Supplemental Materials to "An Agent-Based Model of Sex and Sexual Orientation Differences in Short-Term Mating Behaviors as a Result of Mating Preferences"

A. Overview, Design Concepts, and Details of the Model

This description of the model follows the standard ODD protocol of reporting individual-based and agent-based modeling (Grimm et al., 2006).

Purpose

The model simulated sex differences in short-term mating behavior. Findings in evolutionary psychology suggest that males have a stronger desire for short-term mating than females (Regan, 1998). They are also less choosy regarding short-term mating partners (Buss & Schmitt, 1993; Buss & Schmitt, 2019). This model explores both heterosexual and gay males' as well as heterosexual and lesbian females' behavioral outcomes under these assumptions.

The first version of the model simulated short-term mating behaviors among heterosexual individuals, short-term mating and/or long-term relationships were formed only between individuals of the opposite sex. The second version of the model simulated the behaviors among gay males and lesbian females, where individuals only had short-term matings and/or formed long-term relationships with those of the same sex. The key parameters were individuals' likelihood of engaging in short-term mating and their standards for a short-term partner. We varied those parameters to examine conditions under which sex differences in behavioral outcomes may emerge.

Entities, state variables, and scales

The model included two types of entities: global and agents. In this model, time and space were modeled as discrete variables. During each time step, agents executed the commands described in the schedule. Space was represented as discrete locations on a two-dimensional 33*33 lattice. All state variables are summarized in Supplemental Table 1.

Process overview and scheduling

The model was written using Netlogo 6.2.1 (Wilensky, 1999). The model proceeded in discrete time steps, and the entities executed commands in the following order:

1. Setting up (Global, only executed once)

(a) 300 agents were created with all state variables set to the default

(b) A number of agents were set to either males (number-of-male) or females (300 – number-of-men) with their respective short-term mating likelihood (short-term-likelihood), and standard for a short-term mate (mating-standard)

2. Moving (The following procedures were executed by agents unless specified otherwise)

   (a) If not coupled

      i. If staying within a distance of movement-range from the initial point on both the x and y axis, randomly set their heading and move by a random distance less than movement-range / 2

      ii. If staying outside the distance of movement-range from the initial point on either the x or y axis, head toward the initial point and move by a random distance less than movement-range / 2

   (b) If coupled, do not move

3. Deciding on short-term mating behavior

   (a) Set short-term-mate? to true by short-term-likelihood

4. Short-term and long-term mating (To avoid double count, only females execute this chunk. This does not affect the model outcomes.)

   (a) If any males here, females randomly select one as the target for short-term mating

      i. If the target has desirability higher than her mating-standard & she has desirability higher than the target's mating-standard & both of them have short-term-mate? set to true,

         A. Both of them add 1 to short-term-count

         B. Both of them add each other's ID number to their short-term-history if not in it yet

   (b) If any males here and females are not coupled, females randomly select one as the

potential partner for long-term mating

i. By long-term-likelihood, they form a long-term relationship, and

A. Both of them set coupled? to true

B. Both of them set each other as their long-term partner

5. Updating state variables

(a) Set number-of-partner-short the length of short-term-history

(b) If coupled? is true and short-term-likelihood equals male-/female-short-term-likelihood, set short-term-likelihood to a third of its value

Design concepts

Sensing. Agents were able to detect other agents' mate value so that they could decide whether to have short-term mating with them.

Interaction. Females and males interacted to have short-term mating behaviors or form long-term relationships.

Stochasticity. Agents' movement in this model had stochastic elements, with the heading and the movement distance being randomly selected. Whether agents decided to have short-term mating or form long-term relationships was also randomly determined.

Observation. Simulations were run for 1,000 time steps. The dependent variables were measured at the end of each run.

Supplemental Table A1: Overview of state variables associated with each type of entity.

Entity	State variable	Description	Default or initial value [scale]	Unit
Global	number-of-male	Number of males in the population	150 [0-300]	Individuals
	movement-range	The maximum distance an agent can move from the location where they have been generated	3 [1-15]	Patches
	all-homosexual?	Whether agents are heterosexual (F) vs. gays/lesbians (T)	[True/False]	
Agent	long-term-likelihood	The likelihood of two agents forming a long-term relationship upon meeting	10 [1-100]	%
	coupled?	Whether agents are single (F) or in a long-term relationship (T)	False [True/False]	
	partner	Long-term partner		ID number of the partner
	short-term-likelihood	The likelihood of an agent deciding to engage in short-term mating	40 (men), 25 (women) [0-100]	%
	mating-standard	The minimum mate value of a partner with whom an agent is willing to have short-term mating upon meeting	3 (men), 5 (women) [0-10]	
	desirability	Mate value for short-term mating	Mean = 5; SD = 1.5	
	short-term-mate?	The decision to have short-term mating (T) or not (F) during each time period	False [True/False]	
	short-term-count	Number of past short-term mating behaviors	0	
	short-term-history	List of all short-term mates in the chronological order		ID number of partners
	number-of-partner-short	Number of past short-term mates		Individuals
	initiator?	Whether an agent initiates short-term mating (T) or not (F) (used only in the experiments for gay males and lesbian females)	False [True/False]	

Supplemental Table A2: Parameter setting in the eight conditions of two experiments. Parameters manipulated across experiments are highlighted in italics. Parameters manipulated across conditions are highlighted in boldface.

	Experiment 1: Heterosexual individuals				Experiment 2: Gay males and lesbian females			
	Same likelihood* Same standard	Same likelihood* Different standard	Different likelihood* Same standard	Different likelihood* Different standard	Same likelihood* Same standard	Same likelihood* Different standard	Different likelihood* Same standard	Different likelihood* Different standard
number-of-male	150	150	150	150	150	150	150	150
movement-range	3	3	3	3	3	3	3	3
all-homosexual?	*FALSE*	*FALSE*	*FALSE*	*FALSE*	*TRUE*	*TRUE*	*TRUE*	*TRUE*
long-term-likelihood	10	10	10	10	10	10	10	10
male-short-term-likelihood	**25**	**25**	**40**	**40**	**25**	**25**	**40**	**40**
female-short-term-likelihood	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**
male-mating-standard	**5**	**3**	**5**	**3**	**5**	**3**	**5**	**3**
female-mating-standard	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**

B. Additional Analyses

Supplemental Table B1: Mean proportion of heterosexual males and females in the mating pool and its standard deviation after 1,000 time steps in the model.

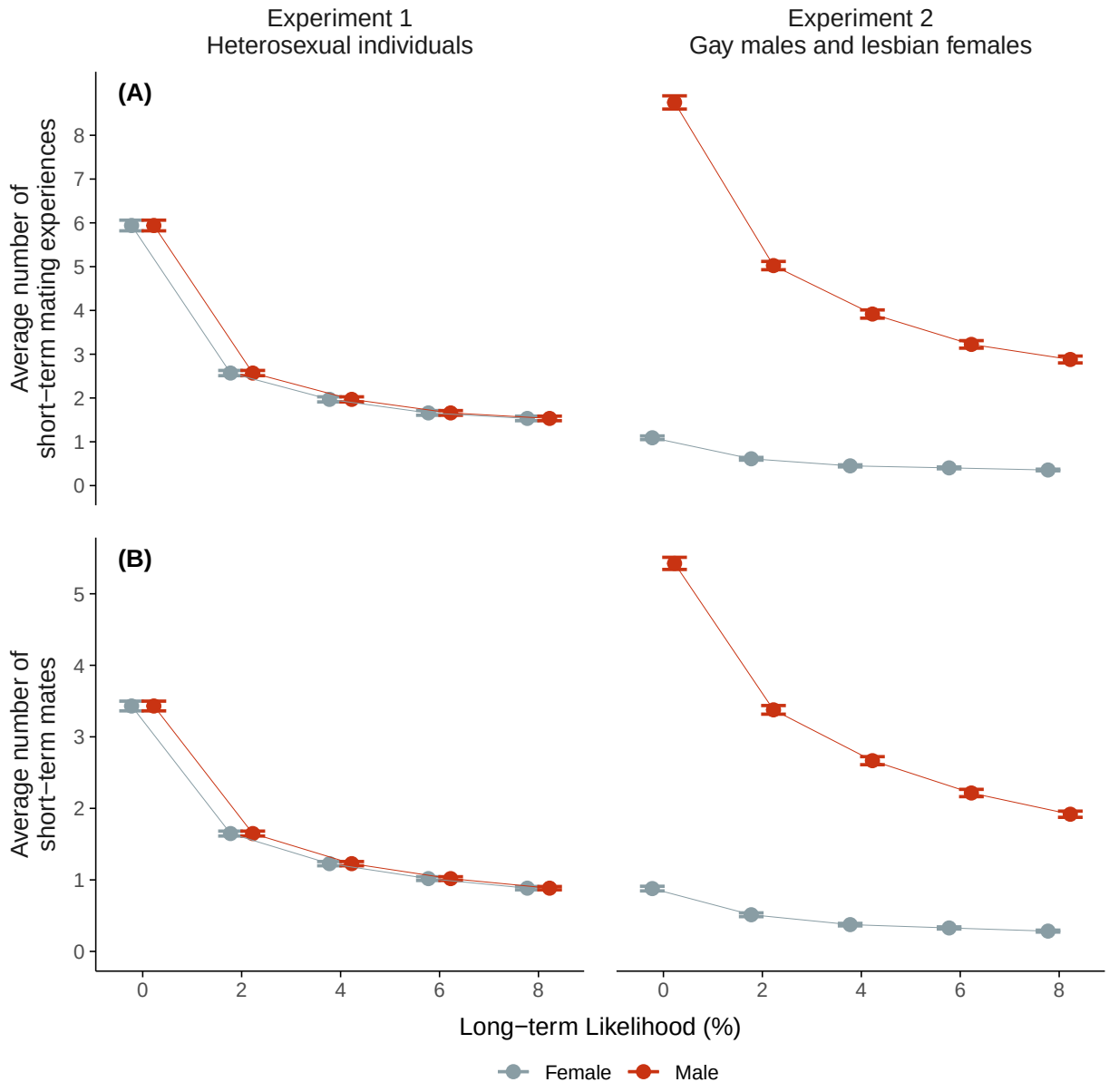
	Males		Females	
	M	*SD*	*M*	*SD*
Same likelihood*Same standard	0.22	0.04	0.23	0.04
Same likelihood*Different standard	0.32	0.04	0.41	0.05
Different likelihood*Same standard	0.28	0.04	0.28	0.04
Different likelihood*Different standard	0.38	0.04	0.51	0.05

Note. N = 2,500 in each condition.

C. Sensitivity Analyses

This section presents the results from sensitivity analyses to complement the main results presented in the paper. We set the parameter long-term-likelihood to 0, 2, 4, 6, 8, and repeated the same set of statistical analyses as the main study for each value. This was to show that the results were robust across different assumptions on the rate of forming long-term relationship. The simulations for sensitivity analyses adopted the same experimental designs but was run only 100 times for each set of parameter setting.

Sensitivity Analysis on Sex Differences in Short-term Mating Behaviors in the Full Population



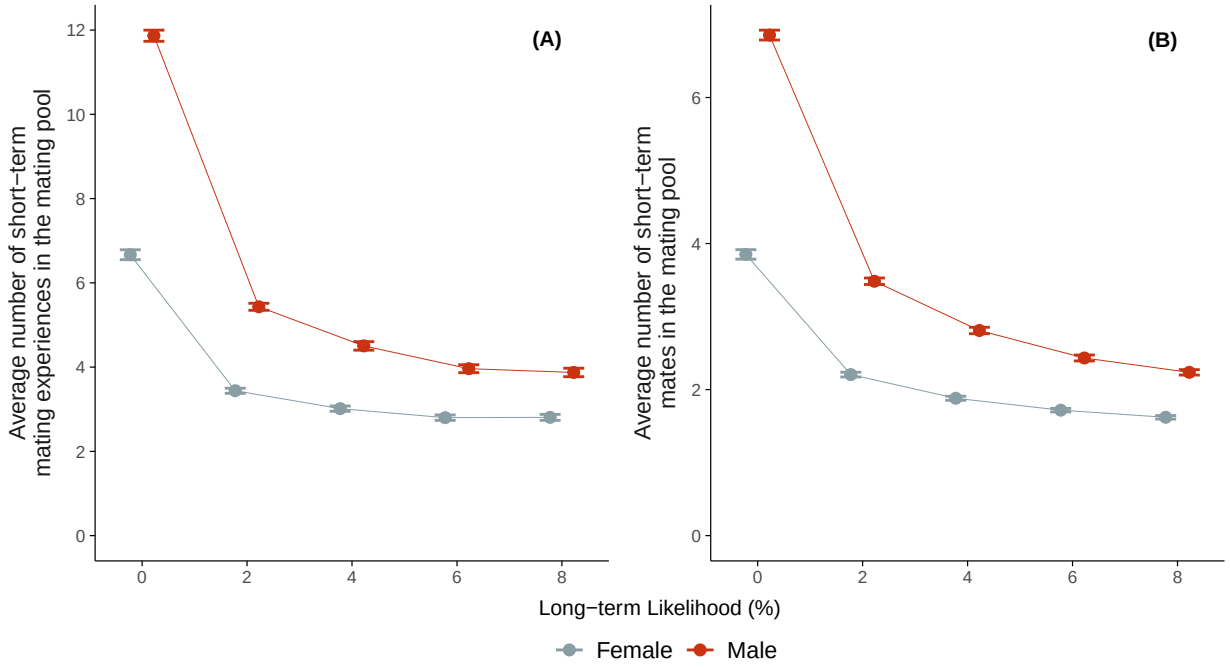
Supplemental Figure C1: Short-term mating behaviors of males and females for 0-8% long-term relationship likelihood when sex differences existed in mating preferences. Line plots summarizing the outcome variables separately for heterosexual individuals and gay males and lesbian females. Plot (A) shows the average number of short-term mating experiences, and plot (B) shows the average number of short-term mates. The points show mean values and whiskers represent standard errors, but the standard errors are small and overlap to form a single bar in some sets of parameter setting. The means were calculated using the full population of males and females in the model (N_{male} = N_{female} = 150).

Supplemental Table C1: Short-term mating behaviors of males and females for 0-8% long-term relationship likelihood when sex differences existed in mating preferences

	Average short-term mating experiences						Average short-term mates					
	Males		Females				Males		Females			
Long-term Likelihood (%)	*M*	*SD*	*M*	*SD*	Mean difference 95%CI [LL, UL]	Cohen's *d*	*M*	*SD*	*M*	*SD*	Mean difference 95%CI [LL, UL]	Cohen's *d*
Experiment 1: Heterosexual individuals												
0	5.94	0.61	5.94	0.61	[–0.17, 0.17]	0.00	3.43	0.34	3.43	0.34	[–0.10, 0.10]	0.00
2	2.57	0.30	2.57	0.30	[–0.08, 0.08]	0.00	1.65	0.17	1.65	0.17	[–0.05, 0.05]	0.00
4	1.97	0.29	1.97	0.29	[–0.08, 0.08]	0.00	1.23	0.15	1.23	0.15	[–0.04, 0.04]	0.00
6	1.66	0.27	1.66	0.27	[–0.07, 0.07]	0.00	1.02	0.13	1.02	0.13	[–0.04, 0.04]	0.00
8	1.53	0.26	1.53	0.26	[–0.07, 0.07]	0.00	0.88	0.12	0.88	0.12	[–0.03, 0.03]	0.00
Experiment 2: Gay males and lesbian females												
0	8.75	0.76	1.09	0.21	[–7.81, –7.50]	13.71	5.42	0.43	0.88	0.16	[–4.64, –4.46]	14.04
2	5.02	0.48	0.61	0.16	[–4.51, –4.31]	12.45	3.38	0.30	0.51	0.13	[–2.93, –2.80]	12.20
4	3.92	0.47	0.45	0.12	[–3.56, –3.37]	10.04	2.67	0.28	0.37	0.09	[–2.35, –2.23]	10.90
6	3.22	0.43	0.40	0.11	[–2.91, –2.73]	8.95	2.21	0.26	0.33	0.08	[–1.94, –1.83]	9.95
8	2.88	0.39	0.36	0.09	[–2.60, –2.44]	8.80	1.92	0.22	0.28	0.07	[–1.68, –1.59]	10.12

Note. M = Mean. *SD* = Standard deviation. CI = Confidence interval. LL = Lower limit. UL = Upper limit. The means were calculated using the full population of males and females in the model (N_{male} = N_{female} = 150).

Sensitivity Analysis on Heterosexual Individuals in the Mating Pool



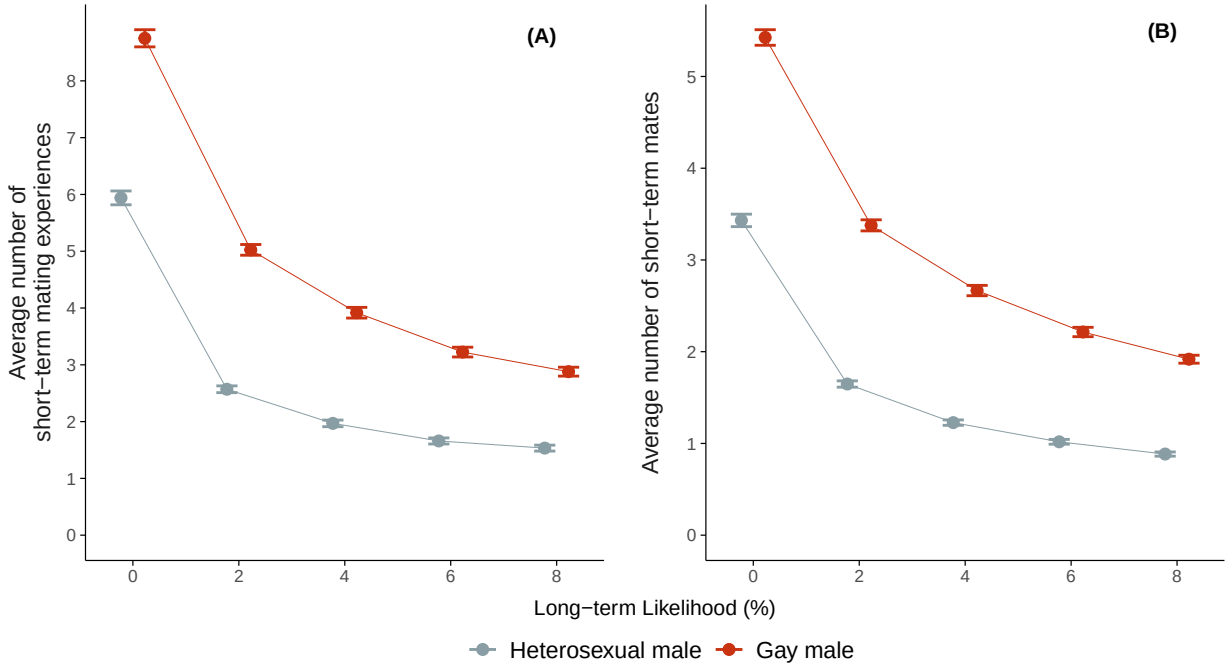
Supplemental Figure C2: Short-term mating behaviors of heterosexual males and females in the mating pool for 0-8% long-term relationship likelihood when sex differences existed in mating preferences. Line plots summarizing the outcome variables. Plot (A) shows the average number of short-term mating experiences in the mating pool, and plot (B) shows the average number of short-term mates in the mating pool. Central points show mean values and whiskers represent standard errors, but the standard errors are small and overlap to form a single bar in some sets of parameter setting. The means were calculated using the population of heterosexual males and females who successfully participated in the mating pool (See Table C2 for the mean and standard deviation of the proportion of individuals in the mating pool).

Supplemental Table C2: Proportion and short-term mating behaviors of heterosexual males and females in the mating pool for 0-8% long-term relationship likelihood when sex differences existed in mating preferences

	Mean proportion of individuals in the mating pool						Average short-term mating experiences (in-pool)						Average short-term mates (in-pool)					
	Males		Females				Males		Females				Males		Females			
Long-term Likelihood (%)	*M*	*SD*	*M*	*SD*	Mean difference 95%CI [LL, UL]	Cohen's *d*	*M*	*SD*	*M*	*SD*	Mean difference 95%CI [LL, UL]	Cohen's *d*	*M*	*SD*	*M*	*SD*	Mean difference 95%CI [LL, UL]	Cohen's *d*
0	0.50	0.04	0.89	0.03	[0.38, 0.40]	10.79	11.87	0.67	6.67	0.59	[–5.37, –5.02]	8.25	6.85	0.34	3.85	0.33	[–3.10, –2.91]	8.98
2	0.47	0.04	0.75	0.04	[0.26, 0.28]	7.19	5.43	0.42	3.44	0.31	[–2.09, –1.89]	5.42	3.48	0.22	2.21	0.16	[–1.33, –1.22]	6.52
4	0.44	0.04	0.65	0.05	[0.20, 0.23]	4.53	4.50	0.51	3.01	0.32	[–1.61, –1.37]	3.51	2.81	0.22	1.88	0.14	[–0.98, –0.88]	4.97
6	0.42	0.04	0.59	0.05	[0.16, 0.19]	3.67	3.96	0.48	2.80	0.33	[–1.28, –1.05]	2.85	2.43	0.20	1.72	0.12	[–0.76, –0.67]	4.26
8	0.40	0.04	0.54	0.05	[0.14, 0.16]	3.36	3.87	0.51	2.81	0.36	[–1.19, –0.94]	2.43	2.24	0.19	1.62	0.12	[–0.66, –0.57]	3.92

Note. M = Mean. *SD* = Standard deviation. CI = Confidence interval. LL = Lower limit. UL = Upper limit. The means were calculated with subsamples of males and females who had ever engaged in short-term mating behaviors.

Sensitivity Analysis on the Comparison Between Heterosexual and Gay Males



Supplemental Figure C3: Short-term mating behaviors of heterosexual males and gay males for 0-8% long-term relationship likelihood when sex differences existed in mating preferences. Line 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 in some sets of parameter setting. The means were calculated using the full population of heterosexual males and gay mlaes in the model (N_{hetero} = N_{gay} = 150).

Supplemental Table C3: Short-term mating behaviors of heterosexual males and gay males for 0-8% long-term relationship likelihood when sex differences existed in mating preferences

Long-term Likelihood (%)	Average short-term mating experiences						Average short-term mates					
	Heterosexual males		Gay males				Heterosexual males		Gay males			
	M	*SD*	*M*	*SD*	Mean difference 95%CI [LL, UL]	Cohen's *d*	*M*	*SD*	*M*	*SD*	Mean difference 95%CI [LL, UL]	Cohen's *d*
0	5.94	0.61	8.75	0.76	[–3.00, –2.62]	4.06	3.43	0.34	5.42	0.43	[–2.10, –1.89]	5.15
2	2.57	0.30	5.02	0.48	[–2.57, –2.34]	6.17	1.65	0.17	3.38	0.30	[–1.80, –1.66]	6.99
4	1.97	0.29	3.92	0.47	[–2.06, –1.84]	4.94	1.23	0.15	2.67	0.28	[–1.50, –1.38]	6.35
6	1.66	0.27	3.22	0.43	[–1.67, –1.46]	4.34	1.02	0.13	2.21	0.26	[–1.25, –1.14]	5.85
8	1.53	0.26	2.88	0.39	[–1.44, –1.25]	4.01	0.88	0.12	1.92	0.22	[–1.08, –0.99]	5.93

Note. M = Mean. *SD* = Standard deviation. CI = Confidence interval. LL = Lower limit. UL = Upper limit. The means were calculated using the full population of heterosexual males and gay males in the model ($N_{hetero} = N_{gay} = 150$).

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