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1 Transition to siblinghood in a wild chacma baboon population

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20 HIGHLIGHTS

- 21 • We examine the transition to siblinghood in wild chacma baboons
- 22 • Maternal behaviour does not change following the birth of a younger sibling
- 23 • But juveniles solicit their mother more often, and show more signs of anxiety
- 24 • These results suggest that weaned siblings may compete for maternal attention

25 ABSTRACT

26 In monotocous mammals (i.e. where females produce one offspring at a time), most juveniles
27 will experience the birth of a younger sibling in their life. Transition to siblinghood (TTS) has
28 rarely been studied in primates, although it reflects the last step in the shift of maternal
29 investment from one offspring to the next and could thus represent a critical moment for
30 mother-offspring conflict and sibling competition. Here, we use behavioural data on juvenile
31 primates who recently experienced, or not, the birth of a younger sibling to investigate
32 changes in mother-juvenile relationships during TTS in a wild population of chacma baboons
33 (*Papio ursinus*). We show that (1) mother-juvenile spatial association remained stable; (2)
34 mothers did not decrease their probability to initiate proximity or affiliation with their
35 juvenile; and (3) juveniles initiated proximity and affiliation more frequently toward their
36 mothers, and showed more signs of anxiety after the birth of their younger sibling. Taken
37 together, these findings suggest that juveniles with a younger sibling solicit their mother more
38 often and seek more maternal attention than juveniles without. Overall, mother-offspring
39 conflict could extend in the post-weaning period, during which more subtle maternal
40 resources, such as maternal attention, could be at stake in sibling competitive relationships.

41 KEYWORDS

42 Maternal behaviour; mother-offspring bonds; mother-offspring conflicts; sibling birth; sibling
43 rivalry; sibship

44 INTRODUCTION

45 Parental investment is defined as any type of investment a parent can provide to its offspring
46 that will enhance the offspring's fitness at the cost of the parent's future reproduction (Trivers,
47 1972). In a seminal paper, Trivers argued that natural selection should favour, in offspring, the
48 expression of traits favouring the monopolisation of parental resources, above the level that
49 parents may be willing to provide (Trivers, 1974). This difference in the optimal amount of
50 parental investment is triggered by an asymmetry in genetic relatedness between the
51 different family members: an offspring is twice as related to himself as it is to its siblings, while
52 a parent is equally related to all offspring. This genetic conflict of interest is predicted to trigger
53 conflicts over the amount and duration of parental investment, not only between parents and
54 offspring, but also between siblings, who should all try to maximize their share of parental
55 investment until the costs for their siblings decrease their own inclusive fitness.

56 Sibling competition has found empirical support in a wide range of taxa from insects
57 to mammals (see for reviews: Mock et Parker 1998; Drummond 2006) where it can largely
58 impact offspring's development, with long-term consequences in three areas: morphology
59 (e.g. insects: Schrader et al., 2018; birds: de Kogel and Prijs, 1996; mammals: Fisher et al.,
60 2018; Hofer and East, 2008), physiology (e.g. birds: Drummond and Rodríguez, 2013; Nettle et
61 al., 2015; Verhulst et al., 2006; mammals: Fey and Trillmich, 2008; Guenther and Trillmich,
62 2015; Stauffer et al., 2018) and behaviour (e.g. birds: Bebbington et al., 2017; Ekman et al.,
63 2002; mammals: Guenther and Trillmich, 2015; Hudson et al., 2011) and even lead to siblicide
64 (e.g. birds: Braun and Hunt, 1983; Fujioka, 1985; Loughheed and Anderson, 1999; mammals:

65 Andersen et al., 2011; Hofer and East, 2008). However, our understanding of family
66 competition suffers from a taxonomic bias: most studies have focused on brood or litter-
67 rearing species (especially in mammals, see for reviews: Drummond 2006, Hudson et Trillmich
68 2008, Roulin et Dreiss 2012). Most of the theoretical models and evolutionary hypotheses
69 have thus been developed for same-age siblings and within-brood competition (Hudson &
70 Trillmich, 2008), leaving the competition between siblings of different ages virtually
71 unstudied.

72 In long-lived species, such as monotocous mammals, which generally produce and
73 nurse one offspring at a time (Altmann 1980, Clutton-Brock et al., 1983), siblings could
74 compete for different resources than milk (Hudson & Trillmich, 2008), meaning that sibling
75 competition can last beyond weaning age. In those species, offspring may form long and
76 enduring bonds with mother that can extend far beyond independency (e.g. yellow baboons,
77 *Papio cynocephalus*: Silk et al., 2006b, 2006a; Asian elephants, *Elephas maximus*: Lynch et al.,
78 2019; red deer, *Cervus elaphus*: Clutton-Brock et al., 1982), and exhibit a period of post-
79 weaning juvenility, during which they keep benefiting from maternal care such as social
80 support, facilitated access to food, or protection against predators (Clutton-Brock, 1991).
81 Maternal presence during the post-weaning developmental period improves offspring growth
82 (e.g. chimpanzees, *Pan troglodytes*: Samuni et al. 2020), and increases future reproductive
83 success and longevity (chimpanzees: Crockford et al., 2020, Stanton et al. 2020; bonobos, *Pan*
84 *paniscus*: Surbeck et al., 2011; red deer: Andres et al., 2013), potentially through a prolonged
85 access to such forms of maternal care. Monopolising such resources might be advantageous
86 for offspring, and could thus induce competition between siblings.

87 In line with this, several empirical studies show that sibling competition can have
88 substantial fitness consequences in monotocous species. In Galapagos fur seals
89 (*Arctocephalus galapagoensis*) and sea lions (*Zalophus wollebaeki*), calves whose mother is
90 still nursing the older sibling experience a reduced growth and increased mortality risk
91 (Trillmich & Wolf, 2008). In rhesus macaques (*Macaca mulatta*), short interbirth intervals
92 reduce the survival to adulthood for the older offspring and the survival to weaning for the
93 younger one (Lee et al., 2019). In female yellow baboons, having a close-in-age younger sibling
94 nearly doubles the mortality risk during adulthood (Tung et al., 2016). Moreover, this effect
95 has intergenerational consequences because adult females whose mother had a close-in-age
96 younger sibling further experienced higher offspring mortality (Zipple et al., 2019). In humans
97 (*Homo sapiens*) as well, short interbirth intervals increase offspring mortality risk (Conde-
98 Agudelo et al., 2006; Rutstein, 2005; Wendt et al., 2012). Overall, these studies show that the
99 dilution of maternal care between different-age offspring has fitness costs, setting the
100 conditions under which sibling competition over access to maternal resources should evolve.

101 Regarding the behavioural mechanisms at play, while many primate studies have
102 focused on mother-offspring conflicts during the weaning period or around a mother's cycle
103 resumption (Barrett and Henzi, 2000; Bateson, 1994; reviewed in Maestriperi, 2002), the birth
104 of a younger sibling has been somewhat overlooked. This is striking as the arrival of a younger
105 sibling is the last step in the mother's shift from her current offspring to the next one, and
106 could thus represent a critical moment for both mother-offspring conflict and sibling
107 competition. A few studies led on captive or free-ranging cercopithecines showed that the
108 birth of a younger sibling induces an abrupt decrease in time spent in contact or in proximity
109 to the mother and in the rate of mother-offspring interactions, primarily driven by the juvenile
110 itself (Devinney et al., 2001; DiGregorio et al., 1987; Holman & Goy, 1988; Schino & Troisi,

111 2001). Maternal rejection and aggression also increased, often associated with signs of stress
112 and “depression” in the offspring (Bolwig, 1980; Deviney et al., 2001; DiGregorio et al., 1987;
113 Holman & Goy, 1988). In bonobos, juveniles face an increase in cortisol and a decrease in
114 neopterin levels that can last more than six months after the birth of their younger sibling
115 (Behringer et al., 2022). The behavioural transition to siblinghood has been more thoroughly
116 studied in humans: it is often characterized by a decrease in maternal care and in the rate of
117 mother-offspring interactions, an increase in the rate of confrontational behaviour with the
118 mother and a reversal in who initiates most interactions, with children (instead of mothers)
119 becoming the primary initiators (Dunn et al., 1981; Dunn & Kendrick, 1980; Stewart et al.,
120 1987; Volling, 2012). Children can also show signs of distress, and exhibit more demanding
121 behaviours (Dunn et al., 1981; Volling, 2012). Finally, a striking aspect emerging from the
122 human literature is the high inter-individual variability in children’s behavioural adjustment to
123 the birth of a sibling (Dunn et al., 1981; Volling, 2012, 2017). Poor behavioural adjustment
124 (e.g. higher frequency of tantrums and jealousy events toward the younger sibling) is
125 associated, possibly causally, with lower quality relationships between siblings later in life
126 (Brody, 1998; Pike et al., 2005), which could potentially be costly as siblings’ relationships and
127 support during adulthood can promote fitness (Pollet & Hoben, 2011).

128 In this study, we investigated changes in mother-juvenile relationships following the
129 birth of a younger sibling in a wild chacma baboon population (*Papio ursinus*). Baboons
130 typically live in matrilineal, multimale-multifemale societies, where females are philopatric
131 and males disperse from their natal group around the age of 7-8 years (Cheney et al., 2004).
132 Females maintain hierarchical and differentiated social bonds and give birth to one offspring
133 every two years on average (Cheney et al., 2004; Dezeure, Baniel, et al., 2021), an interbirth
134 interval somewhat closer to human traditional societies than to great apes (Kramer, 2005).

135 Offspring have a long developmental period and weaning occurs gradually during the second
136 year of life (Carboni et al., 2022; Dezeure, Baniel, et al., 2021), which is characterized by
137 elevated infant mortality (Altmann & Alberts, 2003a). Unweaned infants are sometimes
138 targets of infanticide in this species, with minimal risks to weaned, older offspring (Palombit
139 et al., 2000). In baboons, like in most primates, mothers form long-lasting bonds with their
140 offspring, which facilitate the transition to feeding autonomy (e.g. Lynch et al., 2020) and
141 subsequently translate into preferential grooming relationships and occasional support during
142 conflicts as long as offspring remain in their natal group. All these resources likely increase
143 offspring survival, as observed in chimpanzees (Nakamura et al., 2014; Stanton et al., 2020),
144 and may generate competition among siblings. Specifically, maternal support often allows
145 younger sisters to outrank their older sisters, which suggests that, for a female, having a
146 younger sister could induce lifetime costs through the loss of maternally-transmitted social
147 capital (Pereira, 1989).

148 In three social groups of chacma baboons from Namibia, we investigated immediate
149 changes in the mother-juvenile relationship during the transition to siblinghood (hereafter,
150 TTS), by comparing mother-juvenile interactions among juveniles with no younger sibling and
151 those of comparable ages who recently experienced the birth of a younger sibling. First, we
152 predicted (P1.1) that the amount and quality of affiliative relationships, specifically grooming
153 interactions, between the mother and the juvenile would decrease after the birth of a new
154 infant, with (P1.2) a shift in patterns of initiations of such interactions, from mostly mother-
155 initiated before the birth of the sibling, to mostly juvenile-initiated interactions afterwards, as
156 found in humans. Second, we predicted that juveniles (P2.1) would associate less often with
157 their mother, and (P2.2) would become primarily responsible for initiating and maintaining
158 spatial proximity to their mother after the birth of a younger sibling. Third, we predicted (P3)

159 that juveniles that had recently experienced the birth of a younger sibling would exhibit more
160 self-directed behaviours, generally indicating anxiety (Castles et al., 1999; Maestriperi et al.,
161 1992; Palagi & Norscia, 2011).

162 METHODS

163 Study site and population

164 We studied wild chacma baboons living in Tsaobis Nature Park, on the edge of the Namib
165 Desert (22°23' S, 15°44' E), Namibia. We collected data on three well-habituated troops (J, L
166 and M, the latter a fission group from J since 2016) over three observational periods: July-
167 August 2017, September-December 2018, and April-July 2019. The groups were followed
168 every day from dawn to dusk by observers on foot, collecting demographic, life history and
169 behavioural data. All individuals, including infants, are individually recognizable (Huchard et
170 al., 2013).

171 Individual data

172 Individual birth dates were assessed with certainty when field observers were present during
173 the birth ($N = 10$ offspring), or were estimated using two different methods, depending on the
174 available information: (i) infant's coloration using a standardized, validated protocol, when
175 the infant was not fully grey when first observed ($N = 16$, median date uncertainty = 41 days,
176 see (Dezeure, Dagorrette, et al., 2021)), (ii) mother's reproductive states in the previous
177 months otherwise ($N = 32$, median date uncertainty = 18 days). Overall, age uncertainty in our
178 sample ranged from 0 to 130 days (median = 10 days).

179 Female parity was known from life-history records and was defined as primiparous
180 (between the birth of the first-born offspring and the second one), or multiparous (after the

181 birth of the second offspring). Female dominance ranks were calculated separately for each
182 group and each year, using *ad libitum* data and focal observations of agonistic and approach-
183 avoidance interactions: supplants, displacements, attacks, chases and threats (Huchard et al.,
184 2010). We computed a linear hierarchy using Matman 1.1.4 (Noldus Information Technology,
185 2013), and transformed it into a proportional hierarchy with relative ranks (i.e. absolute rank
186 divided by number of adult females in a group), assigning each female one relative rank per
187 year, ranging from 0 (low-ranking) to 1 (high-ranking). We used proportional ranks rather than
188 simple ordinal ranks because they allow to control for group size across different social groups
189 and/or observational periods. Proportional ranks have recently been shown to better predict
190 some female traits associated with reproductive pace (Levy et al., 2020), and could thus better
191 predict patterns of maternal care during the post-weaning period.

192 Behavioural observations and sample selection

193 We collected 1401 hours of focal observations from 71 offspring born to 37 females (mean \pm
194 SD = 19.7 ± 9.9 h of observation per individual, range 1.3-38.6 h) using 20-min long focal
195 observations ($N = 57.6 \pm 27.9$ focal observations per individual, $N = 4086$ in total). Focal
196 individuals were aged from 1 to 34 months old (mean \pm SD = 16.1 ± 8.7 months old). Focal
197 observations were spread equally across the day (split evenly into four 3h time blocks), and
198 focal individuals were chosen randomly and sampled no more than once per half-day. We
199 recorded the duration and direction of grooming interactions with the mother and the
200 occurrence of self-scratches, a self-directed behaviour generally indicating anxiety.
201 Maintenance of spatial proximity was assessed by recording every close approach or leave (to
202 and from 1m) between the focal individual and its mother. In addition, we collected scans
203 during focal observations every five minutes (i.e., up to 5 scans for each 20-min focal

204 observation, resulting in 20182 scans in total across 4086 focal observations), and recorded
205 whether the mother was in sight, and if yes, her distance to the focal. If the mother was out
206 of sight, observers indicated the number of meters around the focal individual for which they
207 could guarantee that the mother was not in sight (range: 1-100 m). Other cases where visibility
208 was too obstructed (e.g. when focal was in sight but in a dense bush) were recorded as missing
209 data.

210 In this study, we aimed to characterize the immediate behavioural response to the
211 birth of a younger sibling. To do so, we used a cross-sectional approach, comparing juveniles
212 who recently experienced, within the last three months, the birth of a younger sibling to
213 juveniles of similar ages who did not yet. Juveniles who had experienced the birth of a sibling
214 in the more distant past were excluded from this study. This 3-months window was chosen to
215 maximize our chances to detect changes in behaviour that immediately follow the birth of an
216 infant, i.e. reasonably close to the birth event while still ensuring a decent sample size of
217 observations. In our sample of focal observations, juveniles who had recently experienced the
218 birth of a younger sibling were 17- to 29-month-old. Therefore, we restricted our dataset to
219 any juvenile in this age range (17-29 months), who either had no younger sibling ($N = 28$), or
220 a younger sibling born within the last three months ($N = 18$). Individuals who were followed
221 both before and after the birth of their younger sibling were included in each group
222 respectively. We collected a total of 1525 focal observations and 7581 scan observations on
223 38 individuals (8 individuals were observed both with and without a younger sibling).

224 Statistical models

225 Mother-juvenile grooming relationships

226 To test predictions P1.1 and P1.2, we used focal data during which we recorded the duration
227 and direction of each grooming event. First, for each observation, we recorded whether the
228 focal juvenile groomed its mother at least once (binary: yes/no – model 1), and whether it
229 received grooming from its mother (binary: yes/no – model 2). The probability to give or to
230 receive grooming from the mother during a focal observation (models 1 and 2, respectively)
231 was modelled with two generalised linear mixed models (GLMMs) with a binomial error
232 structure. Second, we extracted the total duration (in seconds) the juvenile spent grooming
233 its mother (model 3), or being groomed by its mother (model 4) during a focal observation.
234 We ran two GLMMs with a negative binomial distribution and a log-link function.

235 Mother-juvenile spatial proximity

236 To test prediction P2.1, we used scan data to estimate how often a juvenile was found in close
237 proximity to the mother. For each scan observation (recorded every 5 minutes), we recorded
238 whether the juvenile focal was in proximity (1) or not (0) to its mother. We considered two
239 distinct ranges of proximity: within 1m (model 5) and 5m (model 6) of the mother. We ran two
240 GLMMs with a binomial error structure.

241 Second, to test prediction P2.2 and characterize juveniles' responsibility in the
242 maintenance of spatial association with their mother, we used focal observation data. For
243 each focal observation, we established whether the juvenile initiated an approach to, or a
244 leave from its mother within a circle of 1m-radius (1) or not (0) (models 7 and 8, respectively).
245 We then determined whether the juvenile received an approach or a leave from its mother
246 (1) or not (0) (models 9 and 10, respectively). We ran four GLMMs with a binomial error
247 structure. In addition, we computed 'Hinde's Index' for each mother-juvenile dyad, calculated
248 as the percentage of approaches minus the percentage of leaves initiated by the juvenile

249 (Hinde & Atkinson, 1970). This index ranges from -100 (the mother is fully responsible for
250 maintaining proximity) to +100 (the juvenile is fully responsible for maintaining proximity). We
251 calculated one index per dyad for each observational period (i.e. field season) and for each
252 'sibling status' (i.e., experienced TTS or not). When the focal juvenile experienced TTS during
253 the period, we computed the Hinde's index before and after the birth event. We then tested
254 if the average Hinde's Index for a given sibling status differed from zero using a one-sample
255 Student's t-test ($N = 13$ indices on juveniles with a younger sibling, $N = 22$ on juveniles without
256 a younger sibling). We also tested whether the average Hinde's Index differed between
257 juveniles with or without sibling using a linear model ($N = 34$ indices across both groups). For
258 each test, if a dyad had several indices (because it was observed during two different
259 observational periods or because a sibling was born during a given period – $N = 28$ individuals
260 with 1 index, $N = 9$ with 2 indices and $N = 1$ with 3 indices), we randomly selected one of them
261 to avoid pseudoreplication.

262 Juvenile self-directed behaviour

263 To monitor the anxiety level of juveniles, we calculated the number of self-scratches per focal
264 observation and ran a GLMM with a negative binomial distribution and a log-link function
265 (model 11).

266 Fixed and random effects

267 For each GLMM, we tested the effect of having recently experienced the birth of a younger
268 sibling (yes/no), as well as the following control variables: focal juvenile sex, age (in months),
269 birth rank (first-born vs later-born), and maternal rank. We also tested the interaction terms
270 between the recent birth of a younger sibling and the focal juvenile age and sex (except for
271 model 3 because of a limited and unbalanced sample size). We further included three

272 additional fixed effects as controls: (1) group identity, to account for potential differences
273 between groups; (2) in binomial models, duration of the focal observation (in seconds) (except
274 models 5-6 using scan data) or, in negative binomial models, the log-transformed duration of
275 focal observation as an offset; and (3) in model 11, year of observation because preliminary
276 analyses showed that this variable had a strong effect only on self-scratch frequency.

277 We included the focal juvenile identity as a random effect in all models to control for
278 repeated focal observations within juveniles. In models 5 and 6, we initially fitted the focal
279 observation identity as a random effect to account for the non-independence of multiple scan
280 observations within a same focal observation. However, adding this random effect caused
281 convergence problems. We therefore restricted our dataset to two scans per focal
282 observation, which were separated by >15 minutes and for which the mother-focal juvenile
283 distance was documented (“out of sight” or “in sight” with the approximated distance; missing
284 data were removed). We therefore assumed that such scans were independent from each
285 other and omitted the “focal observation” random effect from our models to facilitate model
286 convergence.

287 In the linear model analysing Hinde’s Index, because of limited sample size ($N = 34$), we
288 only included the three following explanatory variables to avoid over-parametrisation:
289 presence of a younger sibling, focal juvenile’s sex and age (average age in months across the
290 observational period).

291 The structure of each model, the different fixed and random effects, and sample sizes are
292 summarised in Table A1.

293 Note that several other variables could account for some variability in mother-juvenile
294 relationships throughout the TTS, such as the mother’s reproductive stage or the presence or

295 number of older siblings. In the first case, pregnant mothers may reduce their level of care but
296 it was impossible to test with this cross-sectional design because mother's reproductive stage
297 was correlated with the presence of a younger sibling (i.e. mothers of juveniles with a younger
298 sibling are all lactating, while mothers of those without are either cycling or pregnant). In the
299 latter case, older non-adult siblings may represent potential compensatory social partners, or
300 may alternatively contribute to dilute the level of maternal care received by each sibling.
301 Therefore, we re-ran all models with the number of older immature siblings as an additional
302 fixed factor, setting the maximum age threshold at 4 years old for older siblings, as some
303 females can reach menarche at this age in our population, and results are presented in the
304 Supplementary Materials (Tables A2 to A7). This additional control variable was never found
305 to exert a significant effect on our response variables, and did not improve our model fits, so
306 we present the results without it in the main text.

307 Statistical analysis

308 All statistical analyses were conducted using the R Studio software (version 4.0.2). We ran
309 mixed models using the function "glmer" from the lme4 package (Bates et al., 2015) for
310 binomial models and "glmmTMB" from the glmmTMB package (Brooks et al., 2017) for
311 Poisson and negative binomial models. To control for the focal juvenile's age in all analyses,
312 we started by investigating the developmental pattern of each response variable, i.e. the
313 shape of its relationship with age. To do so, we ran generalized additive mixed models
314 (GAMMs), using the "gam" function of the mgvc package (Wood, 2003), and fitted univariate
315 models using a smoothing function, a linear function, and a second- or third-degree
316 polynomial function to model the effect of age (offsets and random effects were also
317 included). We then compared model fits and selected the models with the lowest AIC (Zuur et

318 al., 2009). Linear, first-order functions of age produced the best fit to all types of data
319 analysed, so we subsequently used linear regression between the response variable and age.
320 When we obtained singular fits, we confirmed the results by running a Bayesian approach,
321 using the “bglmer” function from the blme package (Dorie et al., 2021). When a Poisson model
322 was overdispersed, we compared its fit with a type-I negative binomial model and a type-II
323 negative binomial model and selected the model with the lowest AIC (Zuur et al., 2009).
324 Following this test, models 3 and 4 were run with a type-I negative binomial distribution and
325 model 11 was run with a type-II negative binomial distribution. All quantitative variables were
326 z-transformed (mean = 0; SD = 1) using the “scale” function from the car package (Fox &
327 Weisberg, 2019) in order to facilitate model convergence, as well as to compare effect sizes
328 across estimates (Harrison et al., 2018). To diagnose the presence of multicollinearities, we
329 calculated the variance inflation factor (VIF) for each predictor in each model using the “vif”
330 function from the car package (Fox & Weisberg, 2019). VIFs were inferior to 2 in all cases,
331 suggesting that multicollinearities did not impact coefficients’ estimation in our models. To
332 test the significance of fixed factors for each model, we used the likelihood ratio test (LRT) and
333 associated p-values computed by the “drop1” function, and calculated the 95% Wald
334 confidence intervals. Non-significant interactions were removed from the full model to limit
335 the risk of over-parametrisation and facilitate the interpretation of simple effects. Finally, we
336 assessed the significance of our full model by comparing its fit to the equivalent null model
337 (intercept only model, including the random effects) using a likelihood-ratio test. We further
338 checked the distribution of the residuals using “simulateResiduals” from the DHARMA package
339 (Hartig & Lohse, 2021).

340 Ethical Note

341 This study was strictly observational and relied on behavioural data collected noninvasively
342 on animals well habituated to human observers. Our research procedures were evaluated and
343 approved by the Ethics Committee of the Zoological Society of London and adhered to the
344 ASAB/ABS Guidelines for the Treatment of Animals in Behavioural Research and Teaching. This
345 research was carried out with the permission of the Namibian Ministry of Environment and
346 Tourism (MET), the Ministry of Land Reform, and the National Commission on Research,
347 Science and Technology. Our research was conducted under MET permit numbers 2303/2017,
348 RPIV00392018/2019.

349 RESULTS

350 Mother-juvenile grooming relationships

351 We first investigated whether a juvenile's grooming relationship with the mother was affected
352 by the birth of a younger sibling (P1.1 and P1.2). Both the probability and the duration of
353 grooming received from the mother were independent from the birth of a younger sibling
354 (probability: Odds Ratio – OR – = 0.89, duration: mean \pm SD = 36.5 \pm 13.8 seconds per
355 observation; Tables 1 and 2, Fig. 1b, 1d). In contrast, juveniles with a younger sibling had a
356 significantly higher probability (OR = 1.71; mean probability \pm SD with a sibling: 0.10 \pm 0.07 vs
357 without a sibling: 0.05 \pm 0.04), and spent significantly more time grooming their mother (20.9
358 \pm 17.3 seconds per focal observation for juveniles with a sibling vs. 9.1 \pm 7.2 for those without;
359 Tables 1 and 2, Fig. 1a, 1c). Juvenile males had a significantly lower probability, and spent less
360 time grooming their mother than juvenile females (OR = 0.22, Tables 1 and 2). In contrast, the
361 probability and duration of grooming received from the mother was independent of juveniles'
362 sex (Tables 1 and 2). The probability to groom the mother and its duration both significantly
363 increased with age (an increase in one standard deviation in age increased grooming likelihood

364 by 49%, OR = 1.49, Tables 1 and 2), while the probability to receive a grooming from the
365 mother and its duration tended to decrease with juvenile age (OR = 0.84, Tables 1 and 2).

366 Mother-juvenile spatial proximity

367 Mother-juvenile proximity was not influenced by the birth of a younger sibling (P2.1): juveniles
368 with or without a younger sibling had the same probability to be within 1m or 5m of their
369 mother during a scan observation (OR = 0.92 and 1.12 respectively, Table 3). Males were
370 significantly less likely to be within 1m or 5m of their mother than females (OR = 0.53 and 0.72
371 respectively, Table 3). Juveniles born to higher-ranking females were significantly more likely
372 to be within 5m of their mother (OR = 1.21, Table 3). Overall, juveniles were significantly less
373 likely to be within 1m or 5m of their mother as they grew older (OR = 0.81 and 0.80
374 respectively, Table 3).

375 Juveniles who had recently experienced the birth of a younger sibling were, however,
376 significantly more likely to approach (OR = 1.74, mean probability \pm SD = 0.24 ± 0.06 for
377 juveniles with a sibling vs. 0.18 ± 0.05 for juveniles without) and leave (OR = 1.71, 0.20 ± 0.05
378 for juveniles with a sibling vs. 0.14 ± 0.05 for juveniles without) their mother than juveniles
379 who did not yet have a younger sibling (P2.2, Table 4, Fig 2a, 2b). Males were significantly less
380 likely to leave their mother than females (OR = 0.66), while juveniles born to high-ranking
381 females were significantly more likely to approach and leave their mother (OR = 1.19 and 1.21
382 respectively, Table 4). Overall, the probability to approach and to leave the mother decreased
383 with age (OR = 0.81 and 0.83, Table 4).

384 The probability of receiving an approach from the mother (P2.2) was also influenced
385 by the interaction between the sex of the focal juvenile and the birth of a younger sibling:
386 juvenile females with a younger sibling were less likely to be approached by their mother

387 (mean probability \pm SD = 0.05 ± 0.02) than those without a sibling (0.08 ± 0.04), while males
388 with a younger sibling were more likely to be approached by their mother (0.08 ± 0.02) than
389 those without a sibling (0.05 ± 0.04 , Table 5, Fig. 2c). Juveniles born to high-ranking females
390 were also significantly more likely to be approached by their mother than those born to low-
391 ranking females (OR = 1.74, Table 5). The probability to be left by the mother was not
392 influenced by the birth of a younger sibling, and our model did not differ from the null model
393 ($Chi^2 = 13.90$, $P = 0.084$, Table 5, Fig. 2d).

394 Finally, average Hinde's indices were positively and significantly different from zero
395 both for juveniles with a younger sibling (one-sample t-test, $N = 13$, $t = 6.2$, $P < 0.001$) and
396 without (one-sample t-test, $N = 22$, $t = 3.8$, $P < 0.001$), indicating that juveniles were more
397 responsible than their mother for maintaining their close spatial proximity. The average
398 Hinde's index was not different between both groups ($N = 34$, $t = 1.131$, $P = 0.267$), meaning
399 that juveniles were equally primarily responsible for maintaining close spatial proximity with
400 their mother whether they had a younger sibling or not (P2.2).

401 Juvenile self-directed behaviour

402 Finally, juveniles' self-scratch frequency was significantly influenced by the interaction
403 between sibship status and age (P3). Self-scratch frequency generally decreased with age but
404 less so for juveniles who had a younger sibling compared to those with no younger sibling
405 (Table 6, Fig. 3). Juveniles born to higher-ranking females tended to have a lower self-scratch
406 frequency than juveniles born to lower-ranking females (Table 6).

407 DISCUSSION

408 This study investigated changes in mother-juvenile relationships during the transition to
409 siblinghood in young chacma baboons. First, we showed that, contrary to our predictions,
410 mothers did not reduce their investment in terms of grooming and proximity following the
411 birth of a new infant, as their grooming probability and duration (P1.1), and their probability
412 to initiate and stay in close spatial proximity with their older juveniles remained stable (P2.1
413 and P2.2). Second, we showed that juveniles with a younger sibling increased their
414 responsibility in the maintenance of grooming and spatial relationships with their mother.
415 Indeed, they groomed two times more often and two times longer (P1.2), and approached
416 and left their mother a third more often (P2.2), even though they spent on average the same
417 amount of time in close spatial proximity with her than juveniles with no younger sibling.
418 Third, signs of anxiety decreased more slowly with age for juveniles with a younger sibling
419 compared to juveniles of similar age without a sibling (P3). Here, we discuss the implications
420 of our findings for the understanding of mother-offspring conflict and sibling competition in
421 primates.

422 Baboon mothers did not reduce their level of maternal investment in terms of
423 grooming and proximity following the birth of a new infant, while their older offspring initiated
424 interactions more often. These results contradict previous studies on TTS in macaques, which
425 reported an abrupt decrease in maternal grooming, time spent in close spatial proximity and
426 maternal approaches (Devinney et al., 2001; Holman and Goy, 1988; Schino and Troisi, 2001;
427 Singh and Sachdeva, 1977 but see DiGregorio et al., 1987). In these macaques, these changes
428 were also driven by the juveniles themselves, who decreased the rate at which they initiated
429 interactions with their mother (Devinney et al., 2001; Holman & Goy, 1988; Schino & Troisi,
430 2001; Singh & Sachdeva, 1977). These differences with our findings could relate to several,
431 non-mutually exclusive factors. First, the macaque studies were conducted on captive

432 populations (from free-ranging to laboratory housing). Captivity and provisioning could affect
433 mother-offspring relationships and specifically accelerate maternal reproductive pace
434 (Altmann & Alberts, 2003b). Second, and perhaps because of their different environments,
435 young macaques were on average 12 months old at the birth of their younger sibling, while
436 young chacma baboons were on average 23 months old in this study. Although this age
437 difference is partly due to species differences in reproductive pace, it may also reflect
438 differences in juveniles' independence. Indeed, juvenile macaques were still nursing in the few
439 months preceding the birth of their siblings, while our study subjects had stopped suckling
440 long before their sibling was born (Dezeure, Baniel, et al., 2021). In addition, isotopic analyses
441 showed that milk intake ceases around 12 months in our study population (Carboni et al.,
442 2022). Subsequently, weaning and the birth of a younger sibling were simultaneous and
443 impossible to disentangle in the macaque studies, while we were able to measure the effects
444 of TTS on mother-offspring relationships independently of weaning.

445 Our results recall previous findings in human studies. Indeed, in western industrialised
446 societies, children became more responsible for initiating interactions with their mother,
447 including more demanding and clinging behaviour and more signs of anxiety (Dunn et al.,
448 1981; Dunn & Kendrick, 1980; Stewart et al., 1987; Volling, 2012), following the birth of a
449 sibling. Yet, in humans – as in captive macaques – this pattern was associated with a decrease
450 in maternal care and an increase in maternal rejections. The lack of changes in maternal
451 behaviour we observe in our study may be expected in natural populations, as mothers may
452 space births in a way that allows them to provide the care needed by their offspring at
453 different stages of their lives. When a newborn arrives, older juveniles are fully weaned and
454 lactation may not substantially affect mothers' ability to maintain their relationship with their
455 juvenile offspring via proximity, grooming, co-feeding, and occasional acts of social support.

456 Thus, adjustments in maternal behaviour after the birth of new infants may be relatively small,
457 contrasting with patterns reported in (at least some) human societies, where mothers care for
458 multiple dependent offspring at the same time. Overall, studies across species and
459 populations may reveal how flexible maternal strategies are, and the associated range of
460 juveniles' behavioural reactions to TTS, widening our understanding of family ecology.

461 Although juvenile baboons with and without a younger sibling received as much care
462 from their mother, juveniles with a younger sibling approached, left and initiated grooming
463 with their mother more often than those without. These results may first reflect their
464 attraction to the newborn, which is commonly observed across primate species, where non-
465 mother individuals, mainly females, frequently touch or handle newborns (Dunayer &
466 Berman, 2018; Hrdy, 1976; Meredith, 2015). Non-mother females often access the infant by
467 initiating grooming with the mother, resulting in new mothers receiving increased levels of
468 grooming and attention (Caselli et al., 2021; Frank & Silk, 2009; Henzi & Barrett, 2002; Jiang
469 et al., 2019). However, if the increase in juveniles' initiation of interactions with their mother
470 was exclusively triggered by infant attraction, we would expect juvenile females to initiate
471 more interactions with their mother than males following the birth of a younger sibling, which
472 was not supported by our results. Moreover, when approaching their mother, juveniles
473 immediately interacted with their younger sibling in only 13% of cases, while they interacted
474 with their mother in 35% of cases (see Appendix 1). Overall, these results suggest that infant
475 handling was not the primary motivation for juveniles to approach their mother.

476 Second, such behavioural changes driven by juveniles may reflect changes in mother-
477 offspring relationship following TTS, which may contribute to accelerate a juvenile's
478 developmental trajectory. They may develop greater independence and autonomy following

479 their sibling's birth, thus increasing their own responsibility in maintaining the mother-
480 offspring spatial and grooming relationships. TTS may also translate into a rescheduling of
481 mother-juvenile interactions, where juveniles would be conditioned to request maternal care
482 only in convenient times so that it does not interfere with infant care (in a similar manner to
483 the rescheduling during the weaning period proposed by (Altmann, 1980; Bateson, 1994)).
484 Finally, juveniles may solicit their mother more frequently to seek maternal attention and
485 obtain the same 'pre-sibling arrival' level of care, if the birth of a younger sibling leads to lower
486 maternal responsiveness and greater mother-offspring conflict over maternal care. Although
487 most studies on primates have focused on mother-offspring conflicts during weaning or when
488 mothers resume cycling (Maestripieri, 2002), which often manifest through highly
489 conspicuous tantrums (Barrett & Henzi, 2000), conflicts can arise at other developmental
490 stages (Bateson, 1994) and over any type of maternal investment that can be monopolised.
491 As infants grow older and stop throwing tantrums (as was the case of our study baboons),
492 mother-offspring conflict could be expressed through more subtle behaviours, such as who
493 takes the responsibility in maintaining spatial proximity, or other signs of anxiety, such as self-
494 directed behaviours (Maestripieri, 2002).

495 This increased mother-offspring conflict likely translates into sibling rivalry, which
496 could be mediated, at a proximate level, by jealousy, and may explain the increase in juveniles'
497 initiation of association and grooming with the mother. Jealousy is a complex emotional state
498 that arises in a social triangle that consists of the jealous individual (here, the older sibling), a
499 beloved (here, the mother), and a rival (here, the younger infant), and is elicited when the
500 jealous individual perceives the relationship between their beloved and a rival as a threat to
501 their own bond with the beloved one (Volling et al., 2010, 2014). Children undergoing TTS
502 display two main types of jealous reactions when their mother interacts with their sibling:

503 negative/distress behaviours (protesting, disrupting the interactions, directing aggression at
504 the mother), and social approach behaviours (e.g. watching, maintaining proximity and
505 seeking comfort) (Volling et al., 2014). The latter category—social approach— could match
506 the behavioural patterns observed in this study. In humans, sibling jealousy is generally
507 considered as a form of competition for parental attention (Volling et al., 2010), a behaviour
508 that is generally not recognized as a form of parental care *per se* in other species but could be
509 adaptive where parental attention improves offspring survival by preventing risks such as
510 accidents or predation, or by promoting information transmission. In non-human primates,
511 maternal attention could be a form of maternal care that siblings could compete over, but this
512 would require testing whether juveniles who attract more maternal attention experience
513 fitness benefits, such as a greater probability to secure maternal support during conflicts,
514 protection against predators, etc.

515 Finally, further dimensions of TTS should be investigated to foster its description in
516 monotonous species. In modern societies, children's adjustment to TTS is highly variable and
517 is associated with several traits such as children's sex, age, personality or their attachment
518 style (Dunn et al., 1981; Volling, 2012, 2017; Volling et al., 2014). Insecurely attached or
519 younger children typically show more negative reactions to the birth of a younger sibling
520 (Dunn et al., 1981; Volling, 2017). Maternal traits, such as maternal style, could also influence
521 how juvenile primates cope with TTS (Fairbanks, 1996; Maestriperi, 2018). Moreover,
522 throughout this transition, mother and offspring are generally part of a larger social system
523 not restricted to their dyad. In humans, which are often described as communal or cooperative
524 breeders (Mace & Sear, 2005), the presence of other kin such as the father, grandmother and
525 older siblings can also influence how children cope with this transition by developing strong
526 bonds with others to compensate for the weakening of the maternal bond (Gottlieb &

527 Mendelson, 1990; Legg et al., 1974; Stewart et al., 1987; Volling et al., 2014). This could also
528 be the case in baboons to some extent, as juvenile primates primarily associate with their
529 siblings, and can keep benefitting from their father's presence as long as they co-reside
530 (Charpentier et al., 2008; Lynch et al., 2020).

531 Our study is among the first to investigate behavioural changes in mother-juvenile
532 relationships following the birth of a new sibling in wild nonhuman primates. In chacma
533 baboons, the birth of a newborn does not translate into decreased maternal affiliation or
534 association towards the older sibling but it does push juveniles to increase solicitations
535 towards their mother and seems to generate anxiety, which overall suggests that juveniles
536 have to make more effort to maintain the same level of attention and care from their mother.
537 From an ultimate perspective, these results raise the important question of the adaptive
538 significance of maternal attention that siblings seem to compete over. From a proximate
539 perspective, the juveniles' behavioural changes reported here may resemble the jealous
540 reactions commonly observed in young humans during TTS, and may thus offer a relevant
541 context to study emotional development in young primates. Finally, our results, which are
542 distinct from findings in captive primates, show both similarities and differences to human
543 patterns. As such, they emphasize the need to investigate broader aspects of this intriguing
544 developmental milestone in the wild, and across populations and species showing a diversity
545 of life histories and ecologies.

546 DATA AVAILABILITY

547 Data sets and scripts used in this study are available on the following public repository:
548 [https://gitlab.com/AxelleDelaunay/transition-to-siblinghood-in-a-wild-chacma-baboon-
population](https://gitlab.com/AxelleDelaunay/transition-to-siblinghood-in-a-wild-chacma-baboon-
549 population)

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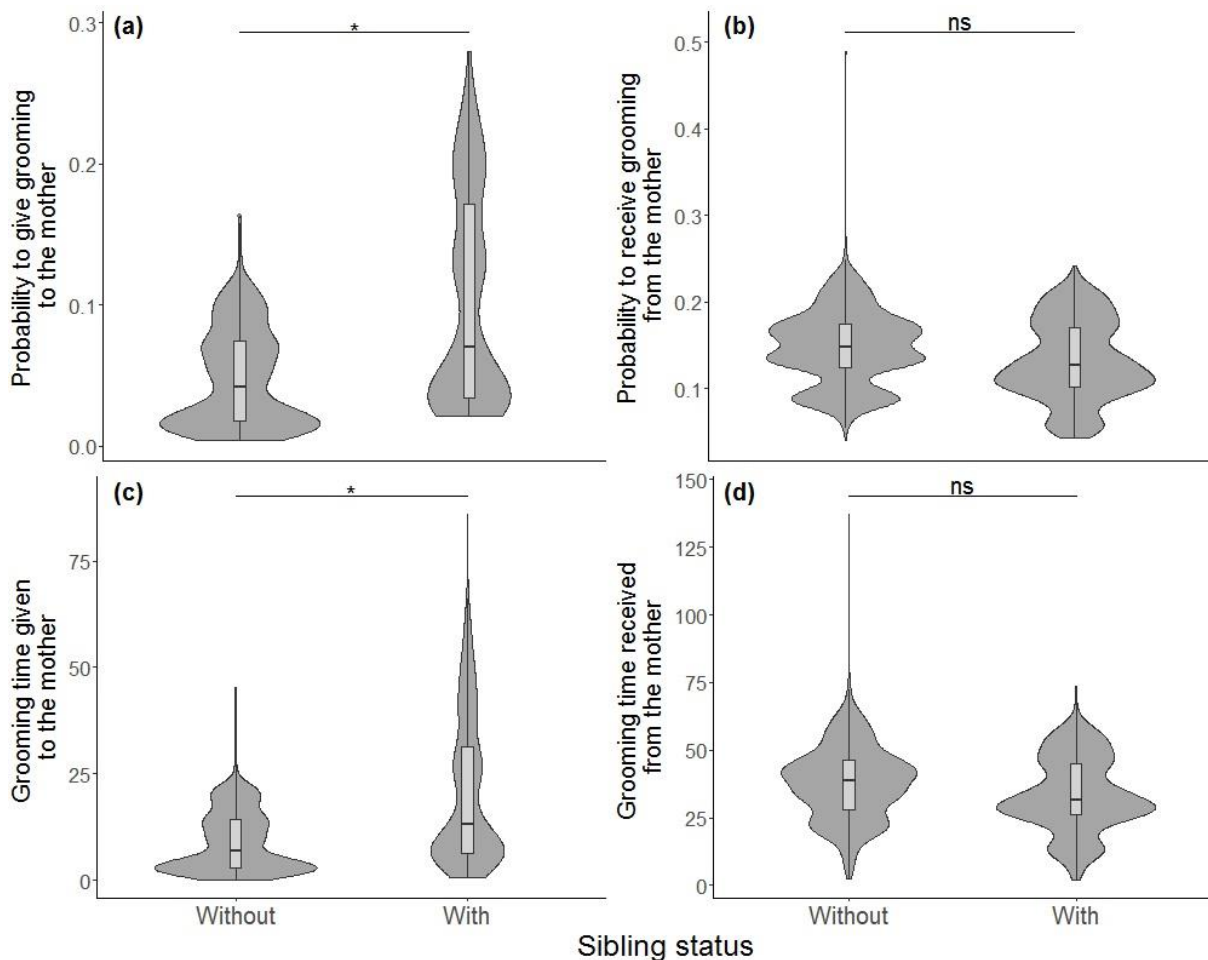
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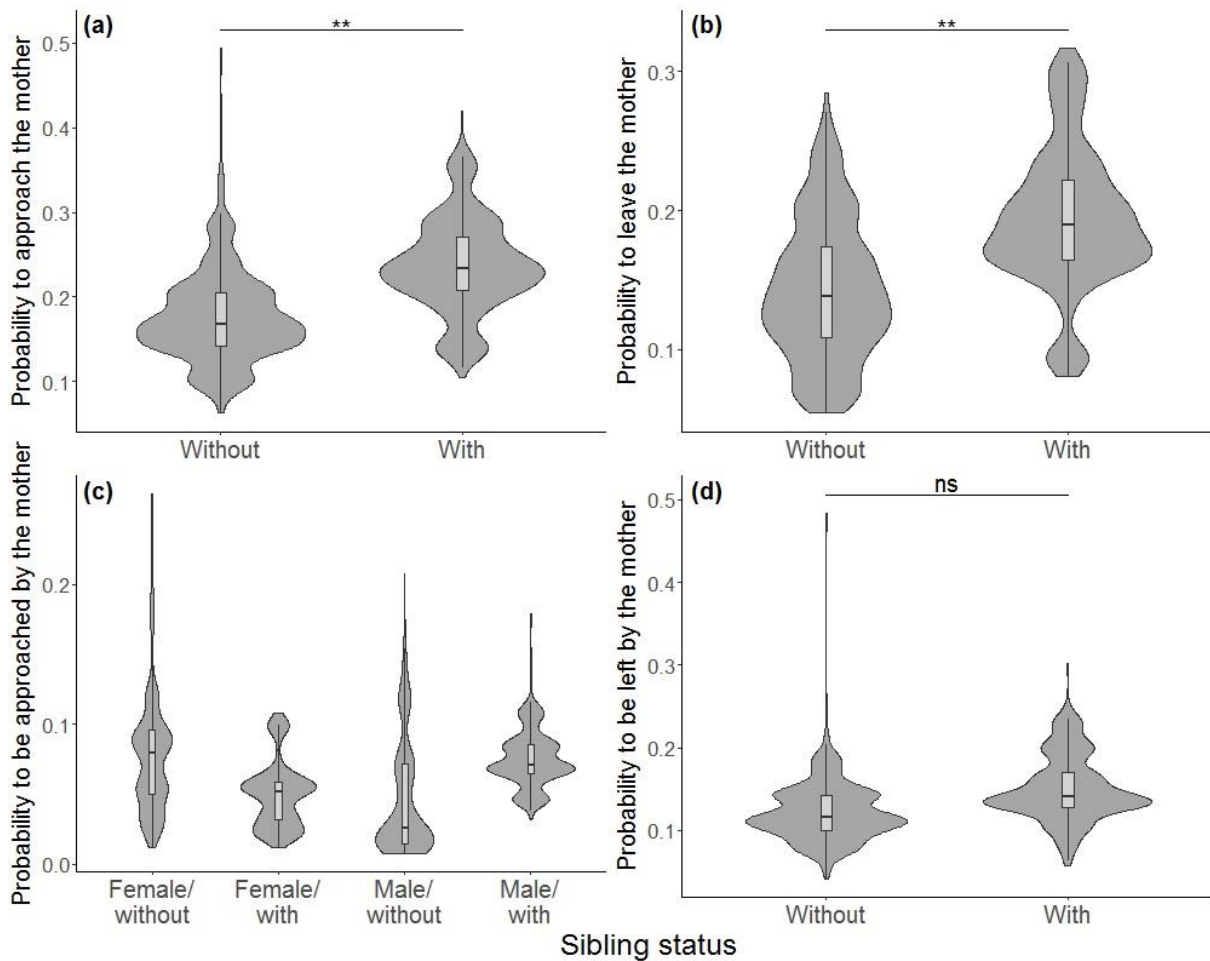
883 *Figure 1 Influence of the birth of the younger sibling on mother-juvenile grooming interactions.*
 884 *In all panels, "Sibling status" refers to whether juveniles have recently experienced the birth of*
 885 *a younger sibling ("With"), or not ("Without"). (a) Predicted probability that a juvenile grooms*
 886 *its mother during a focal observation depending on its "sibling status". (b) Predicted*
 887 *probability that a juvenile is being groomed by its mother depending on its "sibling status". (c)*
 888 *Predicted grooming time (in seconds) given by a juvenile to its mother during a focal*
 889 *observation depending on its "sibling status". (d) Predicted grooming time (in seconds)*
 890 *received by a juvenile from its mother during a focal observation depending on its "sibling*
 891 *status". The violin plots show the distribution of the fitted values and the boxplots show the*
 892 *median of the distribution of the fitted values (black horizontal bar), the 25th and 75th*
 893 *quartiles (bottom and top of the boxes, respectively) and the whiskers include a maximum of*
 894 *1.5 times the interquartile range. The effect of the predictor "Presence of a younger sibling"*
 895 *and the associated p-values are shown. "ns": not significant ($P > 0.05$); * : $P < 0.05$; ** : $P < 0.01$;*
 896 **** : $P < 0.001$*



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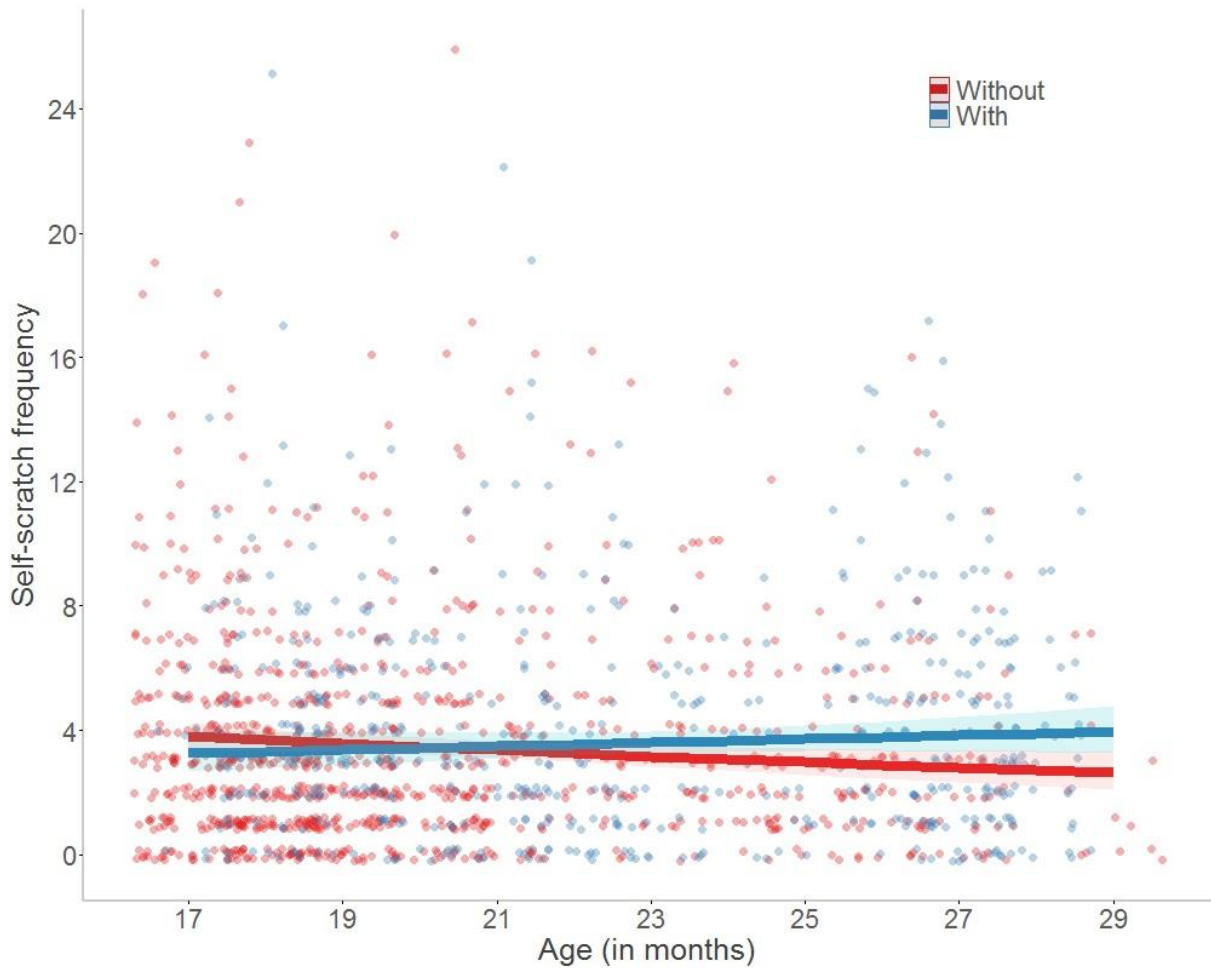
899 Figure 2: Influence of the birth of the younger sibling on mother-juvenile spatial association
 900 (within 1m). In all panels, “Sibling status” refers to whether juveniles have recently experienced
 901 the birth of a younger sibling (“With”), or not (“Without”). The four panels show the effect of
 902 sibling status on (a) the predicted probability that a juvenile approaches its mother during a
 903 focal observation; (b) the predicted probability that a juvenile leaves its mother; (c) the
 904 predicted probability that a juvenile is approached by its mother in interaction with juvenile’s
 905 sex; and (d) the predicted probability that a juvenile is left by its mother. The violin plots show
 906 the distribution of the fitted probabilities. The boxplots show the median of the distribution of
 907 the fitted values (black horizontal bar), the 25th and 75th quartiles (bottom and top of the
 908 boxes, respectively) and the whiskers include a maximum of 1.5 times the interquartile range.
 909 The effect of the predictor “Presence of a younger sibling” and the associated p-values are
 910 shown. “ns”: not significant ($P > 0.05$); * : $P < 0.05$; ** : $P < 0.01$; *** : $P < 0.001$. Note that panel
 911 C shows the predicted values of the model including a significant interaction between sibling
 912 status and juvenile’s sex (model 8), but post-hoc pairwise mean comparisons were not
 913 significant



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915

916 *Figure 3: Variation in the frequency of self-scratches according to juvenile's age and the birth*
917 *of a younger sibling. "With" refers to juveniles who recently experienced the birth of a*
918 *younger sibling, "Without" refers to juveniles who did not experience the birth of a younger*
919 *sibling yet. Dots represent the model's adjusted predicted values and the curves show the*
920 *linear predicted fit from the corresponding mixed model. Predicted values were computed*
921 *using the function "ggeffect" from the ggeffect package, averaging the values of all the other*
922 *variables in the model. The darker area around each curve represents the confidence interval*
923 *of the fitted curve*



924

925 TABLES

926 *Table 1: Determinants of the occurrence of grooming between the mother and the juvenile*

Response variable	Fixed factor	Levels	Estimate	CI		LRT	P-value
				2.5 %	97.5 %		
Model 1: Probability to groom the mother	Intercept		-2.524	-3.063	-1.985	-	-
	Presence of a younger sibling (No)	Yes	0.539	0.023	1.054	4.107	0.043
	Juvenile's age		0.397	0.117	0.678	9.026	0.003
	Juvenile's sex (Female)	Male	-1.476	-2.106	-0.846	20.622	<0.001
	Juvenile's birth rank (Later-born)	First-born	0.184	-0.534	0.901	0.246	0.620
	Mother's rank		0.060	-0.222	0.342	0.171	0.679
	Troop (J)	L	0.133	-0.491	0.758	3.294	0.193
		M	-0.889	-2.035	0.257		
	Focal observation duration		0.065	-0.137	0.266	0.394	0.530
Full –Null model comparison: $X^2_2 = 46.605$, $P < 0.001$ (AIC full = 711.11, AIC null = 741.71)							
Model 2: Probability to be groomed by the mother	Intercept		-1.632	-1.993	-1.270	-	-
	Presence of a younger sibling (No)	Yes	-0.114	-0.495	0.268	0.350	0.554

Juvenile's age		-0.179	-0.371	0.013	3.693	0.055
Juvenile's sex (Female)	Male	-0.234	-0.601	0.133	1.828	0.176
Juvenile's birth rank (Later-born)	First-born	-0.189	-0.679	0.301	0.603	0.437
Mother's rank		-0.017	-0.199	0.166	0.042	0.838
Troop (J)	L	0.099	-0.306	0.504		
	M	-0.638	-1.291	0.016	5.373	0.068
Focal observation duration		0.141	-0.009	0.292	3.515	0.061

Full-Null model comparison: $X^2_2 = 17.211$, $P = 0.028$ (AIC full = 1252.8, AIC null = 1254.0)

927 *Table 1: Results of the mixed models analyzing the probability for a juvenile to groom (model 1) or to receive (model 2) a grooming from its mother during a focal observation. Estimates, 95%*
928 *confidence intervals (CI), LRT statistics and p-values of the predictors were estimated using 1525 focal observations on 38 juveniles (N=18 with a younger sibling, N=28 without). Juvenile*
929 *identity was included as random effect. For categorical predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. We provided AIC values to*
930 *clarify which model performed best in case the full-null model comparison was significant.*

931

932 Table 2: Determinants of the grooming time exchanged between the mother and the juvenile

Response variable	Fixed factor	Levels	Estimate	CI		LRT	P-value
				2.5 %	97.5 %		
Model 3: Time spent	Intercept		-4.460	-5.147	-3.773	-	-
grooming the mother	Presence of a younger sibling (No)	Yes	0.519	0.032	1.007	4.284	0.038
	Juvenile's age		0.394	0.128	0.660	9.957	0.002
	Juvenile's sex (Female)	Male	-1.454	-2.068	-0.840	21.161	<0.001
	Juvenile's birth rank (Later-born)	First-born	0.147	-0.540	0.834	0.172	0.678
	Mother's rank		0.061	-0.212	0.334	0.187	0.665
	Troop (J)	L	0.152	-0.448	0.752	3.544	0.170
	M	-0.879	-2.002	0.244			
Full-Null model comparison: $X^2_2 = 48.106$, $P < 0.001$ (AIC full = 2135.7, AIC null = 2169.8)							
Model 4: Time spent	Intercept		-3.357	-3.793	-2.922	-	-
being groomed by the mother	Presence of a younger sibling (No)	Yes	-0.126	-0.459	0.207	0.552	0.458
	Juvenile's age		-0.167	-0.338	0.003	3.650	0.056
	Juvenile's sex (Female)	Male	-0.229	-0.546	0.087	1.902	0.168

Juvenile's birth rank (Later-born)	First-born	-0.171	-0.589	0.247	0.667	0.414
Mother's rank		-0.015	-0.171	0.142	0.033	0.855
Troop (J)	L	0.142	-0.209	0.493	6.098	0.047
	M	-0.615	-1.206	-0.024		

Full-Null model comparison: $X^2_2 = 14.867$, $P = 0.038$ (AIC full = 4368.7, AIC null = 4369.6)

933 *Table 1 : Results of the mixed models analyzing the grooming time (in seconds) given to the mother (Model 3) or received from the mother (Model 4) by the juvenile during a focal observation.*
934 *Estimates, 95% confidence intervals (CI), LRT statistics and p-values of the predictors were estimated using 1525 focal observations on 38 juveniles (N=18 with a younger sibling, N=28 without).*
935 *Juvenile identity was included as a random effect. For categorical predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. We provided AIC*
936 *values to clarify which model performed best in case the full-null model comparison was significant.*

937

938 *Table 3: Determinants of the spatial proximity between the mother and the juvenile*

Response variable	Fixed factor	Levels	Estimate	CI		LRT	P-value
				2.5 %	97.5 %		
Model 5: Probability to be within 1m from the mother	Intercept		-1.913	-2.238	-1.588	-	-
	Presence of a younger sibling (No)	Yes	-0.080	-0.427	0.266	0.405	0.524
	Juvenile's age		-0.208	-0.383	-0.033	5.480	0.019
	Juvenile's sex (Female)	Male	-0.629	-0.970	-0.288	13.242	<0.001
	Juvenile's birth rank (Later-born)	First-born	-0.240	-0.693	0.213	1.161	0.281
	Mother's rank		0.103	-0.064	0.271	1.810	0.179
	Troop (J)	L	-0.015	-0.397	0.367		
	M	-0.412	-0.978	0.154	2.623	0.269	
Full-Null model comparison: $X^2_2 = 27.008$, $P < 0.001$ (AIC full = 1607.7, AIC null = 1620.7)							
Model 6: Probability to be within 5m from the mother	Intercept		-1.695	-1.967	-1.423	-	-
	Presence of a younger sibling (No)	Yes	0.115	-0.175	0.405	0.632	0.427
	Juvenile's age		-0.223	-0.365	-0.081	10.120	0.001
	Juvenile's sex (Female)	Male	-0.331	-0.598	-0.064	5.432	0.020
Juvenile's birth rank (Later-born)	First-born	0.036	-0.320	0.392	0.040	0.842	

Mother's rank		0.189	0.055	0.323	6.408	0.011
Troop (J)	L	0.034	-0.283	0.352		
	M	0.443	0.074	0.812	5.178	0.075

Full-Null model comparison: $\chi^2_2 = 25.398$, $P < 0.001$ (AIC full = 2195.2, AIC null = 2206.6)

939 *Table 2 : Results of the mixed models analyzing the probability for a juvenile to be within 1 meter (model 5) or within 5 meters (model 6) from its mother during a scan observation. Estimates,*
940 *95% confidence intervals (CI), LRT statistics and p-values of the predictors were estimated using 2562 and 2532 scan observations respectively, on 38 juveniles (N=18 with a younger sibling,*
941 *N=28 without). Juvenile identity was included as random effect. For categorical predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. We*
942 *provided AIC values to clarify which model performed best in case the full-null model comparison was significant.*

943

944 Table 4: Determinants of proximity maintenance by the juvenile

Response variable	Fixed factor	Levels	Estimate	CI	LRT	P-value	
				2.5 %	97.5 %		
Model 7: Probability to approach the mother	Intercept		-1.572	-1.906	-1.237	-	-
	Presence of a younger sibling (No)	Yes	0.552	0.225	0.879	10.628	0.001
	Juvenile's age		-0.207	-0.374	-0.039	5.864	0.015
	Juvenile's sex (Female)	Male	-0.160	-0.479	0.159	0.973	0.324
	Juvenile's birth rank (Later-born)	First-born	-0.099	-0.540	0.342	0.197	0.657
	Mother's rank		0.175	0.019	0.330	4.430	0.035
	Troop (J)	L	-0.123	-0.502	0.257	7.373	0,025
		M	0.571	0.113	1.029		
	Focal observation duration		0.139	0.003	0.275	4.148	0.042
Full-Null model comparison: $X^2_2 = 26.202$, $P < 0.001$ (AIC full = 1505.2, AIC null = 1515.4)							
Model 8: Probability to leave the mother	Intercept		-1.726	-2.087	-1.365	-	-
	Presence of a younger sibling (No)	Yes	0.538	0.186	0.891	9.402	0.002
	Juvenile's age		-0.185	-0.366	-0.003	4.534	0.033

Juvenile's sex (Female)	Male	-0.421	-0.770	-0.072	6.168	0.013
Juvenile's birth rank (Later-born)	First-born	-0.089	-0.565	0.388	0.099	0.753
Mother's rank		0.194	0.024	0.364	5.493	0.019
Troop (J)	L	-0.119	-0.521	0.284	9.065	0.011
	M	0.665	0.173	1.157		
Focal Observation duration		0.069	-0.075	0.213	0.916	0.338

Full-Null model comparison: $X^2_2 = 25.193$, $P = 0.001$ (AIC full = 1340.8, AIC null = 1350.0)

945 *Table 3 : Results of the mixed models analyzing the probability for a juvenile to approach (model 7) or to leave (model 8) its mother within 1 meter during a focal observation. Estimates, 95%*
946 *confidence intervals (CI), LRT statistics and p-values of the predictors were estimated using 1525 focal observations on 38 juveniles (N=18 with a younger sibling, N=28 without). Juvenile*
947 *identity was included as random effect. For categorical predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. We provided AIC values to*
948 *clarify which model performed best in case the full-null model comparison was significant.*

949

Response variable	Fixed factors	Levels	Estimate	CI		LRT	P-value
				2.5 %	97.5 %		
Model 9: Probability to be approached by the mother	Intercept		-3.177	-3.758	-2.596	-	-
	Presence of a younger sibling (No)	Yes	-0.512	-1.201	0.177	-	-
	Juvenile's age		0.050	-0.211	0.311	0.100	0.752
	Juvenile's sex (Female)	Male	-0.557	-1.189	0.075	-	-
	Juvenile's birth rank (Later-born)	First-born	0.233	-0.448	0.914	0.484	0.486
	Mother's rank		0.556	0.286	0.827	18.123	<0.001
	Troop (J)	L	0.792	0.203	1.382	17.726	<0.001
		M	1.430	0.743	2.117		
	Focal observation duration		0.156	-0.062	0.373	1.943	0.163
	Presence of a younger sibling (No)*Juvenile's sex (Female)	Yes, Male	1.138	0.156	2.119	6.070	0.014
Full-Null model comparison: $X^2_2 = 30.352$, $P < 0.001$ (AIC full = 712.29, AIC null = 724.65)							
Intercept			-1.919	-2.295	-1.544	-	-

Model 10: Probability to be left by the mother	Presence of a younger sibling (No)	Yes	0.254	-0.121	0.629	1.751	0.186
	Juvenile's age		-0.134	-0.325	0.056	1.943	0.163
	Juvenile's sex (Female)	Male	-0.273	-0.638	0.093	2.034	0.154
	Juvenile's birth rank (Later-born)	First-born	-0.370	-0.893	0.153	2.066	0.151
	Mother's rank		0.011	-0.169	0.190	0.014	0.907
	Troop (J)	L	0.171	-0.260	0.602		
		M	0.339	-0.203	0.882	1.531	0.465
	Focal observation duration		0.188	0.028	0.347	5.557	0.018

Full-Null model comparison: $X^2_2 = 13.902$, $P = 0.084$ (AIC full = 1197.5, AIC null = 1195.4)

951 *Table 4 : Results of the mixed models analyzing the probability for a juvenile to be approached (model 9) or left (model 10) within 1 meter by its mother during a focal observation. Estimates,*
952 *95% confidence intervals (CI), LRT statistics and p-values of the predictors were estimated using 1525 focal observations on 38 juveniles (N=18 with a younger sibling, N=28 without). Juvenile*
953 *identity was included as random effect. For categorical predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. Whenever an interaction is*
954 *significant, LRT and p-values for the simple predictors are not shown. We provided AIC values to clarify which model performed best in case the full-null model comparison was significant.*

955

Fixed factor	Levels	Estimate	CI		LRT	P-value
			2.5 %	97.5 %		
Intercept		-5.814	-5.966	-5.661	-	-
Presence of a younger sibling (No)	Yes	0.040	-0.102	0.183	-	-
Juvenile's age		-0.110	-0.197	-0.023	-	-
Juvenile's sex (Female)	Male	0.050	-0.082	0.182	0.536	0.464
Juvenile's birth rank (Later-born)	First-born	-0.105	-0.286	0.075	1.266	0.260
Mother's rank		-0.065	-0.132	0.001	3.498	0.061
Troop (J)	L	0.008	-0.138	0.154	10.806	0.005
	M	-0.358	-0.565	-0.150		
Year (2017)	2018	-0.317	-0.518	-0.115	14.086	0.001
	2019	0.085	-0.059	0.228		
Presence of a younger sibling (No)*juvenile's age	Yes	0.166	0.036	0.296	5.873	0.015

Full-Null model comparison: $X^2_2 = 26.07$, $P = 0.004$ (AIC full = 7158.1, AIC null = 7164.1)

957 *Table 5 : Results of the mixed models analyzing the frequency of self-scratches during a focal observation (model 11). Estimates, 95% confidence intervals (CI), LRT statistics and p-values of the*
 958 *predictors were estimated using 1523 focal observations on 38 juveniles (N=18 with a younger sibling, N=28 without). Juvenile identity was included as random effect. For categorical*
 959 *predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. Whenever an interaction is significant, LRT and p-values for the simple predictors*
 960 *are not shown. We provided AIC values to clarify which model performed best in case the full-null model comparison was significant.*

961 *Table A1: Summary of all models included in the study*

Model Number	Response variable	Model type	Sample size (number of observations/number of juveniles)	Fixed effects	Random effects	Offset
1	Probability to groom the mother	Binomial GLMM	1525/38	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop, focal duration	Juvenile identity	NA
2	Probability to be groomed by the mother	Binomial GLMM	1525/38	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop, focal duration	Juvenile identity	NA
3	Total time grooming the mother	Negative binomial GLMM	1525/38	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop	Juvenile identity	Focal duration
4	Total time being groomed by the mother	Negative binomial GLMM	1525/38	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop	Juvenile identity	Focal duration

5	Probability to be within 1m from the mother	Binomial GLMM	2562/38	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop, focal duration	Juvenile identity	NA
6	Probability to be within 5m from the mother	Binomial GLMM	2532/38	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop	Juvenile identity	NA
7	Probability to approach the mother	Binomial GLMM	1525/38	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop, focal duration	Juvenile identity	NA
8	Probability to leave the mother	Binomial GLMM	1525/38	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop, focal duration	Juvenile identity	NA
9	Probability to be approached by the mother	Binomial GLMM	1525/38	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop, focal	Juvenile identity	NA

10	Probability to be left by the mother	Binomial GLMM	1525/38	duration, presence of a younger sibling*juvenile's sex	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop, focal duration	Juvenile identity	NA
11	Frequency of self-scratch	Negative binomial GLMM	1523/38	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop	Presence of a younger sibling, juvenile's age, sex and birth rank, maternal rank, troop	Juvenile identity	Focal duration

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964 Table A2: Determinants of the occurrence of grooming between the mother and the juvenile

Response variable	Fixed factor	Levels	Estimate	CI		LRT	P-value
				2.5 %	97.5 %		
Model S1: Probability to groom the mother	Intercept		-2.522	-3.071	-1.973	-	-
	Presence of a younger sibling (No)	Yes	0.542	0.001	1.082	3.829	0.050
	Juvenile's age		0.395	0.077	0.712	6.344	0.012
	Juvenile's sex (Female)	Male	-1.477	-2.109	-0.845	20.623	<0.001
	Juvenile's birth rank (Later-born)	First-born	0.175	-0.690	1.039	0.153	0.695
	Mother's rank		0.060	-0.222	0.343	0.172	0.678
	Number of immature older siblings		-0.006	-0.357	0.344	0.001	0.971
	Troop (J)	L	0.132	-0.495	0.759	3.228	0.199
		M	-0.893	-2.059	0.273		
		Focal observation duration		0.065	-0.137	0.266	0.391
Full-Null model comparison: $X^2_2 = 46.607$, $P < 0.001$ (AIC full = 713.11, AIC null = 741.11)							
Model 1-Model S1 comparison: $X^2_2 = 0.0013$, $P = 0.971$ (AIC Model 1 = 711.11, AIC Model S1 = 713.11)							
	Intercept		-1.648	-2.018	-1.277	-	-

Model S2: Probability to be groomed by the mother	Presence of a younger sibling (No)	Yes	-0.137	-0.537	0.263	0.476	0.490
	Juvenile's age		-0.154	-0.387	0.079	1.854	0.173
	Juvenile's sex (Female)	Male	-0.229	-0.596	0.137	1.770	0.183
	Juvenile's birth rank (Later-born)	First-born	-0.118	-0.734	0.498	0.125	0.723
	Mother's rank		-0.021	-0.205	0.162	0.066	0.798
	Number of immature older siblings		0.048	-0.209	0.305	0.168	0.682
	Troop (J)	L	0.107	-0.299	0.512	4.428	0.109
		M	-0.596	-1.285	0.093		
	Focal observation duration		0.142	-0.009	0.292	3.545	0.060

Full-Null model comparison: $X^2_2 = 17.379$, $P < 0.043$ (AIC full = 1254.6, AIC null = 1254.0)

Model 2-Model S2 comparison: $X^2_2 = 0.168$, $P = 0.682$ (AIC Model 2 = 1252.8, AIC Model S1 = 1254.6)

965 *Table A2: Results of the mixed models analyzing the probability for a juvenile to groom (model 1) or to receive (model 2) a grooming from its mother during a focal observation. Estimates, 95%*
966 *confidence intervals (CI), LRT statistics and p-values of the predictors were estimated using 1525 focal observations on 38 juveniles (N=18 with a younger sibling, N=28 without). Juvenile*
967 *identity was included as random effect. For categorical predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. We provided AIC values to*
968 *clarify which model performed best in case the full-null model comparison was significant.*

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970 *Table A3: Determinants of the grooming time exchanged between the mother and the juvenile*

Response variable	Fixed factor	Levels	Estimate	CI		LRT	P-value
				2.5 %	97.5 %		
Model S3: Time spent grooming the mother	Intercept		-4.459	-5.153	-3.765	-	-
	Presence of a younger sibling (No)	Yes	0.521	0.009	1.032	3.978	0.046
	Juvenile's age		0.393	0.094	0.691	7.097	0.008
	Juvenile's sex (Female)	Male	-1.455	-2.071	-0.838	21.161	<0.001
	Juvenile's birth rank (Later-born)	First-born	0.143	-0.683	0.969	0.112	0.738
	Mother's rank		0.061	-0.213	0.335	0.188	0.665
	Number of immature older siblings		-0.003	-0.335	0.329	0.000	0.985
	Troop (J)	L	0.152	-0.451	0.754	3.466	0.177
	M	-0.881	-2.024	0.262			

Full-Null model comparison: $X^2_2 = 48.106$, $P < 0.001$ (AIC full = 2137.7, AIC null = 2169.8)

Model 3-Model S3 comparison: $X^2_2 = 0.0003$, $P = 0.986$ (AIC Model 3 = 2135.7, AIC Model S3 = 2137.7)

Intercept		-3.375	-3.814	-2.936	-	-
Presence of a younger sibling (No)	Yes	-0.153	-0.500	0.194	0.749	0.387

Model S4: Time spent	Juvenile's age		-0.137	-0.342	0.067	1.730	0.188
being groomed by the	Juvenile's sex (Female)	Male	-0.226	-0.540	0.088	1.869	0.172
mother	Juvenile's birth rank (Later-born)	First-born	-0.084	-0.613	0.445	0.098	0.754
	Mother's rank		-0.020	-0.176	0.137	0.063	0.803
	Number of immature older siblings		0.058	-0.164	0.280	0.262	0.609
	Troop (J)	L	0.151	-0.197	0.499		
		M	-0.566	-1.181	0.048	5.062	0.080

Full-Null model comparison: $X^2_2 = 15.129$, $P = 0.057$ (AIC full = 4370.4, AIC null = 4369.6)

Model 4-Model S4 comparison: $X^2_2 = 0.262$, $P = 0.609$ (AIC Model 4 = 4368.7, AIC Model S4 = 4370.4)

971 *Table A3: Results of the mixed models analyzing the grooming time (in seconds) given to the mother (Model 3) or received from the mother (Model 4) by the juvenile during a focal observation.*
972 *Estimates, 95% confidence intervals (CI), LRT statistics and p-values of the predictors were estimated using 1525 focal observations on 38 juveniles (N=18 with a younger sibling, N=28 without).*
973 *Juvenile identity was included as a random effect. For categorical predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. We provided AIC*
974 *values to clarify which model performed best in case the full-null model comparison was significant.*

975

976 *Table A4: Determinants of the spatial proximity between the mother and the juvenile*

Response variable	Fixed factor	Levels	Estimate	CI		LRT	P-value
				2.5 %	97.5 %		
Model S5: Probability to be within 1m from the mother	Intercept		-1.896	-2.227	-1.566	-	-
	Presence of a younger sibling (No)	Yes	-0.049	-0.417	0.319	0.182	0.670
	Juvenile's age		-0.240	-0.453	-0.027	4.948	0.026
	Juvenile's sex (Female)	Male	-0.636	-0.979	-0.292	13.418	<0.001
	Juvenile's birth rank (Later-born)	First-born	-0.325	-0.879	0.230	1.368	0.242
	Mother's rank		0.106	-0.062	0.274	1.854	0.173
	Number of older immature siblings		-0.061	-0.288	0.166	0.251	0.617
	Troop (J)	L	-0.021	-0.407	0.364	2.875	0.237
	M	-0.461	-1.057	0.134			
Full-Null model comparison: $X^2_2 = 27.259$, $P < 0.001$ (AIC full = 1609.4, AIC null = 1620.7)							
Model S6: Probability to be within 5m from the mother	Model 5-Model S5 comparison: $X^2_2 = 0.251$, $P = 0.617$ (AIC Model 5 = 1607.7, AIC Model S5 = 1609.4)						
	Intercept		-1.682	-1.961	-1.403	-	-
	Presence of a younger sibling (No)	Yes	0.155	-0.164	0.474	0.968	0.325
	Juvenile's age		-0.256	-0.432	-0.080	9.135	0.003

Juvenile's sex (Female)	Male	-0.338	-0.610	-0.065	5.508	0.019
Juvenile's birth rank (Later-born)	First-born	-0.046	-0.485	0.394	0.042	0.838
Mother's rank		0.190	0.054	0.326	6.387	0.011
Number of immature older siblings		-0.064	-0.256	0.128	0.439	0.508
Troop (J)	L	0.024	-0.303	0.351		
	M	0.388	-0.023	0.800	3.255	0.196

Full-Null model comparison: $X^2_2 = 25.837$, $P = 0.001$ (AIC full = 2196.7, AIC null = 2206.6)

Model 5-Model S5 comparison: $X^2_2 = 0.439$, $P = 0.508$ (AIC Model 6 = 2195.2, AIC Model S6 = 2196.7)

977 *Table A4: Results of the mixed models analyzing the probability for a juvenile to be within 1 meter (model 5) or within 5 meters (model 6) from its mother during a scan observation. Estimates,*
978 *95% confidence intervals (CI), LRT statistics and p-values of the predictors were estimated using 2562 and 2532 scan observations respectively, on 38 juveniles (N=18 with a younger sibling,*
979 *N=28 without). Juvenile identity was included as random effect. For categorical predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. We*
980 *provided AIC values to clarify which model performed best in case the full-null model comparison was significant.*

981

Response variable	Fixed factor	Levels	Estimate	CI	LRT	P-value	
				2.5 %	97.5 %		
Model S7: Probability to approach the mother	Intercept		-1.606	-1.943	-1.270	-	-
	Presence of a younger sibling (No)	Yes	0.503	0.163	0.844	8.293	0.004
	Juvenile's age		-0.161	-0.356	0.034	2.655	0.103
	Juvenile's sex (Female)	Male	-0.149	-0.463	0.165	0.874	0.350
	Juvenile's birth rank (Later-born)	First-born	0.036	-0.490	0.562	0.018	0.894
	Mother's rank		0.170	0.016	0.323	4.257	0.039
	Number of immature older siblings		0.096	-0.123	0.315	0.734	0.392
	Troop (J)	L	-0.104	-0.477	0.270	8.063	0.018
		M	0.662	0.168	1.157		
	Focal observation duration		0.141	0.005	0.277	4.275	0.039

Full-Null model comparison: $X^2_2 = 26.936$, $P = 0.001$ (AIC full = 1506.5, AIC null = 1515.4)

Model 7-Model S7 comparison: $X^2_2 = 0.0003$, $P = 0.734$ (AIC Model 7 = 1505.2, AIC Model S7 = 1506.5)

Intercept			-1.778	-2.144	-1.413	-	-
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Model S8: Probability to leave the mother	Presence of a younger sibling (No)	Yes	0.468	0.101	0.835	6.758	0.009
	Juvenile's age		-0.116	-0.327	0.096	1.426	0.232
	Juvenile's sex (Female)	Male	-0.407	-0.752	-0.062	5.915	0.015
	Juvenile's birth rank (Later-born)	First-born	0.120	-0.452	0.692	0.223	0.637
	Mother's rank		0.187	0.019	0.356	5.244	0.022
	Number of immature older siblings		0.152	-0.088	0.393	1.691	0.194
	Troop (J)	L	-0.100	-0.497	0.296	10.745	0.005
		M	0.803	0.269	1.338		
	Focal Observation duration		0.073	-0.071	0.217	1.039	0.308

Full-Null model comparison: $X^2_2 = 26.884$, $P = 0.002$ (AIC full = 1341.1, AIC null = 1350.0)

Model 8-Model S8 comparison: $X^2_2 = 1.691$, $P = 0.196$ (AIC Model 8 = 1340.8, AIC Model S8 = 1341.1)

983 *Table A5: Results of the mixed models analyzing the probability for a juvenile to approach (model 7) or to leave (model 8) its mother within 1 meter during a focal observation. Estimates, 95%*
984 *confidence intervals (CI), LRT statistics and p-values of the predictors were estimated using 1525 focal observations on 38 juveniles (N=18 with a younger sibling, N=28 without). Juvenile*
985 *identity was included as random effect. For categorical predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. We provided AIC values to*
986 *clarify which model performed best in case the full-null model comparison was significant.*

987

Response variable	Fixed factors	Levels	Estimate	CI		LRT	P-value
				2.5 %	97.5 %		
Model S9: Probability to be approached by the mother	Intercept		-3.163	-3.749	-2.577	-	-
	Presence of a younger sibling (No)	Yes	-0.498	-1.191	0.195	-	-
	Juvenile's age		0.017	-0.292	0.325	0.006	0.941
	Juvenile's sex (Female)	Male	-0.585	-1.234	0.064	-	-
	Juvenile's birth rank (Later-born)	First-born	0.145	-0.659	0.949	0.155	0.694
	Mother's rank		0.565	0.290	0.840	18.241	<0.001
	Number of immature older siblings		-0.075	-0.438	0.289	0.141	0.707
	Troop (J)	L	0.807	0.210	1.404	15.725	<0.001
		M	1.378	0.645	2.111		
	Focal observation duration		0.154	-0.064	0.372	1.893	0.169
Presence of a younger sibling (No)*Juvenile's sex (Female)	Yes, Male	1.190	0.171	2.210	6.184	0.013	

Full-Null model comparison: $X^2_2 = 30.493$, $P < 0.001$ (AIC full = 714.15, AIC null = 724.65)

Model 9-Model S9 comparison: $X^2_2 = 0.141$, $P = 0.707$ (AIC Model 9 = 712.29, AIC Model S9 = 714.15)

Model S10: Probability to be left by the mother	Predictor	Reference	Estimate	95% CI	LRT	p-value
	Intercept		-1.977	-2.355 -1.599	-	-
	Presence of a younger sibling (No)	Yes	0.175	-0.213 0.563	0.779	0.377
	Juvenile's age		-0.055	-0.281 0.172	0.225	0.636
	Juvenile's sex (Female)	Male	-0.253	-0.612 0.107	1.788	0.181
	Juvenile's birth rank (Later-born)	First-born	-0.147	-0.763 0.470	0.222	0.638
	Mother's rank		0.000	-0.178 0.178	0.000	0.998
	Number of immature older siblings		0.157	-0.096 0.411	1.482	0.223
	Troop (J)	L	0.204	-0.214 0.623	2.578	0.276
		M	0.481	-0.095 1.057		
	Focal observation duration		0.190	0.031 0.349	5.726	0.017

Full-Null model comparison: $X^2_2 = 15.384$, $P = 0.081$ (AIC full = 1198.0, AIC null = 1195.4)

Model 10-Model S10 comparison: $X^2_2 = 1.482$, $P = 0.223$ (AIC Model 10 = 1197.5, AIC Model S10 = 1198.0)

989 *Table A6: Results of the mixed models analyzing the probability for a juvenile to be approached (model 9) or left (model 10) within 1 meter by its mother during a focal observation. Estimates,*
 990 *95% confidence intervals (CI), LRT statistics and p-values of the predictors were estimated using 1525 focal observations on 38 juveniles (N=18 with a younger sibling, N=28 without). Juvenile*
 991 *identity was included as random effect. For categorical predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. Whenever an interaction is*
 992 *significant, LRT and p-values for the simple predictors are not shown. We provided AIC values to clarify which model performed best in case the full-null model comparison was significant.*

993

Fixed factor	Levels	Estimate	CI		LRT	P-value
			2.5 %	97.5 %		
Intercept		-5.813	-5.971	-5.656	-	-
Presence of a younger sibling (No)	Yes	0.041	-0.113	0.194	-	-
Juvenile's age		-0.110	-0.209	-0.012	-	-
Juvenile's sex (Female)	Male	0.050	-0.083	0.182	0.529	0.467
Juvenile's birth rank (Later-born)	First-born	-0.106	-0.325	0.112	0.880	0.348
Mother's rank		-0.065	-0.132	0.001	3.476	0.062
Number of older immature siblings		-0.001	-0.090	0.089	0.000	0.989
Troop (J)	L	0.008	-0.140	0.156	9.775	0.008
	M	-0.358	-0.578	-0.138		
Year (2017)	2018	-0.316	-0.519	-0.114	13.809	0.001
	2019	0.085	-0.060	0.230		
Presence of a younger sibling (No)*juvenile's age	Yes	0.166	0.036	0.296	5.866	0.015

Full-Null model comparison: $X^2_2 = 26.07$, $P = 0.006$ (AIC full = 7160.1, AIC null = 7164.1)

Model 11-Model S11 comparison: $X^2_2 = 0.0002$, $P = 0.989$ (AIC Model 11 = 7158.1, AIC Model S11 = 7160.1)

995 *Table A7: Results of the mixed models analyzing the frequency of self-scratches during a focal observation (model S11). Estimates, 95% confidence intervals (CI), LRT statistics and p-values of*
996 *the predictors were estimated using 1523 focal observations on 38 juveniles (N=18 with a younger sibling, N=28 without). Juvenile identity was included as random effect. For categorical*
997 *predictors, the reference category is indicated between parentheses. Significant effects are indicated in bold. Whenever an interaction is significant, LRT and p-values for the simple predictors*
998 *are not shown. We provided AIC values to clarify which model performed best in case the full-null model comparison was significant.*

999

1000 Appendix 1: Test of the newborn attraction hypothesis

1001 To estimate if juveniles were approaching their mother to access the newborn, we used focal
1002 data on the 18 juveniles who experienced the birth of a younger sibling within the last three
1003 months. Each time the juvenile approached their mother within 1m, we calculated whether
1004 the juvenile initiated an interaction with the newborn and/or the mother (yes=1, no=0) within
1005 one minute following the approach, or until one of them left if a leave happened less than one
1006 minute after the approach. We considered the following interactions: grooming, playing (with
1007 the newborn only), affiliative and aggressive interactions. For interactions with the newborn,
1008 we considered only the interactions initiated by the juvenile because young baboon infants
1009 tend to touch or climb on individuals interacting with their mother. For interactions with the
1010 mother, we considered interactions initiated both by the juvenile and its mother. We then
1011 calculated the percentage of approach followed by an interaction with the newborn (whether
1012 the juvenile interacted with the newborn only or both with the mother and the newborn) or
1013 with the mother (the juvenile interacted with the mother only).