

1 Sexual coercion in a natural mandrill population

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3 Authors

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21 **Supplementary materials**

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23 **Methods**

24 **Sexual harassment and sexual punishment**

25 To study sexual harassment and sexual punishment we used only 5 minutes-long (complete) focal
26 observations performed on adult swollen females or adult males. To test for sexual harassment,
27 we assessed whether a male directed aggression towards a swollen female during the first half of
28 the focal observation (150 seconds). If aggression occurred ('post-aggression observation'; figure
29 S2a, middle line), we assessed whether a copulation occurred between the female and the male
30 within a 150 second-time window following this aggression. We planned to use a post-conflict
31 matched-control statistical framework to test whether females were more likely to copulate with
32 a male immediately after he attacked her versus in absence of aggression from him. In short, we
33 had planned to match each post-aggression observation with matched-control observations (i.e.,
34 observations of the same individuals in which no male aggression occurred during the first half;
35 figure S2a) and compare the likelihood of copulation in those two different contexts. The time
36 span of 150 seconds was chosen as the maximum length allowing post-aggression and matched-
37 control observation to be of equal length. Similarly, to test for sexual punishment we assessed
38 whether a male copulated with a swollen female during the first half of the focal observation. If a
39 copulation occurred ('post-copulation observation'; figure S2b, middle line), we assessed whether an
40 aggression from another male towards the copulating female was observed within a 150 second-time
41 window following the copulation. We had planned to use a similar post-copulation matched-control
42 analysis to test whether females were more likely to be attacked in the post-copulation observations

43 versus in the matched-control observations without copulation. However, since we found few or
44 no instance(s) of post-conflict copulations and post-copulation aggression, we did not pursue those
45 analyses and only report raw data.

46 **Testing the “aggressive male phenotype” hypothesis**

47 We explored an alternative scenario to sexual coercion, the “aggressive male phenotype” hypothe-
48 sis, by testing whether males that are more aggressive towards any groupmate are also those that
49 copulate the most because aggression may act as a sexual trait chosen by females. We reran the
50 same GLMM as the one used for testing the occurrence of intimidation, including as an explanatory
51 variable, in addition to the aggression towards the given female, the rate of the overall aggression
52 the male directed towards all groupmates except adult females during the corresponding mating
53 season. Such overall aggression was quantified as the number of aggression events initiated by a
54 given male towards any non-adult female group member divided by the total time of observation
55 of this male during a given mating season.

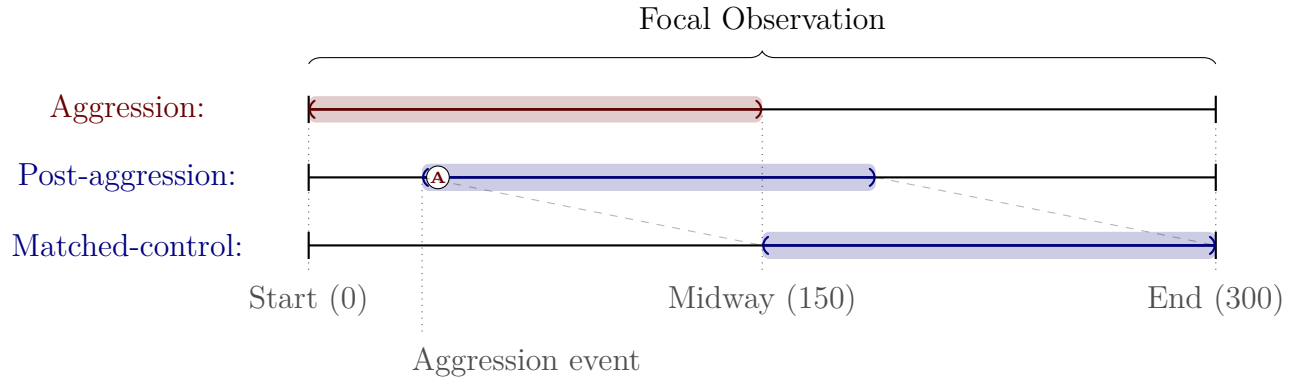
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57 The overall aggression displayed by males towards non-adult females did not influence their cop-
58 ulation success with adult females suggesting that females do not copulate more with the most
59 aggressive males of the group, but with males that have been the most aggressive to them before
60 their fertile (swollen) period. In particular, in the model including both aggression rates (overall
61 and dyadic), the aggression rate towards all groupmates except adult females was not significant
62 (Chisq=2.12, p-value=0.15) but the rate of aggression towards the dyad female was marginally
63 significant (Estimate=1.529, CI95%=[-0.039;3.097], Chisq=3.654, p-value=0.056) in comparison
64 to the model without the overall aggression rate where the dyadic aggression rate was clearly
65 significant (Table 3).



Figure S1: Analytical design for the tests of sexual intimidation. The swollen period is shown in blue, and the “aggression windows” are depicted in red. The top line represents the original test of intimidation. The bottom line represents the test with the alternative “aggression window”. On the horizontal axis, the relevant temporally consecutive events (from left to right) are depicted (the distances among them can contextually fluctuate considerably). “Onset of mating season”: onset of mating season (for residents) or arrival in the group (for non-residents), “Swelling”: onset of the swollen period of the female, “Max”: onset of the maximal swollen period of the female, “Max end”: end of the swollen period (the last day of maximal swelling) and “End”: complete deflation of the sexual swelling that started in “MaxEnd”.

a



b

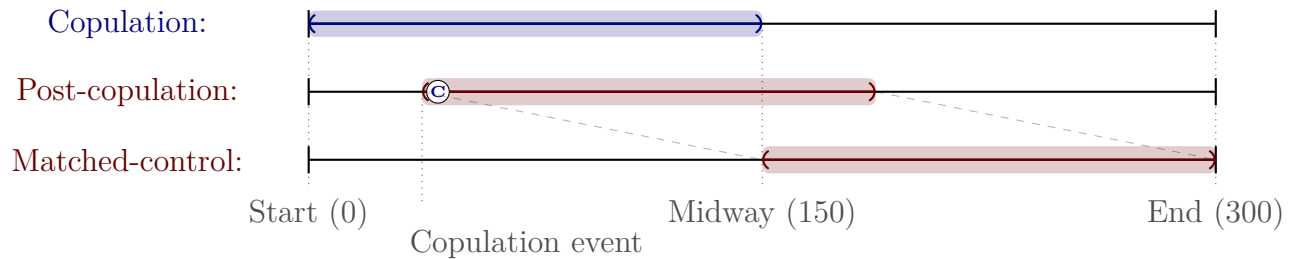


Figure S2: Analytical design for the planned test of sexual harassment and sexual punishment. (a) For each female or male focal observation, if an aggression occurred from a male towards a swollen female in the first 150 seconds (red), we assessed whether copulation of the same heterosexual dyad occurred within the 150 seconds following the aggression (post-aggression observation, blue – middle line); for the matched-control observations where no aggression occurred in this dyad in the first 150 seconds of the focal, we assessed whether a copulation was observed within the dyad during the last 150 seconds of the focal observation (blue – bottom line). (b) For each female or male focal observation, if a copulation occurred between a male and a swollen female in the first 150 seconds (blue), we examined whether aggression from another male towards the copulating female occurred within the 150 seconds following the copulation (post-copulation observation, red – middle line); for the matched-control observations where no copulation occurred in this dyad in the first 150 seconds of the focal, we assessed whether an aggression was observed during the last 150 seconds of the focal observation (red – bottom line).

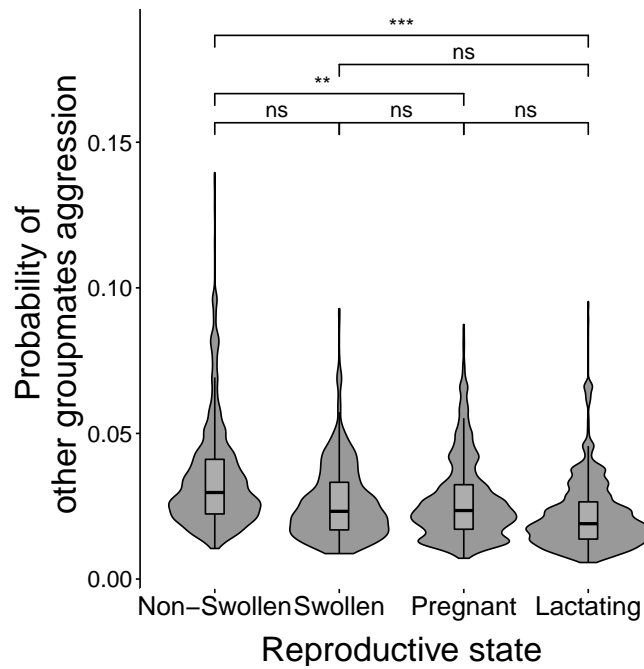


Figure S3: Predicted probability of aggression received by adult females from groupmates other than adult males in relation to female reproductive state. The fitted values of the GLMMs are shown on the Y-axis. The violin plots show the probability density. Pairwise comparisons across female reproductive states and corresponding p-values are shown. ‘ns’, not significant: $p > 0.05$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$.

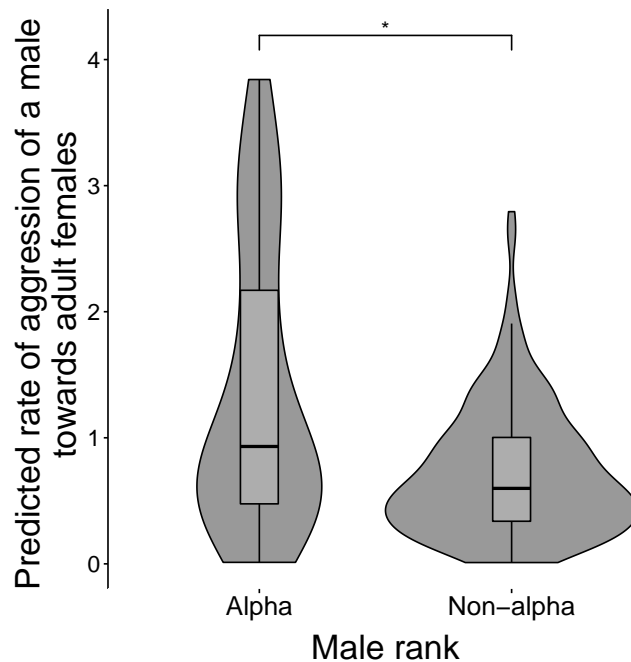


Figure S4: Predicted aggression rate of males towards adult females in relation to male rank (alpha vs non-alpha). The fitted values of the GLMM are shown on the Y-axis. The violin plots show the probability density. Pairwise comparisons across female reproductive states and corresponding p-values are shown. ‘ns’, not significant: $p > 0.05$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$.

Table S1: Summary of predictions and analyses with relevant sample size, figures and tables. All models followed a binomial distribution. S: swollen, NS: non-swollen, P: pregnant, L: lactating.

Prediction	Resp. Variable	Sample	Fixed factors	Random Factors	Tabs & Figs
Swollen females receive more male aggression (1st prediction)	Probability of receiving male aggression during a focal observation	31633 focals (2113h) on 80 females	Reproductive state (NS, S, P, L) Female rank Female parity Group sex ratio	Female identity Year of observation	Figure 1a Table 1
Swollen females do not receive more aggression from other groupmates	Probability of receiving other groupmate aggression during a focal observation	31633 focals (2113h) on 80 females	Reproductive state (NS, S, P, L) Female rank Female parity Group sex ratio	Female identity Year of observation	Figure S4 Table S2
Swollen females are at higher risk of injury (2nd prediction)	Probability of having an injury	116.291 female.days (79 females and 2712 days)	Reproductive state (NS, S, P, L) Female rank Female parity Group sex ratio	Female identity Year of observation	Figure 1b Table 2
Male aggression increases male mating success (3rd prediction) & Aggressive phenotype hypothesis	Probability of copulation during the relevant period	Harassment/ Punishment: 1023 focals (85h) on 55 swollen females & 3590 focals (299h) on 34 males Intimidation: 16212 focals (1116h) on 79 females & 5178 focals (366h) on 33 males	Male aggression (during the relevant period, towards the relevant individuals) Female rank Female parity Operational sex ratio Male rank (in interaction with aggression)	Female identity Male identity Year of observation	Figure 1c Figure S1 Figure S2 Table 3 Table S3 Table S4
Alpha males are more aggressive towards females	Aggression towards adult females	16212 focals (1116h) on 79 females & 5178 focals (366h) on 33 males	Male rank Male age Operational sex ratio	Male identity Year of observation	Figure S4 Table S4

Table S2: Aggression from other groupmates and female reproductive state. Significant p-values and confidence intervals (CI) that did not cross zero appear in bold. The significance of each variable was assessed using chi-square tests (Chisq), while the significance of each level of a categorical variable was evaluated against a reference level (noted ‘Ref’) according to whether their confidence intervals overlap or not.

Response variable: Probability of receiving aggression from other groupmates (0/1)					
Fixed Factor	Level	Estimate	CI 95%	Chisq	P-value
Reproductive State	Swollen (Ref: Non-Swollen)	-0.192	[-0.474;0.090]	21.386	<0.001
	Pregnant (Ref: Non-Swollen)	-0.241	[-0.412;-0.070]		
	Lactating (Ref: Non-Swollen)	-0.432	[-0.618;-0.246]		
	Swollen (Ref: Lactating)	0.239	[-0.056;0.534]		
	Pregnant (Ref: Lactating)	0.191	[0.003;0.379]		
	Swollen (Ref: Pregnant)	0.049	[-0.234;0.331]		
Female Rank	Medium Rank (Ref: High Rank)	0.256	[-0.090;0.602]	17.765	<0.001
	Low Rank (Ref: High Rank)	0.578	[0.308;0.847]		
Female Parity	Parous (Ref: Nulliparous)	-0.352	[-0.683;-0.021]	4.347	0.037
Group Sex Ratio		-0.024	[-0.062;0.014]	1.533	0.216
Observation time		0.028	[-0.041;0.098]	0.647	0.421

Table S3: Male aggression and mating success (intimidation; alternative “aggression window”). (a) Probability of copulation of a male-female dyad during female’s swollen period in relation to the rate of aggression received from the male during the female’s swollen period. Probability of copulation of a male-female dyad during female’s swollen period in relation to the rate of (b) severe aggression or (c) threats received from the male before the female’s swollen period. Significant p-values and confidence intervals (CI) that did not cross zero appear in bold. The significance of each variable was assessed using chi-square tests (Chisq), while the significance of each level of a categorical variable was evaluated against a reference level (noted ‘Ref’) according to whether their confidence intervals overlap or not.

Response variable: Mating during the swollen period (0/1)						
Test	Fixed Factor	Level	Estimate	CI 95%	Chisq	P-value
a. Aggression in swollen period	Aggression Rate		0.173	[-1.016;1.363]	0.082	0.775
	Male Rank	Alpha (Ref: Non-alpha)	1.261	[0.542;1.979]	11.819	0.001
	Female Rank	Low Rank (Ref: High Rank)	0.617	[-0.233;1.467]	2.030	0.362
		Medium Rank (Ref: High Rank)	0.288	[-0.985;1.560]		
	Female Parity	Parous (Ref: Nulliparous)	0.304	[-1.675;2.282]	0.090	0.764
	Operational Sex Ratio		0.112	[-0.373;0.597]	0.205	0.65
	Observation Time		0.461	[0.160;0.761]	9.030	0.003
b. Severe aggression only	Aggression Rate		6.307	[0.927;11.686]	5.280	0.022
	Male Rank	Alpha (Ref: Non-alpha)	1.291	[0.531;2.050]	11.086	0.001
	Female Rank	Low Rank (Ref: High Rank)	0.737	[-0.153;1.627]	2.879	0.237
		Medium Rank (Ref: High Rank)	0.724	[-0.639;2.087]		
	Female Parity	Parous (Ref: Nulliparous)	-0.456	[-2.843;1.931]	0.140	0.708
	Operational Sex Ratio		0.036	[-0.494;0.565]	0.017	0.895
	Observation Time		0.537	[0.211;0.863]	10.446	0.001
c. Threats only	Aggression Rate		2.111	[-0.465;4.688]	2.580	0.108
	Male Rank	Alpha (Ref: Non-alpha)	1.247	[0.511;1.983]	11.026	0.001
	Female Rank	Low Rank (Ref: High Rank)	0.682	[-0.182;1.545]	2.609	0.271
		Medium Rank (Ref: High Rank)	0.673	[-0.672;2.019]		
	Female Parity	Parous (Ref: Nulliparous)	-0.510	[-2.854;1.834]	0.182	0.67
	Operational Sex Ratio		0.005	[-0.509;0.519]	0.000	0.985
	Observation Time		0.544	[0.220;0.868]	10.817	0.001