics were calculated using the full population of heterosexual and gay men in the model ($N_{hm} = N_{gm} = 150$).

Among heterosexual individuals, gender differences in short-term mating behaviors, as calculated among individuals in the mating pool, emerged when men and women had different standards for short-term mates. Heterosexual men in the mating pool had a higher average number of short-term mating experiences and short-term mates than women in the mating pool, even when no gender difference existed in short-term mating likelihood (experiences: $M_m = 2.82$, $SD_m = 0.36$, $M_w = 2.21$, $SD_w = 0.28$, Cohen's $d = 1.89$; partners: $M_m = 1.76$, $SD_m = 0.15$; $M_w = 1.38$, $SD_w = 0.09$, Cohen's $d = 3.13$). In comparison, virtually no gender differences in short-term mating behaviors existed when men and women had the same mating standards (Table 1).

Among gay men and lesbian women, gender differences in short-term mating behaviors emerged either when they had different short-term mating likelihood or when their mating standards were different. Gay men had a higher average number of short-term mating experiences and short-term mates when they had a higher short-term mating likelihood than lesbian women (experiences: $M_m = 0.80$, $SD_m = 0.23$, $M_w = 0.32$, $SD_w = 0.10$, Cohen's $d = 2.67$; partners: $M_m = 0.52$, $SD_m = 0.13$, $M_w = 0.25$, $SD_w = 0.07$, Cohen's $d = 2.60$), or when they had a lower mating standards (experiences: $M_m = 1.05$, $SD_m = 0.18$, $M_w = 0.32$, $SD_w = 0.10$, Cohen's $d = 5.10$; partners: $M_m =$

Table 1: Short-term mating behaviors of heterosexual men and women in the mating pool after 1,000 time steps in the model

	Average short-term mating experiences (in-pool)					Average short-term mates (in-pool)				
	Men		Women		<i>d</i>	Men		Women		<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Same likelihood*Same standard	2.21	0.38	2.20	0.37	0.03	1.39	0.12	1.39	0.12	0.04
Same likelihood*Different standard	2.82	0.36	2.21	0.28	1.89	1.76	0.15	1.38	0.09	3.13
Different likelihood*Same standard	2.80	0.48	2.78	0.47	0.03	1.57	0.14	1.56	0.14	0.05
Different likelihood*Different standard	3.78	0.50	2.79	0.35	2.31	2.12	0.17	1.56	0.11	3.84

Note. The statistics were calculated with subsamples of men and women who had had engaged in short-term mating behaviors. See Supplementary Materials for the mean and standard deviation of sample sizes.

0.82, $SD_m = 0.12$, $M_w = 0.25$, $SD_w = 0.07$, Cohen's $d = 5.78$). In comparison, virtually no gender differences in short-term mating behaviors existed when gay men and lesbian women had the same short-term mating likelihood and mating standards (Table 2).

4 Discussion

The present study aimed at using agent-based modeling to investigate whether men and women's different mating preferences resulted in any gender differences in short-term mating behaviors, specifically, in the number of short-term mating experiences and short-term mates, and if they did, under what circumstances. We raised two hypotheses: 1) there would be gender differences in short-term mating behaviors among gay men and lesbian women, with gay men being engaged in more such behaviors, and 2) gay men would engage in more short-term mating behaviors as compared to heterosexual men. The results from 1,000 time steps in a model simulating men and women's mating behaviors supported our hypotheses. First of all, as compared to lesbian women, gay men had a higher average number of short-term mating experiences and short-term mates. In contrast, we found no gender differences in short-term mating behaviors between heterosexual men and women. Secondly, gay men also had a higher average number of short-term mating experiences and short-term mates as compared to heterosexual men.

Table 2: Short-term mating behaviors of gay men and lesbian women after 1,000 time steps in the model

	Average short-term mating experiences					Average short-term mates				
	Men		Women		<i>d</i>	Men		Women		<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Same likelihood*Same standard	0.32	0.10	0.32	0.10	0.04	0.25	0.07	0.25	0.07	0.03
Same likelihood*Different standard	1.05	0.18	0.32	0.10	5.10	0.82	0.12	0.25	0.07	5.78
Different likelihood*Same standard	0.80	0.23	0.32	0.10	2.67	0.52	0.13	0.25	0.07	2.60
Different likelihood*Different standard	2.63	0.37	0.32	0.10	8.54	1.72	0.19	0.25	0.07	10.12

Note. $N_m = N_w = 150$ in all conditions.

As we expected, heterosexual men and women did not differ in short-term mating behaviors despite their different mating preferences. This was because the total numbers of short-term mating experiences and short-term mates of heterosexual men and women were exactly the same. Since the sex ratio was 1:1 in our model, the average number of short-term mating experiences and short-term mates must be equal between men and women as well. However, we did find that among individuals in the mating pool, men engaged in more short-term mating behaviors as compared to women. This was because there were more women than men in the mating pool (i.e., had ever engaged in short-term mating behaviors), resulting in lower averages among heterosexual women despite equal numbers of experiences and mates in total.

Moreover, gender differences in short-term mating behaviors emerged when heterosexual men and women had different standards for short-term mates, but not when they had different likelihood of engaging in short-term mating. When women had a higher standard than men did, less men than women in the population were above a potential partner's standards and thus had a chance to have sex with them. This contributed to the unequal number of men and women in the mating pool, which led to gender differences in short-term mating behaviors.

In the light of these results, the empirical observation of gender differences in short-term mating behaviors among heterosexual individuals (e.g., Petersen & Hyde, 2010) appear to be perplexing because this is theoretically illogical (e.g., Gurman, 1989). Possible explanations for these em-

pirical results have to highlight caveats in the observation process. One possibility is that there was sampling bias in the observations (e.g., Wiederman & Dubois, 1998) since surveys regarding short-term mating behaviors may tend to attract individuals who already engage in such behaviors. Another possibility is that heterosexual men and women tend to report short-term mating behaviors differently. This difference may be a result of social desirability bias (Alexander & Fisher, 2003) or due to men and women's different estimation strategies (e.g., men tend to round up) (Brown & Sinclair, 1999).

Among gay men and lesbian women, large gender differences in short-term mating behaviors existed when men and women had different mating preferences, which was in line with empirical observations (e.g., Peplau et al., 1997, 2004). This was probably because the number of short-term mating experiences and short-term mates no longer counted towards men and women simultaneously. Any gender differences in mating preferences would result in differences in behaviors. A closer look at the results did support this postulation. Either a difference in the likelihood of short-term mating or a difference in mating standards alone could contribute to gender differences in mating behaviors. This was perhaps because the former increased the probability of both parties of a given gay couple deciding to have short-term mating, and the latter increased the probability of both of them meeting each other's standards, as compared to the case of a given lesbian couple.

Supporting the idea that gay men's preferences for short-term mating were not constrained by those of women, we found that gay men engaged in more short-term mating behaviors as compared to heterosexual men. This was consistent with the empirical literature (e.g., Peplau et al., 1997). Interestingly, gay men and heterosexual men had the same likelihood of short-term mating and the same standards for short-term mates in our model. The only difference was a change in the preferences in their potential partners. When men's partners had a stronger preferences for short-term mating (i.e., having men vs. having women as potential partners), men also appeared to engage in more short-term mating behaviors.

5 Conclusion

Using agent-based modeling, the present study theoretically explored the circumstances under which men and women's different mating preferences resulted in gender differences in short-term mating behaviors. We found when men (vs. women) had a stronger preferences for short-term mating, heterosexual men and women engaged in short-term mating behaviors to the same extent, while gay men engaged in more short-term mating behaviors as compared to lesbian women. We also found that gay men engaged in more short-term mating behaviors than heterosexual men did.

These results highlight the distinction between psychological preferences and behaviors in human mating. Individuals' mating behaviors do not only depend on one's own preferences, but are also constrained by partners' preferences. Future research in human mating should not only focus on the psychological aspect but also pay attention to the interaction between individuals' psychology and its context. These results also cast doubt to the prevalent belief in the gender differences in short-term mating behaviors, especially among heterosexual individuals. Our findings suggest that there may be factors in the observation process that lead to such differences. Future research in human sexuality should note such possibilities and interpret any observed gender differences in short-term mating behaviors cautiously.

6 Acknowledgements

7 Data availability

All models, data, and analysis code can be downloaded at: [link masked for peer review]

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