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A cooperatively breeding mouse shows flexible use of its vocal repertoire according to social context

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8 9 **Abstract**

10 Mice exchange information using chemical, visual and acoustic signals. Long ignored,
11 mouse ultrasonic communication is now considered to be an important aspect of their
12 social life, transferring information such as individual identity or stress levels. However,
13 whether and how mice modulate their acoustic communications is largely unknown.
14 Here we show that the cooperatively breeding African striped mouse *Rhabdomys*
15 *pumilio* controls its vocal production both qualitatively and quantitatively, depending on
16 naturally relevant social context. By conducting controlled experiments in captivity, we
17 found a vocal repertoire consisting of seven vocalisation types, which it uses differently
18 depending on different types of social interactions. Familiar individuals of the same or
19 different sex vocalise more than two unfamiliar same-sex individuals. The greatest
20 diversity of vocalisations was recorded during the encounter between an unfamiliar
21 female and male, suggesting that certain vocalisations are mainly used for courtship.
22 Our results highlight that familiar mice may alternate their vocalisations while unfamiliar
23 individuals tend to overlap one another. These observations suggest that African
24 striped mice control the production and temporal dynamics of their vocalisations,
25 addressing targeted information to specific receivers via the acoustic channel.

26
27 **Keywords:** Ultrasonic vocalisations, social communication, vocal repertoire, vocal
28 complexity, rodent, African striped mouse.

29 **1. Introduction**

30 In recent decades, our understanding of the importance of vocal communication in
31 mammals in areas such as vocal recognition [1–3], mate choice [4,5], and antagonist
32 interactions [6,7] has increased significantly. However, studies focused on a limited
33 number of mammal groups such as primates and marine mammals [8,9]. Rodents
34 constitute over 40% of all mammal species [10], but received less attention [11–16].
35 Our knowledge how rodents exchange vocal information in contexts like aggression,
36 play, and exploration remains rudimentary [11,17,18]. This is partly due to the technical
37 challenge of studying ultrasonic communication. Yet understanding acoustic
38 communication in rodents is crucial for understanding their social life. The subfamily
39 Murinae (old World mice and rats) is especially interesting, due to its biomedical
40 significance [19,20]. Studies regarding the use of ultrasound communication focused
41 so far on laboratory strains of house mice and of brown rats (*Mus musculus* and *Rattus*
42 *norvegicus*) with marginal consideration of the social contexts faced by animals in their
43 natural environments [21,22]. To address this, an increasing number of studies have
44 been recently conducted in semi-natural and natural environments [23], providing a
45 more naturalistic framework for examining ultrasonic communication. While rodent
46 vocalisations are still widely regarded as mere indicators of emotional states that are
47 stereotypic without variation, ultrasonic vocalisations (USVs) likely hold greater
48 complexity than previously thought [24], suggesting a more dynamic role of USVs [25].
49 Nevertheless, the extent to which rodents can flexibly control their ultrasonic
50 vocalizations remains unclear [22]. Describing and associating the acoustic
51 characteristics of vocalisations within the social contexts in which they are produced
52 might indicate such flexibility. Traditionally, rat vocalisations have been categorized
53 based on frequency and temporal criteria into two categories with some subcategories
54 [26,27]: around 22 kHz (aversive contexts) and around 50 kHz (positive contexts [28–
55 30]), though recent studies suggest found that vocalizations around 31 kHz were
56 emitted in stressful social contexts [31,32]. Laboratory mice also produce a variety of
57 vocalisations, classified according to their acoustic parameters, particularly their
58 frequency shape [33], though it is challenging to attribute clear emotional
59 characteristics to it [18]. Interestingly, recent research has shown variations in
60 vocalisation types as a function of social context, with females producing longer, more
61 complex vocalisations than males [34] in a strain specific way [35].

62 Ultrasonic vocalisations is part of multi-channel communication, often involving the
63 olfactory channel. For example, male house mice produce more USVs in the presence
64 of female urine than male urine, especially if the female is unfamiliar [36]. In same-sex
65 interactions, males are less vocal in response to other males, and females are more
66 likely to communicate with a familiar than unfamiliar female [36–38]. While these
67 experiments report quantitative changes in USVs, recent studies have begun to focus
68 on the repertoire of wild house mice, showing that variations in frequency modulations
69 can be induced by presenting different individuals behind a Plexiglass cover [39]. In
70 rodents outside the family Murinae, vocalisations also mediate social interactions
71 [40,41]. For instance, spiny mice produce USVs during sexual behaviour and social
72 investigation [42], and various species of voles use USVs to regulate aggressive
73 behaviour [43].

74 Studying rodent USVs remains challenging. Unlike the discrete vocal repertoire of
75 many bird species that we can easily distinguish acoustically (e.g. zebra finch [44]),
76 the vocal repertoire of mice and rats is graded, with blurred acoustic boundaries
77 between vocalisation categories [45]. Traditionally, authors have used thresholds
78 based on a few acoustic parameters to define vocalisation categories (e.g. average
79 vocalisation duration or frequency [27,33]). Recent advances in artificial intelligence
80 made more objective descriptions of vocal repertoires possible, allowing the
81 exploration of large recording banks [18,46–48]. In the present study, we used machine
82 learning techniques dedicated to describing the vocal repertoire of the house mouse
83 and rat [34,49,50] to understand the complexity of the ultrasound repertoire in a wild
84 rodent.

85 We studied acoustic communication in the African striped mouse *Rhabdomys pumilio*,
86 a murine rodent closely related to laboratory mice and rats. The striped mouse
87 diverged from the genera *Mus* and *Rattus* 5 to 6 million years ago [51]. Its social system
88 has been extensively studied in the wild and in the laboratory, making it a key model
89 for exploring the links between environmental variation and social flexibility [51,52].
90 The African striped mouse exhibits remarkable social flexibility, alternating between
91 solitary living and family groups depending on reproductive competition and population
92 density [53]. Family groups generally comprise one breeding male, 2 to 4 breeding
93 females, and up to 25 adult offspring of both sexes [54]. Group members can recognize
94 each other and behave amicable towards each other, but aggressive towards mice
95 from other groups [54,55]. This suggests a complex communication system involving
96 chemical, visual and acoustic channels. From a practical point of view, the striped

97 mouse offers the advantage of being diurnal and easy to observe both in captivity and
98 in the field [54,56]. It therefore represents a good model for understanding the
99 evolutionary diversity of vocalizations and acoustic communication in rodents as well
100 as the interactions between social complexity and communication.

101 Here we tested the hypothesis that the vocalisations produced by African striped mice
102 differ according to the social context, depending on the sex and social familiarity of the
103 interacting individuals. We recorded vocal exchanges between two African striped
104 mice in captivity, reproducing realistic meeting contexts as they exist in the wild when
105 two individuals, familiar or not, meet while they are foraging. We conducted an
106 unsupervised machine learning classification of the vocalizations produced in different
107 social contexts. We also measured the precise timing of acoustic communication to
108 assess the occurrence *versus* avoidance of vocalization overlap when two mice
109 vocalised, an index that could reflect a propensity to 'turn-take' in these rodents. We
110 address the following questions: 1) What is the extent of the striped mouse vocal
111 repertoire? 2) do striped mice demonstrate flexibility in their vocal repertoire usage
112 depending on social context? 3) are both the qualitative and quantitative aspects of
113 vocal exchanges between individuals influenced by their familiarity and their respective
114 sex?

115

116 **2. Methods**

117 *2.1. Ethical note*

118 Mice were kept in large cages with rich enrichment (tubes, houses, rodents' wheels).
119 Weekly enrichment rotations prevented the manifestation of stereotypical behaviour.
120 Furthermore, mice were reared alongside their parents for a minimum of two months
121 prior to separation, a practice demonstrated to significantly reduce striped mice's
122 stereotypical behaviour in adulthood [57]. Manipulation of an animal (e.g., for cage
123 cleaning or transfer to the experiment room) was executed using small boxes, thereby
124 circumventing direct human handling and minimizing induced stress. To minimize
125 stress, during testing, all experiments were conducted within the same cage model
126 used for housing animals. Video monitoring from outside the room enabled quick
127 intervention and cessation of experiments in cases of severe aggression. However,
128 the most aggressive behaviour observed was chasing, with no instance of physical
129 aggression noted. Following the experiments, animals underwent visual inspection for
130 injuries before being returned to their house cage, and no injury was observed. Finally,

131 animals were closely monitored for a period of two days after the experiment, with
132 particular attention given to observing normal behaviours, especially during social
133 interactions and feeding. All procedures were approved by the Loire Ethic Committee
134 for Animal Experimentation of the University of Saint-Etienne (CEEAL-UJM n°98)
135 under agreement number E422180901, for “Study of ultrasonic vocalisations of African
136 striped mice”.

137

138 2.2. *Subjects*

139 We performed 45 pairwise encounters with a total of 87 African striped mice (3 mice
140 were used in two different encounters). All animals were born in captivity and
141 represents in average the 15th generation descending from wild individuals captured in
142 2016 in the Goegap Nature Reserve in South Africa. Animals are housed in pairs
143 (unrelated breeding pair) or unisex groups (siblings) in Zolux Neo Panas XL cages
144 (71*41*48 cm). Enrichments (tubes, wooden houses and platforms) are regularly
145 installed, moved and changed in their cage. The mice are kept under a 12/12h light-
146 dark cycle (lights on at 08:00 to 20:00), in rooms maintained between 24 and 26°C.
147 The experiments were carried out between 10:00 am and 14:00 pm. Mice were fed 90
148 minutes before the start of the experiment with 4 g of seeds’ mix for rodents (Zolux©),
149 and have access to water *ad libitum* in their housing cage.

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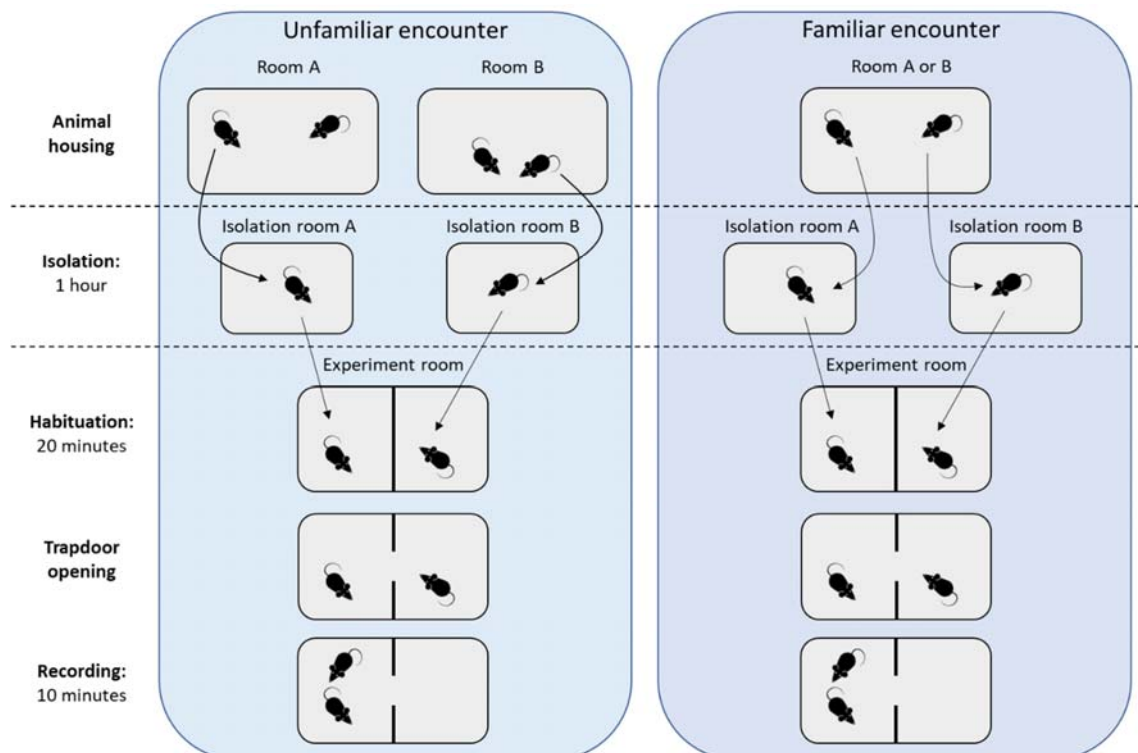
151 2.3. *Experimental design*

152 The pairwise encounters were carried out with 2 adult individuals (aged from 4 to 8
153 months), either familiar or unfamiliar. For each of these categories, we carried out
154 encounters between two males, two females or two individuals of different sex. Familiar
155 encounters between males and females were carried out with unrelated breeding pairs
156 of individuals housed in the same cage for at least 3 weeks and with no dependent
157 offspring. Familiar encounters between individuals of the same sex were carried out
158 with brothers or sisters housed together since birth. In this situation, the familiar
159 individuals were also related. These first two situations mimic what happens in the wild,
160 where the familiar individuals who share the same community nest are the parental
161 pair and the siblings. Unfamiliar encounters (individuals of the same or different sex)
162 were carried out with two individuals born and housed in two separate rooms, with no
163 possibility of having seen, heard or smelled each other since birth.

164 For each pairwise trial in each part of the experiment, the two individuals were taken
 165 out of their maintenance cage and isolated separately in two other cages, which were
 166 placed in separated acoustic chambers for the hour preceding the experiment. The
 167 mice were then introduced into an experimental cage placed in another acoustic
 168 chamber (SilentBox© with acoustic foam-covered walls). The experimental cage
 169 comprised two compartments separated by an opaque, acoustically insulated partition,
 170 meaning animals were not able to hear each other before the encounter (one
 171 compartment per mouse; Zolux Neo Panas XL cage, 71*41*48 cm). The partition was
 172 effective, as no USVs were recorded before the encounter. A trapdoor (with a 6 cm
 173 diameter round opening) allowed communication between the two compartments,
 174 which opening of the trapdoor was controlled from outside the acoustic chamber,
 175 avoiding any disturbance by human intervention. The cage floor was covered with 1
 176 cm of clean bedding (Zolux Chambiose Nature). After a 20-minute habituation period,
 177 during which the mice remained in their respective compartments, the trapdoor was
 178 opened. Once one of the two mice had joined the other in its compartment, the two
 179 individuals remained together for 10 minutes, during which their vocal production was
 180 recorded (Figure 1).

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185 **Figure 1. Encounter experiments.** Left panel: encounter of unfamiliar individuals
186 (housed in different rooms). Right panel: encounter of familiar individuals (housed in
187 the same cage).

188

189 2.4. Acquisition and detection of ultrasonic vocalisations

190 We recorded the ultrasonic vocalisations of the mice with an Avisoft© Bioacoustics
191 CM16 microphone connected to a sound gate (Avisoft© Ultrasound Gate 416H,
192 sampling rate = 300 kHz). The microphone was placed above the centre of the
193 experimental cage, at 55 cm above the cage floor. We performed the acoustic analysis
194 using Deepsqueak© v3.0, a MATLAB software dedicated to the automatic detection
195 and analysis of ultrasonic rodent vocalisations [46]. Spectrograms were generated with
196 a 0.0056-s window, 90% overlap and 0.0056 s NFFT. Two neural networks already
197 trained in Deepsqueak© were used to detect vocalisations (Rat Detector YOLO R1
198 and Mouse Detector YOLO R2). To decide on the best parametrization to optimize the
199 accuracy of automatic detection by the software, we first visually inspected the
200 spectrograms of three randomly selected encounter experiments. Based on this test
201 phase, we chose to set the tonality (Wiener entropy of the detected vocalisation) and
202 the neural network score thresholds at 0.25 and 0.55 respectively.

203 We tested the ability of Deepsqueak software to identify the ultrasonic vocalisations of
204 the African striped mouse by comparing the results of automatic analysis with manual
205 analysis. We randomly selected 6 recording sequences (10 minutes each; 1 sequence
206 per encounter type). The evaluation of DeepSqueak's effectiveness was based on the
207 calculation of several metrics:

- 208 - *Precision*, corresponding to the proportion of USVs detected (True Positive =
209 TP) relative to the total number of sound events detected by Deepsqueak (TP
210 + False Positive FP):

$$211 \text{Precision} = \frac{TP}{TP + FP}$$

212

- 213 - *Recall*, corresponds to the proportion of USVs detected by Deepsqueak relative
214 to the total number of USVs identified manually (TP + False Negative FN):

$$215 \text{Recall} = \frac{TP}{TP + FN}$$

216

217 - *F1-Score*: score of correct USV detection (score representative of the
218 performance of the model, by penalizing large disparities between precision and
219 recall), calculated as follows:

$$220 \quad F1 \text{ score} = 2 \times \frac{\textit{Precision} \times \textit{Recall}}{\textit{Precision} + \textit{Recall}}$$

221

- 222 - *Missed USVs rate*: proportion of missed vocalisations over all vocalisations.
- 223 - *False USVs rate*: proportion of sound events detected by Deepsqueak© which
224 are not USV over all sound events detected.

225 The comparison of automatic and manual analysis shows that the two approaches give
226 almost identical results, confirming that Deepsqueak is a suitable tool for the analysis
227 of the African striped mouse's vocalisations (Supplementary Table 1).

228

229 2.5. Classification of vocalisations

230 When vocalising, mice generally emitted a series of vocalisations separated by
231 silences. Using Deepsqueak© software, we isolated and analysed each vocalisation
232 produced during each recording (average: 159 ± 112 vocalisations per minute of
233 recording). Each vocalisation was described by a set of 9 acoustic descriptors
234 representing its spectro-temporal characteristics (frequency contour, duration and
235 average frequency of vocalisations; Table 1).

236

237 **Table 1. Acoustic parameters used to describe the mice vocalisations.** The
238 frequency parameters are measured on the frequency contour, which is the frequency
239 pattern over time (see Supplementary Figure 1).

240

Acoustic feature	Description
Vocalisation Length (s)	Duration of the vocalisation
Principle Frequency (kHz)	Median frequency of the vocalisation contour
Lowest Frequency (kHz)	Lowest frequency of the vocalisation contour
Highest Frequency (kHz)	Highest frequency of the vocalisation contour
Frequency Bandwidth (kHz)	Total frequency modulation of the vocalisation contour
Frequency Standard Deviation (kHz)	Standard deviation of the frequency of the vocalisation contour
Slope (kHz/s)	Mean slope of the vocalisation contour

Tonality	Wiener entropy of the vocalisation contour
Sinuosity	Length between the first and last points of the vocalisation contour divided by the Euclidean distance between the first and last points

241

242

243 We then classified these vocalisations according to the 9 acoustic descriptors, using
 244 Deepsqueak's unsupervised k-means clustering method (*kmeans_opt* functions in
 245 Deepsqueak package). The maximum number of clusters was set to 100 in order to
 246 achieve the most accurate clustering possible, with 10 replicates. Elbow method was
 247 used to determine the optimal number of clusters. The cut-off was set at 27 clusters
 248 which were then visually inspected. Clusters of vocalisations with a similar frequency
 249 contour were then merged. Clusters containing vocalisations or noise that overlapped
 250 in time were excluded. This resulted in the 7 clusters presented in the results section
 251 (see below). For this classification, we chose to double the weights given to the
 252 parameters describing the frequency contour (maximum amplitude for each time point
 253 in the spectrogram), compared with the weight for vocalisation duration and mean
 254 frequency. We adopted this method emphasizing spectral features because frequency
 255 modulation is expected to be particularly significant in mammalian vocal
 256 communication [58], and after extensive testing of the clustering results with different
 257 weights combined with pilot evaluations based on manual examination of the calls.

258

259 2.6. *Quantifying the temporal overlap between vocalisations*

260 We defined vocalisations as overlapping when the spectrogram presented two different
 261 frequencies at the same time. Because Deepsqueak detected overlapping
 262 vocalisations as one single vocalisation, we first used the software's unsupervised
 263 classification which assigned most of these paired vocalisations to a novel cluster,
 264 different than non-overlapping vocalisations. We then visually reviewed vocalisations
 265 of this novel cluster to exclude non-overlapping ones that had been included due to
 266 classification errors.

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271 2.7. *Visualization of data and statistics*

272 To visualize mouse vocalisations in a two-dimensional acoustic space, we applied the
273 UMAP algorithm (a non-linear algorithm of dimension reduction) on the 9 acoustic
274 predictors used to classify vocalisations using “uwot” package [59].

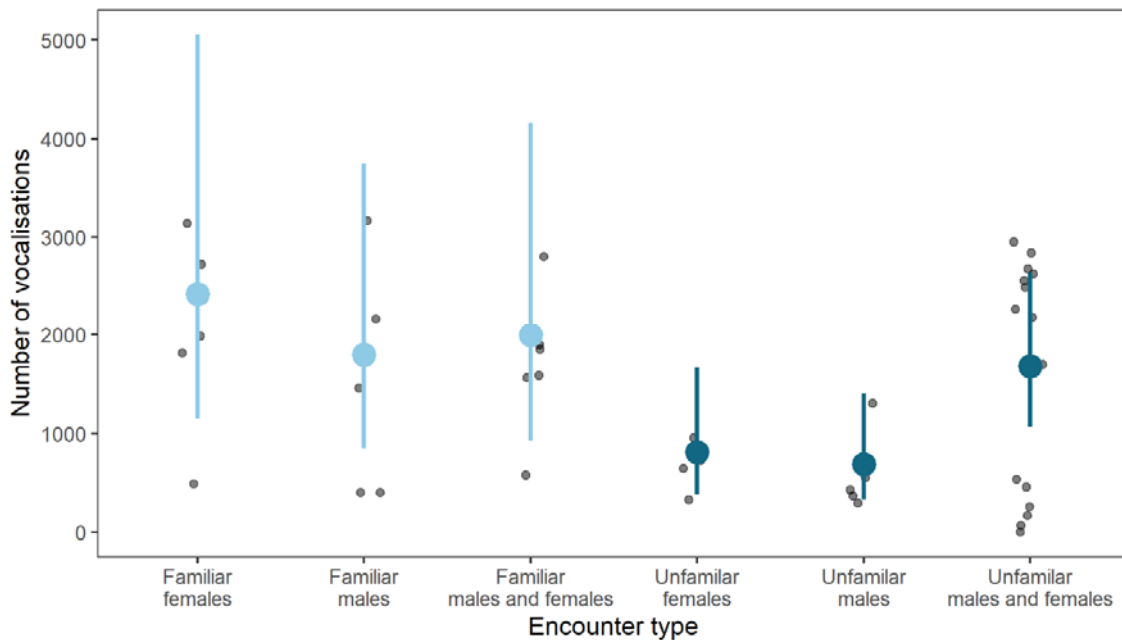
275 For statistical analyses of the effect of social context on the number, temporal
276 dynamics (number of vocalisations / minutes) and overlapping patterns of
277 vocalisations, we used Bayesian multilevel models fitted with the “brms” R package
278 with default priors [60]. Posterior distributions of fitted values were discussed using
279 their medians and 95% credible intervals (CIs). Differences were considered credible
280 when the 95% CI of the difference between posterior distribution of the median
281 between two conditions did not include the null value.

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3. Results

3.1. Vocal production depends on familiarity and sex

Figure 2 shows the average number of vocalisations recorded over 10 minutes for each type of encounter (66,137 vocalisations for all 45 trials). Mice made significantly fewer vocalisations during encounters between same-sex unfamiliar individuals compared to the other types of contexts. Compared to other conditions, they produced on average 1157 less vocalisations over 10 minutes (95% CI [-2241; -142]) for two unfamiliar females and 1259 less (95% CI [-2350; -354]) for two unfamiliar males (see Supplementary Table 2 for all differences between conditions). The number of vocalisations emitted was not significantly different between all other conditions, i.e. all encounters between familiar individuals, whether of the same sex or not, and encounters between unfamiliar individuals of the opposite sex.



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Figure 2. Mice vocal production depends on social context. Solid disks represent the medians of the posterior distributions of the mean and bars represent 95% CI of the data fitted using the Bayesian model *Percentage of overlapping vocalisations ~ Encounter type* (gaussian distribution). Points represent the number of vocalisations emitted by a pair of mice during ten-minute encounters between two individuals, familiar or unfamiliar, of the same or different sex ($n = 15$ for unfamiliar males and females encounter, and $n = 6$ for other encounter types). We recorded on average more vocalisations when the two individuals, female or male, were already living together ("familiar" contexts) than if they had never met before ("Unfamiliar" contexts), unless when the two unfamiliar individuals were of different sexes. In the latter case,

307 the distribution of vocalisations was bimodal: there were either a high number of
308 vocalisations (between 2,000 and 3,000), or a low number (between 0 and 500).

309

310 3.2. *The African striped mouse vocal repertoire*

311 We detected and categorized recorded vocalisations using Deepsqueak© software.

312 We performed a k-means classification based on the frequency contour and duration

313 of the vocalisations. This unsupervised method separated the vocalisations into seven

314 clusters, i.e. corresponding to 7 different types of vocalisations, characterized by

315 particular spectro-temporal parameters (Figure 3). Table 2 summarizes the mean

316 values of these acoustic parameters for each cluster. Most mouse vocalisations were

317 characterized by narrow frequency bands, with varying degrees of frequency

318 modulation. For five of the clusters, frequency modulation was either zero ("flat"

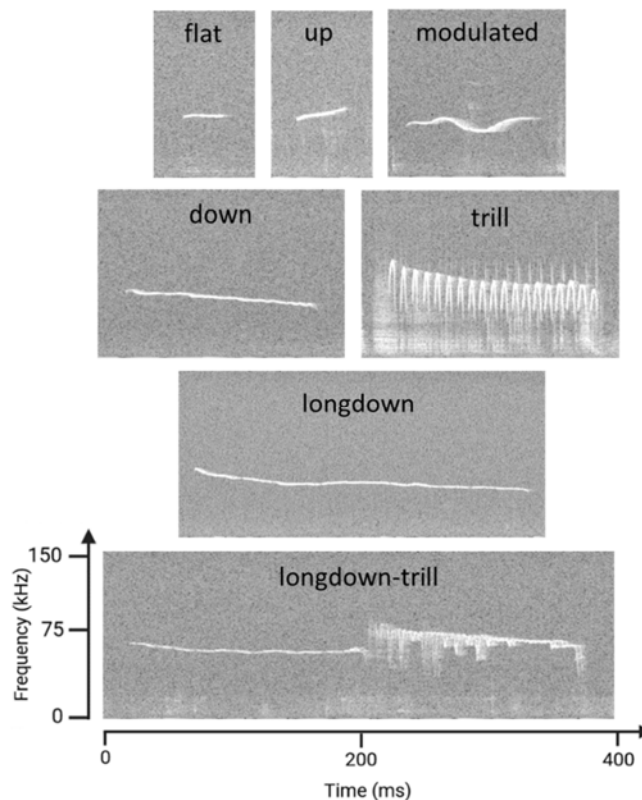
319 cluster), rising ("up" cluster), falling ("down" and "longdown" clusters) or S-shaped

320 ("modulated" cluster). The "trill" and "longdown-trill" clusters were distinguished from

321 the others by a rapid, pronounced sinusoidal frequency modulation, which

322 characterizes all or part of the signal.

323



324

325 **Figure 3. The vocal repertoire of the African striped mouse.** Unsupervised K-
326 means clustering on frequency contours of 63,694 recorded vocalisations led to a

327 repertoire of seven acoustic clusters. The acoustic characteristics of these clusters are
 328 detailed in Table 2.

329

330

331 **Table 2. Spectro-temporal features of the African striped mouse vocalisations.**
 332 Values are the mean of acoustic measurements for each vocalisation type \pm standard
 333 deviation (extracted from 63,694 vocalisations).

<i>Vocalisation type</i>	<i>Number of vocalisations</i>	<i>Duration (ms)</i>	<i>Main Frequency (kHz)</i>	<i>Lowest Frequency (kHz)</i>	<i>Highest Frequency (kHz)</i>	<i>Frequency Bandwidth (kHz)</i>
flat	41,713	25.5 \pm 1.2	59.6 \pm 5.1	57.9 \pm 5.4	61.8 \pm 5.3	3.9 \pm 3.0
up	8,437	36.5 \pm 1.2	59.1 \pm 2.5	57.3 \pm 2.8	64.1 \pm 2.9	6.7 \pm 3.0
modulated	6,455	69.8 \pm 1.6	58.1 \pm 3.0	55.7 \pm 3.2	61.1 \pm 3.6	5.4 \pm 3.3
down	3,174	128.5 \pm 2.5	54.9 \pm 4.5	51.1 \pm 5.2	60.5 \pm 5.2	9.3 \pm 4.7
trill	2,435	77.3 \pm 4.5	74.3 \pm 8.4	64.8 \pm 10.8	83.1 \pm 8.0	18.3 \pm 10.4
longdown	1,203	266.1 \pm 11.9	56.6 \pm 6.6	50.1 \pm 6.7	68.1 \pm 10.1	18.0 \pm 10.5
longdown-trill	277	249.9 \pm 9.7	64.7 \pm 7.7	50.8 \pm 6.9	78.0 \pm 7.0	27.2 \pm 8.2

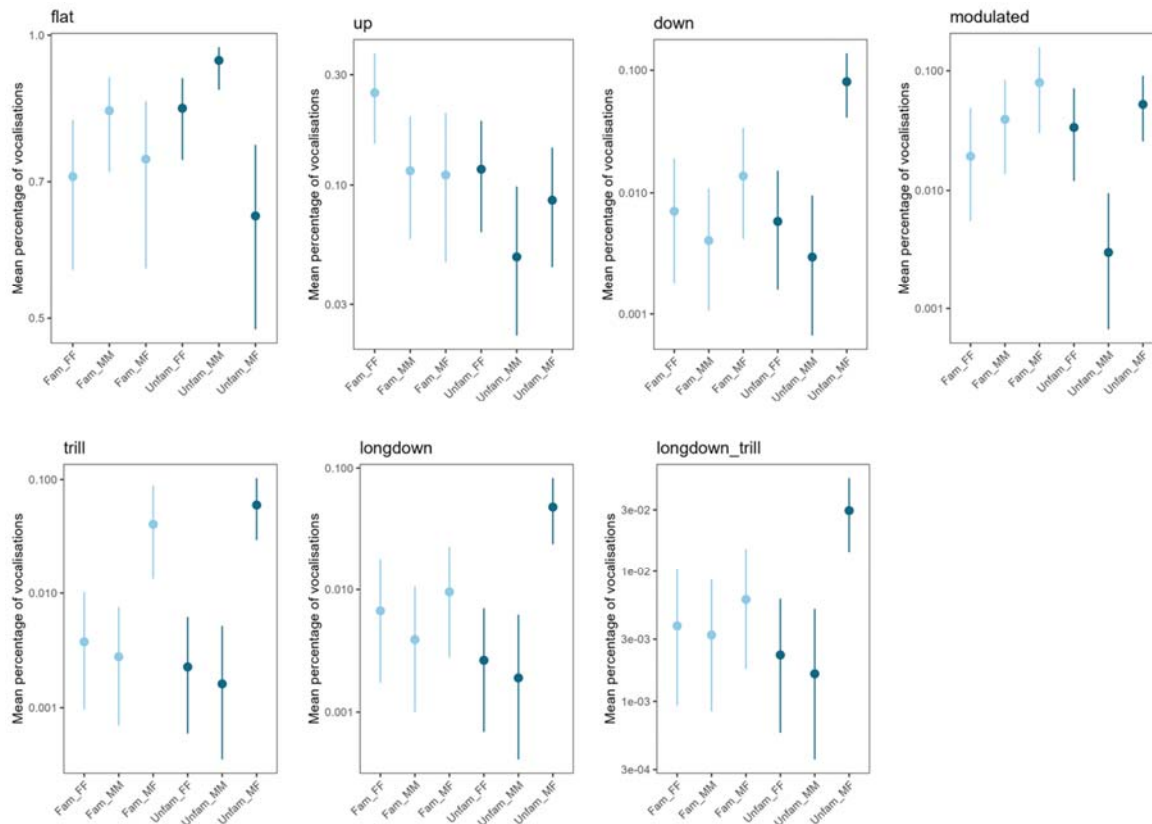
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336 3.3. *Social context drives the use of vocal repertoire*

337 As illustrated in Figure 4, the vocal repertoire deployed by the mice depended on the
 338 sex and familiarity of the individuals in contact. The mice emitted "flat" vocalisations in
 339 all contexts (shown in red in Figure 5), and these vocalisations account for most of the
 340 vocalisations emitted when two unfamiliar males meet (94.8%). In other contexts, mice
 341 used a more varied repertoire. This variation was particularly true during encounters
 342 between unfamiliar females and males. In this context, the mice produced 63.1% "flat"
 343 vocalisations (other contexts: 71-94.8%), but compared to all other contexts more
 344 "down" vocalisations (6.6% vs. 0.1-3.8%), more "longdown" vocalisations (2.7%, vs.
 345 0.0-1.5%), more trills (6.6% vs.0.0-0.2%) and more longdown trills (0.8% vs. 0.0%).
 346 The mice also used a diversified repertoire when familiar females and males met, with
 347 more "down" vocalisations (3.8%), "longdown" (1.5%) and a few trills (0.2%), than
 348 when unfamiliar individuals of the same sex met. Modulated vocalisations were emitted
 349 in greater proportion during encounters between individuals of the opposite sex,
 350 whether unfamiliar (10.5%) or familiar (7.3%), than during encounters between same-
 351 sex individuals. However, the proportion of modulated vocalisations was higher when

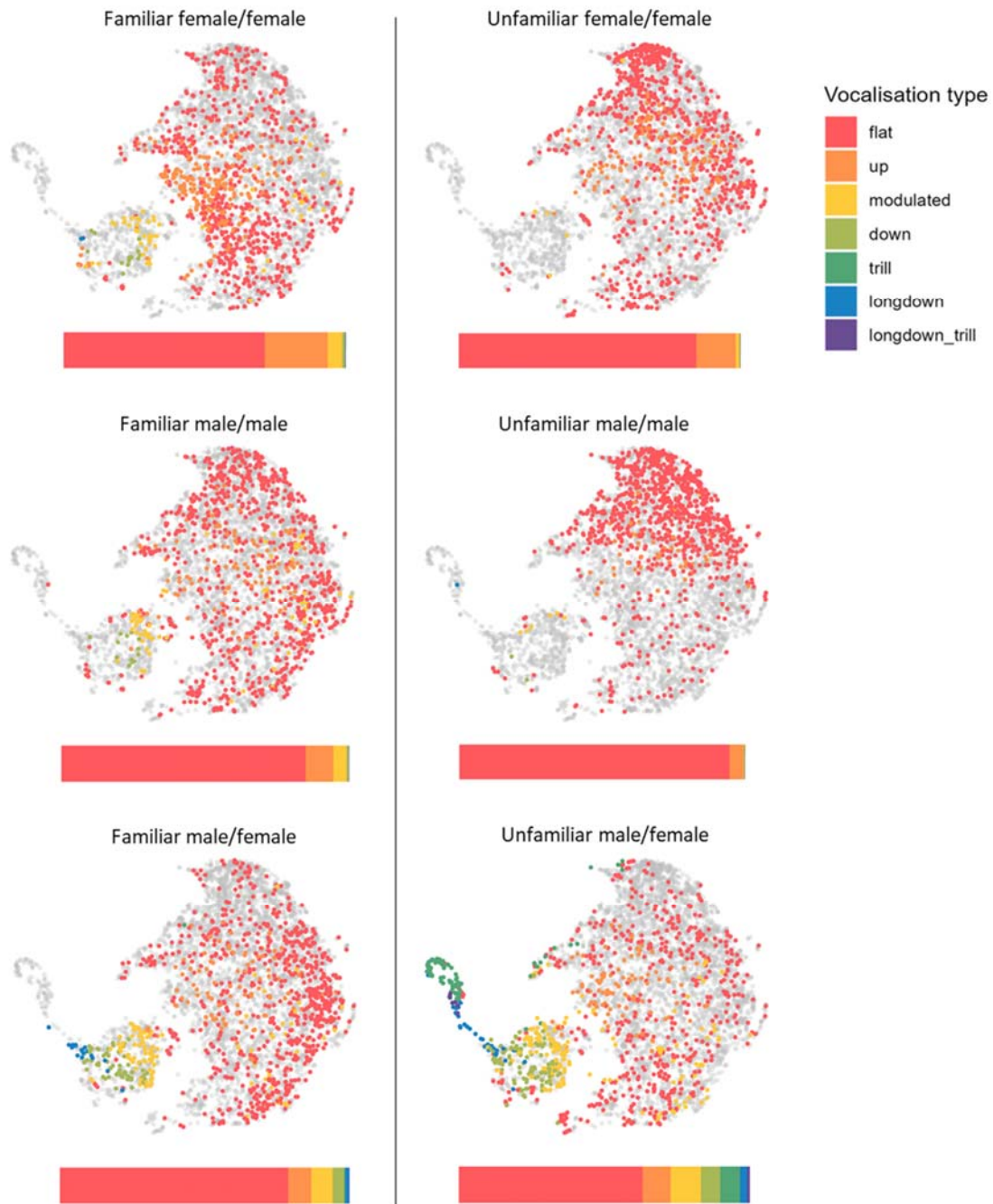
352 the individuals are of the same sex but familiar than when they have never met (4.5%
 353 for familiar males and 5% for familiar females vs. 0.3% and 1.2% for unfamiliar
 354 individuals, respectively for each sex). In encounters between familiar females, there
 355 was a significant proportion of “up” vocalisations (22.3%) compared to other
 356 encounters (see Supplementary Table 3 for all comparisons).



357

358 **Figure 4. The relative proportion of vocalisation types depends on social**
 359 **context.** Fam_FF: familiar females; Fam_MM: familiar males; Unfam_FF: unfamiliar
 360 females; Unfam_MM: unfamiliar males; Unfam_MF: unfamiliar female and male. Solid
 361 disks represent the medians of the posterior distributions and bars represent 95% CI
 362 of the data fitted using the Bayesian model *Percentage of vocalisations ~ Encounter*
 363 *type*. Model fitted using a Dirichlet distribution.

364



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367 **Figure 5. The use of the vocal repertoire by the African striped mouse is context-**
 368 **dependent.** Each panel is an acoustic space constructed using UMAP algorithm of
 369 dimension reduction applied on nine acoustic parameters extracted with Deepsqueak
 370 software. Each dot represents one vocalisation (for clarity, only 1500 vocalisations
 371 randomly selected among all vocalisations detected within an encounter type are
 372 represented). The coloured labels correspond to the vocal repertoire illustrated in
 373 Figure 3. In each of the panels, the vocalisations recorded in the corresponding social
 374 context are represented in colour. The grey dots represent the vocalisations from other
 375 contexts. Bar charts under the UMAP representation show the distribution of
 376 vocalisations for each type of encounter. The longdown, the longdown trill, the trill, the

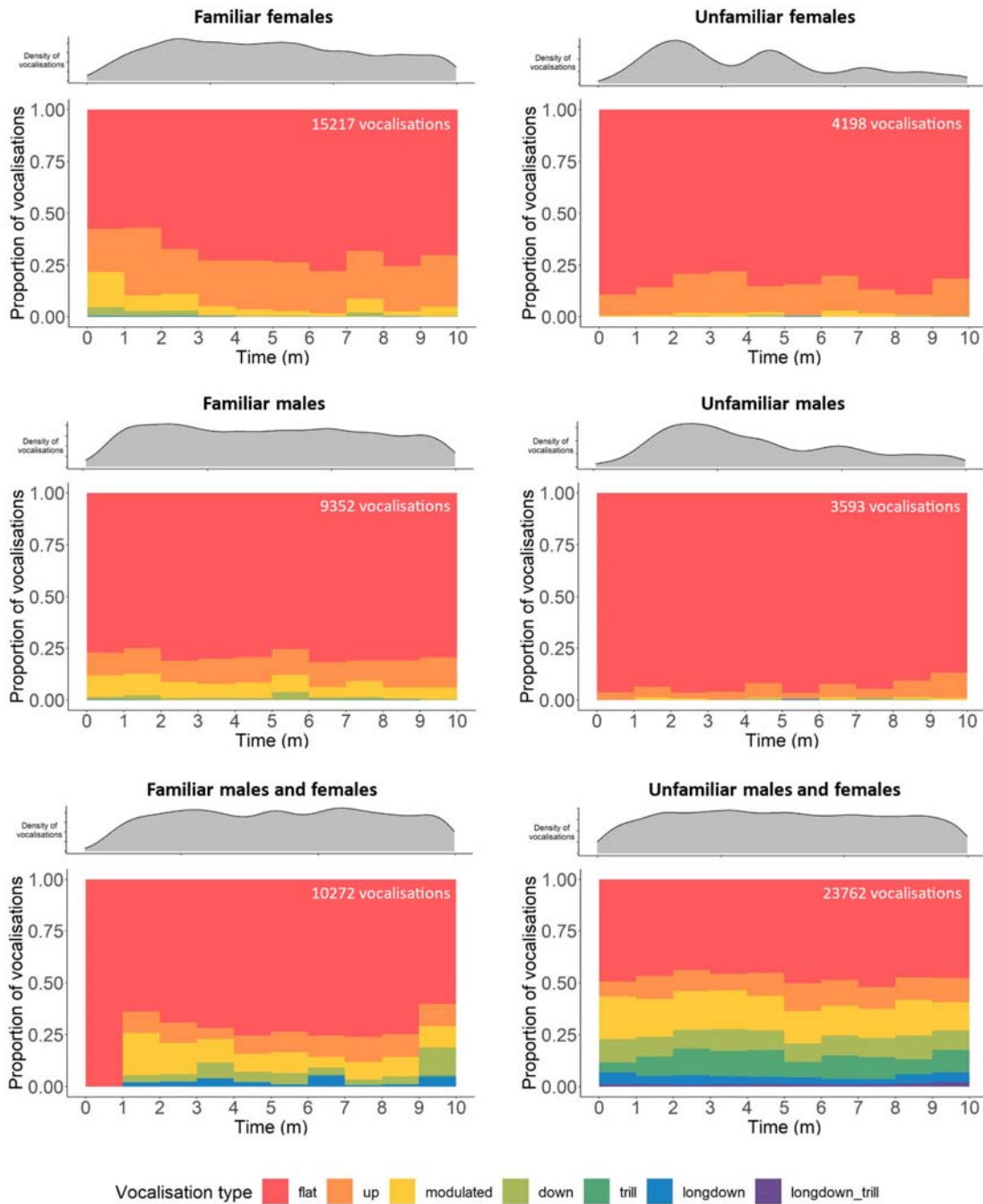
377 modulated and the down vocalisations types make a cluster (including sub-clusters for
378 each of these vocalisations types) distinct from another cluster made of flat and up
379 vocalisations.

380

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382 *3.4. Number of vocalisations and proportion between vocalisation types do not*
383 *change over time*

384 We measured the number of vocalisations and their distribution between the different
385 vocalisation types during the 10 minutes of recording, for each of the six types of
386 encounters (Figure 6). In all contexts, we observed a short adaptation time: during the
387 first minutes, the mice emitted few vocalisations, but their rate of vocal production
388 reached its regular level as early as the third or fourth minute. The rate of vocal
389 production remained stable over time (On average, 12% of the total vocalizations in an
390 encounter were produced per minute between the third and final minute, with a
391 standard deviation of 4%). As illustrated in Figure 6, the relative proportion of the
392 different types of vocalisations is characteristic of each social context (Bayesian model:
393 percentage of vocalisations \sim Time * Type of vocalisation + (1 | Identity of animals)).
394 The African striped mouse therefore modulates the use of its vocal repertoire according
395 to the type of social interaction.



396

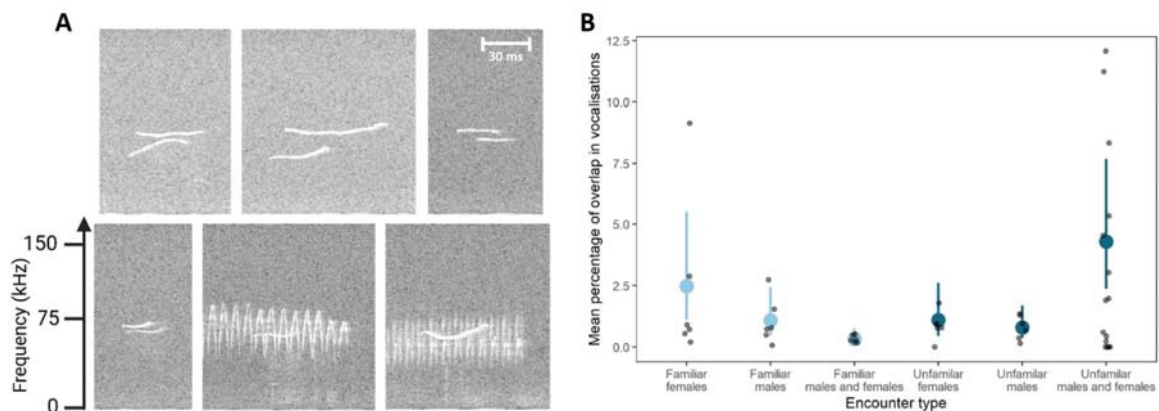
397

398 **Figure 6. Temporal dynamic of vocalisations as a function of social context.** The
 399 grey curves represent the evolution of the number of vocalisations per minute over the
 400 ten minutes of recording. Coloured bar graphs represent the average percentage of
 401 each type of vocalisations.

402 3.5. *Familiar males and females display fewer overlapping vocalisations*

403 We measured the number and proportion of temporally overlapping vocalisations in
404 each recording context. The results show that overlaps between vocalisations were
405 rarest during encounters between familiar females and males compare to encounters
406 between unfamiliar females and males (-3.68% [-7.32%; -2.03%], Figure 7). No
407 differences were observed between familiar same-sex males and females encounter,
408 nor between unfamiliar same-sex ones (see Supplementary Table 4 for all
409 comparisons). The comparison across familiarity is not relevant here, as familiar and
410 unfamiliar same-sex animals show differences of number of vocalisations and time
411 spent vocalising, therefore diminishing the likelihood of observing vocal overlap (Figure
412 1; supplementary Figure 2).

413



414

415

416 **Figure 7. Vocal overlapping during mice encounters. A.** Examples of overlapping
417 vocalisations. **B.** Proportion of overlapping vocalisations for each encounter type. The
418 highest proportion of overlap is observed in encounters between an unfamiliar female
419 and an unfamiliar male. Solid disks represent the medians of the posterior distributions
420 and bars represent 95% CI of the data fitted using the Bayesian model *Percentage of*
421 *overlapping vocalisations* ~ *Encounter type* (hurdle gamma distribution).

422

423 **4. Discussion**

424 Here we reveal how the striped mouse uses its diverse vocal repertoire according to
425 social context, in a both quantitatively and qualitatively flexible way. The content of
426 vocal exchanges between two striped mice differed according to whether they were
427 familiar with each other (sisters, brothers or a paired female and male), or not (from
428 different family groups). Although our experimental setup involved interactions
429 between animals kept in a confined space, our results highlight the complexity of
430 acoustic exchanges in this highly social rodent of wild origin. Together with a few other
431 species like voles [41] and the African gerbil [61], the African striped mouse highlights
432 the diversity of vocal exchanges within Muridae [62].

433 Our methodological approach allowed us to analyse vocalizations at the dyad level,
434 providing valuable insights into social interactions. While precisely identifying the
435 emitter remains a technical challenge due to the absence of visible indicators during
436 vocalization and the proximity of individuals, recent technical developments [63,64]
437 promise to resolve this identification question [11], which will enable exploration of
438 temporal syllable sequences and testing for syntactic rules in this species. Our study
439 establishes a solid foundation for these future investigations and already demonstrates
440 that African striped mice possess a complex ultrasonic vocal repertoire comprising at
441 least seven distinct call forms. Our results reveal that these rodents control their vocal
442 production both qualitatively and quantitatively depending on social context, notably
443 distinguishing between group members and strangers. Communication becomes
444 particularly intensive between unrelated male-female pairs, suggesting a crucial role
445 in courtship.

446 African striped mice vocalised least during encounters between unfamiliar same-sex
447 individuals, mainly emitting flat vocalisations. The mice appear to establish vocal
448 contact during the first few minutes of the encounter, with a marked increase in the
449 number of vocalisations emitted, before rapidly decreasing it. In the field, encounters
450 between two African striped mice from different groups results in short lasting agonistic
451 interactions, after which the animals rapidly move away from each other [54,65]. Our
452 results are congruent with findings in female house mice *Mus musculus*, where two
453 unfamiliar females vocalised less during the first night of contact compared to the
454 second night [37]. In such contexts, the olfactory channel may become rapidly
455 dominant over the acoustic channel [66].

456 In encounters of unfamiliar striped mice of opposite sexes, a bimodal pattern emerged:
457 either very low or very high vocal activity. This bimodality may be attributed to
458 variations in sexual motivation. Male house mice, for instance, produce more
459 vocalisations when presented with receptive females [38], and high USVs production
460 correlates with sexual behaviour in spiny mice [42]. In striped mice, the rate of vocal
461 production remained high throughout the encounter, and the vocalisations were
462 diverse, using particularly modulated vocalisations and trills. The oestrus cycle in
463 striped mice spans 11 days, with five days in oestrus [67], potentially explaining the
464 bimodal distribution, as approximately 45% of females might be in oestrus by chance.
465 Additionally, individuals brought into contact may or may not be attracted to each other.
466 In our laboratory breeding facilities, some mouse pairs reproduce easily, while others
467 do not, possibly due to a lack of mutual attraction. No bimodal pattern was observed
468 in same-sex encounters or between familiar individuals.

469 When familiar individuals reunited after separation, their vocal production increased
470 rapidly and remained high throughout the encounter. This mirrors observation in the
471 wild, when African striped mice emerge from the nest at first sunlight and interact for
472 about 30 minutes [54,55]. The vocal repertoire in these encounters was diverse and
473 similar between females and between males. The only minor difference was the “up”
474 vocalisation that was more present during encounters between familiar females. The
475 richest vocal repertoire was observed in familiar female-male encounters, with a high
476 production of modulated vocalisations. Notably, trills were nearly absent, contrasting
477 with their prevalence in unfamiliar female-male interactions, where the repertoire was
478 most diverse. This suggests that different information is communicated in these
479 contexts.

480 Overall, these results demonstrate that African striped mice possess the ability to
481 discriminate between the sexes and between familiar and unfamiliar conspecifics.
482 Behavioural studies in the field already showed that striped mice can recognize
483 individuals, showing a preference for specific group members with which they interact
484 more upon their return after an experimental removal for one day [55]. In rodents, the
485 olfactory channel also allows the identification of sex and status [68]. While the
486 similarity of vocal repertoire used across same-sex encounters suggests the absence
487 of sexual vocal differences, individual recognition via vocal signatures, as described
488 for prairie voles [69], is still a possibility.

489 In our study, encounters between familiar female and male were at the same time
490 encounters between brothers and sisters, confounding familiarity and relatedness [70].
491 Our experimental setup mimicked natural conditions, where members of one group are
492 both familiar with each other and close kin [52]. Apart from the breeding male, no
493 outsider ever joins a family group. Additionally, all mice in our laboratory share a strong
494 genetic background, descending from the same South African population. This genetic
495 proximity does not diminish the generalizability of our results to unrelated individuals,
496 as a study on house mice [71] has shown that familiar unrelated individuals and familiar
497 related individuals display the same social behaviours towards each other.

498 Understanding how exactly African striped mice use USVs for social communication
499 requires further studies where one can identify individual vocal contributions during
500 interactions. The present work already revealed that the vocal repertoire of the African
501 striped mouse forms an acoustic continuum, with the exception of the trill, which has
502 distinct acoustic features. This acoustic gradation could encode dynamic information,
503 related to short-term fluctuations in the sender's physiological and psychological states
504 [2,72,73]. Graded vocal signals are common in social species where individuals
505 exchange subtle dynamic information [74]. For example, the five most common tonal
506 vocalisations of the bonobo *Pan paniscus* form an acoustic continuum reflecting the
507 sender's arousal level [2]. In the African striped mouse, the up, modulated and down
508 vocalisations define an acoustic continuum around the flat vocalisation, potentially
509 enabling mice to encode dynamic information (level of arousal and/or valence). This is
510 supported by the context-dependent use of these vocalisations. The use of up,
511 modulated and down vocalisations in female-male encounter contexts may reflect a
512 high arousal level. Moreover, these modulated vocalisations may allow animals to
513 produce more complex, less redundant patterns, increasing the likelihood that these
514 vocalisations contain more information (cf. Shannon on the Mathematical Theory of
515 Communication [75]). This hypothesis is reinforced by the fact that most trills are
516 recorded in the female-male contexts - particularly when the individuals are unfamiliar.
517 Trills may therefore play a role in courtship, potentially indicating the quality of the
518 animals. Therefore, it would be valuable to determine whether both males and females
519 produce trills and to correlate their production with body condition and fitness.

520 African striped mice adjust the timing of their vocalisations based on their interaction
521 partner, generally avoiding overlap with a neighbour's vocalizations. The incidence of
522 overlapping declines from 5% in unfamiliar male/female pairs to less than 1% in familiar
523 male/female pairs. Avoiding overlap may facilitate information exchange. This seems

524 to be the case in great apes [76] and cetaceans [77,78]. In birds, overlapping often
525 occurs during territorial interactions as a marker of aggression [79]. Here we described
526 for the first time such control over interactive timing in a murid rodent, suggesting the
527 possibility of “intentionality” (“capacity to act with, and understand, communicative
528 intentions” [80–82]) and rhythm adjustments [83].

529 Since our study has been limited to dyadic interactions, the vocal repertoire presented
530 here may not be exhaustive. In interactions involving more individuals, especially when
531 of different ages and statuses, other vocalisations may be identified. In this respect,
532 the interactions between pups and adults of different classes (breeders and helpers)
533 deserves to be explored. Furthermore, laboratory rodents are known to vocalise in
534 frequencies audible to humans when handled or when in an agonistic context
535 (squeaks, [84]). We have had occasion to hear such vocalisations in African striped
536 mice when handling them [85], but not when the animals were interacting in their
537 cages, nor during our field observations. It could be that the significant risk of predation
538 faced by striped mice in their natural environment causes them to avoid using audible
539 sounds.

540 African striped mice display a diverse ultrasound communication system, in line with
541 the social complexity hypothesis [86]. These animals demonstrate the ability to
542 optimise communication efficiency by controlling the emission of USVs based on the
543 social context, and by adjusting their timing to avoid overlap when interacting with
544 familiar individuals. Additionally, these mice adapt their repertoire use between group
545 members and strangers in their ultrasound communication, with the most intensive
546 interactions occurring between unrelated male-female pairs. By comparing acoustic
547 communication between rodents and taking advantage of the unique social structure
548 of striped mice, future research can certainly deepen our understanding of how vocal
549 communication is shaped by social complexity.

550

551 **Data availability**

552 All code and data are available online in a zenodo repository, and will be available on
553 author’s GitHub in case of publication: <https://zenodo.org/records/11083441>

554

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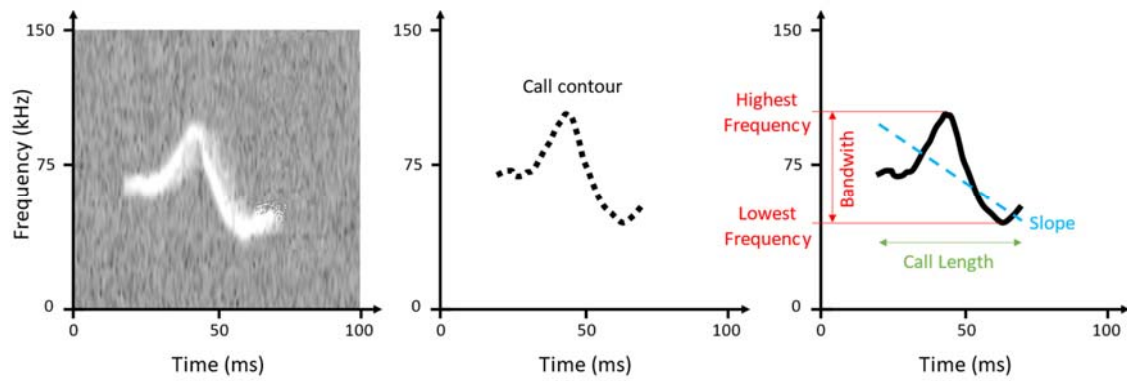
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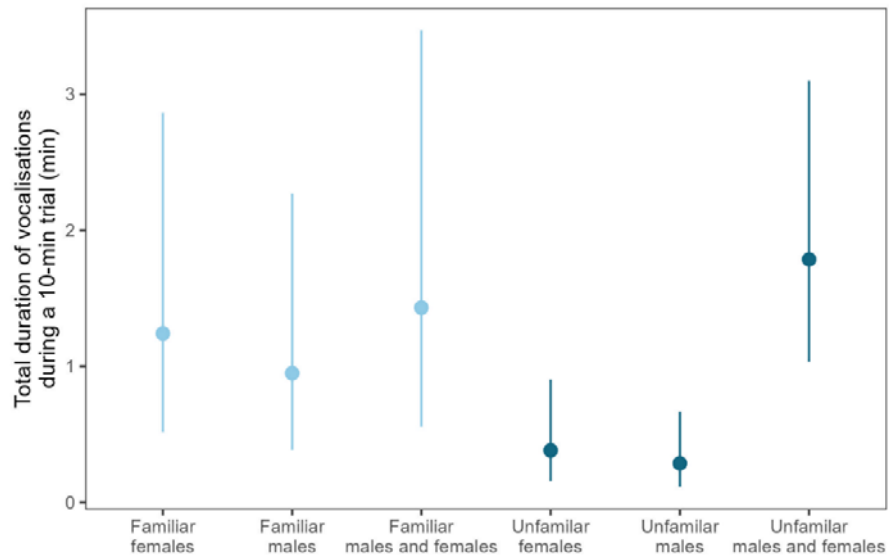
829 **Supplementary figures**

830



831

832 **Supplementary Figure 1. Measurement of acoustic parameters from the**
833 **spectrogram of a vocalisation using Deepsqueak software.** From left to right:
834 spectrogram of an USV call; call contour extracted from the USV; acoustic parameters
835 measured from this call contour.



836

837 **Supplementary Figure 2. Total duration of vocalisations depending on social**
 838 **context.** Solid disks represent the medians of the posterior distributions and bars
 839 represent 95% CI of the data fitted using the Bayesian model *Total duration of*
 840 *vocalisations over a 10-min trial ~ Encounter type.* Model fitted using a gamma
 841 distribution.

842 **Supplementary Table 1. Efficiency of automatic detection of ultrasonic**
 843 **vocalisations (USVs) by Deepsqueak software.** “FF”: Female-Female, “MM” Male-
 844 Male, “MF” Male Female. “Precision”: Proportion of USVs detected relative to the total
 845 number of sound events detected by Deepsqueak. “Recall”: Proportion of USVs
 846 detected by Deepsqueak relative to the total number of USVs identified manually. “F1-
 847 score”: score of correct USV detection.

848

Familiarity	Sexes	Precision	Recall	F1-score	Missed USVs rate	False USVs rate
Familiar	FF	100,00%	97,33%	98,65%	2,67%	0,00%
	MM	99,50%	96,01%	97,72%	2,86%	0,38%
	MF	99,62%	97,14%	98,37%	3,99%	0,50%
Unfamiliar	FF	98,36%	98,12%	98,24%	1,88%	1,66%
	MM	99,34%	95,09%	97,17%	5,16%	1,46%
	MF	98,56%	94,84%	96,67%	4,91%	0,67%

849

850 **Supplementary Table 2. Bayesian comparison of number of vocalisations**
 851 **produced for each encounter type.** The table displays differences in the number
 852 vocalisations for the encounter type in rows compared to the encounter type in column.
 853 Comparisons are presented using median of posterior distribution difference with its
 854 95% credible interval. Values represent the percentage difference for each vocalisation
 855 type (difference is condition on the left minus condition on top).
 856

	Fam_FF	Fam_MM	Fam_MF	Unfam_FF	Unfam_MM	Unfam_MF
Fam_FF		540, [-1706, 3450]	380, [-2169, 3359]	1415, [73, 4296]	1546, [234, 4370]	561, [-875, 3450]
Fam_MM	-540, [-3450, 1706]		-176, [-2577, 2014]	870, [-307, 2964]	979, [-69, 3145]	8, [-1249, 2138]
Fam_MF	-380, [-3359, 2169]	176, [-2014, 2577]		1036, [-199, 3461]	1143, [30, 3477]	179, [-1134, 2591]
Unfam_FF	-1415, [-4296, -73]	-870, [-2964, 307]	-1036, [-3461, 199]		96, [-724, 1111]	-866, [-1960, 173]
Unfam_MM	-1546, [-4370, -234]	-979, [-3145, 69]	-1143, [-3477, -30]	-96, [-1111, 724]		-966, [-2085, -59]
Unfam_MF	-561, [-3450, 875]	-8, [-2138, 1249]	-179, [-2591, 1134]	866, [-173, 1960]	966, [59, 2085]	

857

858 **Supplementary Table 3. Bayesian comparison of vocalisation types use for each**
 859 **encounter type.** The tables display differences in the absolute percentage of
 860 vocalisations for each call type, for the encounter type in rows compared to the
 861 encounter type in column. Comparisons are presented using median of posterior
 862 distribution difference with its 95% credible interval. Values represent the percentage
 863 difference for each vocalisation type (difference is condition on the left minus condition
 864 on top).
 865

flat

	Unfam_MF	Fam_MF	Unfam_FF	Fam_FF	Unfam_MM	Fam_MM
Unfam_MF		-9.73% [-29.18%, 11.08%]	-18.9% [-36.11%, -4.24%]	-6.51% [-25.18%, 12.05%]	-29.22% [-45.92%, -16.38%]	-18.57% [-36.19%, -2.36%]
Fam_MF	9.73% [-11.08%, 29.18%]		-8.96% [-27.84%, 4.9%]	3.4% [-16.39%, 21.1%]	-19.21% [-37.51%, -7.45%]	-8.69% [-27.73%, 6.87%]
Unfam_FF	18.9% [4.24%, 36.11%]	8.96% [-4.9%, 27.84%]		12.44% [-1.52%, 28.67%]	-10.1% [-20.71%, -1.53%]	0.33% [-11.93%, 13.36%]
Fam_FF	6.51% [-12.05%, 25.18%]	-3.4% [-21.1%, 16.39%]	-12.44% [-28.67%, 1.52%]		-22.66% [-38.04%, -11.13%]	-12.09% [-27.9%, 3.11%]
Unfam_MM	29.22% [16.38%, 45.92%]	19.21% [7.45%, 37.51%]	10.1% [1.53%, 20.71%]	22.66% [11.13%, 38.04%]		10.41% [1.59%, 22.88%]
Fam_MM	18.57% [2.36%, 36.19%]	8.69% [-6.87%, 27.73%]	-0.33% [-13.36%, 11.93%]	12.09% [-3.11%, 27.9%]	-10.41% [-22.88%, -1.59%]	

up

	Unfam_MF	Fam_MF	Unfam_FF	Fam_FF	Unfam_MM	Fam_MM
Unfam_MF		-2.21% [-12.8%, 6.3%]	-3.05% [-11.42%, 4.95%]	-16.23% [-29.43%, -5%]	3.65% [-2.64%, 10.31%]	-2.78% [-12.25%, 5.4%]
Fam_MF	2.21% [-6.3%, 12.8%]		-0.84% [-10.31%, 10.19%]	-13.89% [-28.05%, -0.47%]	5.85% [-1.69%, 16.1%]	-0.57% [-11.1%, 10.59%]
Unfam_FF	3.05% [-4.95%, 11.42%]	0.84% [-10.19%, 10.31%]		-13.12% [-26.8%, -1%]	6.78% [-0.35%, 14.64%]	0.28% [-9.56%, 9.4%]
Fam_FF	16.23% [5%, 29.43%]	13.89% [0.47%, 28.05%]	13.12% [1%, 26.8%]		19.89% [9.01%, 32.81%]	13.39% [0.64%, 27%]
Unfam_MM	-3.65% [-10.31%, 2.64%]	-5.85% [-16.1%, 1.69%]	-6.78% [-14.64%, 0.35%]	-19.89% [-32.81%, -9.01%]		-6.43% [-15.53%, 0.62%]
Fam_MM	2.78% [-5.4%, 12.25%]	0.57% [-10.59%, 11.1%]	-0.28% [-9.4%, 9.56%]	-13.39% [-27%, -0.64%]	6.43% [-0.62%, 15.53%]	

modulated

	Unfam_MF	Fam_MF	Unfam_FF	Fam_FF	Unfam_MM	Fam_MM
Unfam_MF		-2.39% [-11.12%, 3.66%]	1.88% [-2.67%, 6.38%]	3.21% [-0.54%, 7.5%]	4.71% [2.2%, 8.86%]	1.39% [-3.91%, 5.91%]
Fam_MF	2.39% [-3.66%, 11.12%]		4.22% [-1.63%, 12.94%]	5.6% [0.32%, 14.11%]	7.15% [2.65%, 15.5%]	3.74% [-2.61%, 12.47%]
Unfam_FF	-1.88% [-6.38%, 2.67%]	-4.22% [-12.94%, 1.63%]		1.32% [-2.33%, 5.52%]	2.76% [0.85%, 6.88%]	-0.5% [-5.7%, 4.12%]
Fam_FF	-3.21% [-7.5%, 0.54%]	-5.6% [-14.11%, -0.32%]	-1.32% [-5.52%, 2.33%]		1.39% [0.1%, 4.59%]	-1.81% [-6.69%, 1.9%]
Unfam_MM	-4.71% [-8.86%, -2.2%]	-7.15% [-15.5%, -2.65%]	-2.76% [-6.88%, -0.85%]	-1.39% [-4.59%, -0.1%]		-3.28% [-8.12%, -1.02%]
Fam_MM	-1.39% [-5.91%, 3.91%]	-3.74% [-12.47%, 2.61%]	0.5% [-4.12%, 5.7%]	1.81% [-1.9%, 6.69%]	3.28% [1.02%, 8.12%]	

866

down

	Unfam_MF	Fam_MF	Unfam_FF	Fam_FF	Unfam_MM	Fam_MM
Unfam_MF		6.39% [2.31%, 12.51%]	7.2% [3.4%, 13.22%]	7.09% [3.23%, 13.12%]	7.48% [3.73%, 13.5%]	7.37% [3.61%, 13.38%]
Fam_MF	-6.39% [-12.51%, -2.31%]		0.67% [-0.55%, 2.82%]	0.57% [-0.88%, 2.74%]	0.93% [-0.06%, 3.06%]	0.83% [-0.22%, 2.99%]
Unfam_FF	-7.2% [-13.22%, -3.4%]	-0.67% [-2.82%, 0.55%]		-0.08% [-1.44%, 0.97%]	0.24% [-0.49%, 1.29%]	0.14% [-0.65%, 1.16%]
Fam_FF	-7.09% [-13.12%, -3.23%]	-0.57% [-2.74%, 0.88%]	0.08% [-0.97%, 1.44%]		0.34% [-0.43%, 1.67%]	0.23% [-0.6%, 1.57%]
Unfam_MM	-7.48% [-13.5%, -3.73%]	-0.93% [-3.06%, 0.06%]	-0.24% [-1.29%, 0.49%]	-0.34% [-1.67%, 0.43%]		-0.1% [-0.87%, 0.62%]
Fam_MM	-7.37% [-13.38%, -3.61%]	-0.83% [-2.99%, 0.22%]	-0.14% [-1.16%, 0.65%]	-0.23% [-1.57%, 0.6%]	0.1% [-0.62%, 0.87%]	

trill

	Unfam_MF	Fam_MF	Unfam_FF	Fam_FF	Unfam_MM	Fam_MM
Unfam_MF		2.02% [-3.94%, 7.19%]	5.53% [2.71%, 10.09%]	5.39% [2.5%, 9.93%]	5.59% [2.76%, 10.11%]	5.47% [2.66%, 10.03%]
Fam_MF	-2.02% [-7.19%, 3.94%]		3.48% [1.09%, 8.7%]	3.34% [0.9%, 8.55%]	3.55% [1.14%, 8.72%]	3.43% [1.01%, 8.64%]
Unfam_FF	-5.53% [-10.09%, -2.71%]	-3.48% [-8.7%, -1.09%]		-0.11% [-0.83%, 0.34%]	0.06% [-0.33%, 0.49%]	-0.04% [-0.56%, 0.4%]
Fam_FF	-5.39% [-9.93%, -2.5%]	-3.34% [-8.55%, -0.9%]	0.11% [-0.34%, 0.83%]		0.18% [-0.25%, 0.88%]	0.08% [-0.46%, 0.78%]
Unfam_MM	-5.59% [-10.11%, -2.76%]	-3.55% [-8.72%, -1.14%]	-0.06% [-0.49%, 0.33%]	-0.18% [-0.88%, 0.25%]		-0.1% [-0.64%, 0.3%]
Fam_MM	-5.47% [-10.03%, -2.66%]	-3.43% [-8.64%, -1.01%]	0.04% [-0.4%, 0.56%]	-0.08% [-0.78%, 0.46%]	0.1% [-0.3%, 0.64%]	

longdown

	Unfam_MF	Fam_MF	Unfam_FF	Fam_FF	Unfam_MM	Fam_MM
Unfam_MF		3.7% [1.14%, 7.46%]	4.36% [2.09%, 8.02%]	3.98% [1.49%, 7.7%]	4.43% [2.17%, 8.1%]	4.23% [1.9%, 7.93%]
Fam_MF	-3.7% [-7.46%, -1.14%]		0.59% [-0.1%, 2.04%]	0.25% [-1.06%, 1.76%]	0.66% [-0.02%, 2.12%]	0.48% [-0.37%, 1.94%]
Unfam_FF	-4.36% [-8.02%, -2.09%]	-0.59% [-2.04%, 0.1%]		-0.32% [-1.57%, 0.26%]	0.07% [-0.4%, 0.56%]	-0.1% [-0.83%, 0.41%]
Fam_FF	-3.98% [-7.7%, -1.49%]	-0.25% [-1.76%, 1.06%]	0.32% [-0.26%, 1.57%]		0.39% [-0.17%, 1.63%]	0.22% [-0.58%, 1.47%]
Unfam_MM	-4.43% [-8.1%, -2.17%]	-0.66% [-2.12%, 0.02%]	-0.07% [-0.56%, 0.4%]	-0.39% [-1.63%, 0.17%]		-0.17% [-0.9%, 0.32%]
Fam_MM	-4.23% [-7.93%, -1.9%]	-0.48% [-1.94%, 0.37%]	0.1% [-0.41%, 0.83%]	-0.22% [-1.47%, 0.58%]	0.17% [-0.32%, 0.9%]	

longdown-trill

	Unfam_MF	Fam_MF	Unfam_FF	Fam_FF	Unfam_MM	Fam_MM
Unfam_MF		2.25% [0.6%, 4.74%]	2.6% [1.16%, 5.04%]	2.47% [0.92%, 4.91%]	2.67% [1.22%, 5.12%]	2.52% [1.02%, 4.96%]
Fam_MF	-2.25% [-4.74%, -0.6%]		0.32% [-0.2%, 1.3%]	0.19% [-0.57%, 1.19%]	0.38% [-0.1%, 1.36%]	0.24% [-0.42%, 1.21%]
Unfam_FF	-2.6% [-5.04%, -1.16%]	-0.32% [-1.3%, 0.2%]		-0.12% [-0.83%, 0.34%]	0.06% [-0.33%, 0.49%]	-0.08% [-0.69%, 0.38%]
Fam_FF	-2.47% [-4.91%, -0.92%]	-0.19% [-1.19%, 0.57%]	0.12% [-0.34%, 0.83%]		0.17% [-0.25%, 0.89%]	0.04% [-0.58%, 0.77%]
Unfam_MM	-2.67% [-5.12%, -1.22%]	-0.38% [-1.36%, 0.1%]	-0.06% [-0.49%, 0.33%]	-0.17% [-0.89%, 0.25%]		-0.13% [-0.73%, 0.27%]
Fam_MM	-2.52% [-4.96%, -1.02%]	-0.24% [-1.21%, 0.42%]	0.08% [-0.38%, 0.69%]	-0.04% [-0.77%, 0.58%]	0.13% [-0.27%, 0.73%]	

868 **Supplementary Table 4. Bayesian comparisons of overlapping in striped mice**
869 **vocalisations during dyadic encounters.** The table displays differences in the
870 absolute percentage of overlapping vocalisations for the encounter type in rows
871 compared to the encounter type in column. Comparisons are presented using median
872 of posterior distribution difference with its 95% credible interval. Values represent the
873 percentage difference for each vocalisation type (difference is condition on the left
874 minus condition on top).
875

	Fam_FF	Fam_MM	Fam_MF	Unfam_FF	Unfam_MM	Unfam_MF
Fam_FF	0% [0%, 0%]	1.2% [-0.48%, 4.46%]	1.88% [0.72%, 5.16%]	1.19% [-0.58%, 4.46%]	1.44% [0.09%, 4.72%]	-1.74% [-5.6%, 1.67%]
Fam_MM	-1.2% [-4.46%, 0.48%]	0% [0%, 0%]	0.65% [0.02%, 2.08%]	0.01% [-1.64%, 1.5%]	0.23% [-0.79%, 1.61%]	-2.98% [-6.71%, -1.01%]
Fam_MF	-1.88% [-5.16%, -0.72%]	-0.65% [-2.08%, -0.02%]	0% [0%, 0%]	-0.63% [-2.28%, -0.02%]	-0.41% [-1.36%, 0.13%]	-3.68% [-7.32%, -2.03%]
Unfam_FF	-1.19% [-4.46%, 0.58%]	-0.01% [-1.5%, 1.64%]	0.63% [0.02%, 2.28%]	0% [0%, 0%]	0.21% [-0.82%, 1.82%]	-2.97% [-6.58%, -0.88%]
Unfam_MM	-1.44% [-4.72%, -0.09%]	-0.23% [-1.61%, 0.79%]	0.41% [-0.13%, 1.36%]	-0.21% [-1.82%, 0.82%]	0% [0%, 0%]	-3.21% [-6.93%, -1.49%]
Unfam_MF	1.74% [-1.67%, 5.6%]	2.98% [1.01%, 6.71%]	3.68% [2.03%, 7.32%]	2.97% [0.88%, 6.58%]	3.21% [1.49%, 6.93%]	0% [0%, 0%]

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