

1 **Appendix S1. Details of new data for wild free-ranging chimpanzees**

2 To confirm the scarcity of vocal turn-taking in chimpanzees that we observed in a captive
3 group (Pougnault *et al.*, in press), and that Arcadi (2000) previously reported for wild adult
4 males, we conducted a study on a free-ranging population using a methodology established
5 for other non-human great apes [gorilla *Gorilla gorilla* (Lemasson *et al.*, 2018); bonobo *Pan*
6 *paniscus* (Levréro *et al.*, 2019)].

7

8 ***Compliance with ethical standards***

9 Permission and ethical approval to conduct the study was granted by the Uganda Wildlife
10 Authority (UWA) (permit number: COD/96/05), the Uganda National Council for Science
11 and Technology (UNCST) (permit number: NS47ES) and the Animal Welfare & Ethical
12 Review Body from the University of Warwick, UK (permit number: AWERB.36/17-18).

13

14 ***Group composition***

15 The study was conducted between February and May 2019 on free-ranging chimpanzees (*Pan*
16 *trogodytes*) of the Sonso community in the Budongo Forest Reserve, Uganda, comprising 42
17 adult individuals (12 males and 30 females) with a home range of approximately 15 km².

18 The Sonso community has been studied since 1990 and is well habituated to the presence of
19 humans.

20 Our study included 35 identified individuals (12 adult males, 13 adult females, three sub-adult
21 males, one sub-adult female, one juvenile male, one juvenile female, two infant males and
22 two infant females; see Table S1).

23

24 **Table 1.** Details of the identified individuals in the studied Sonso chimpanzee community.

Subject name	Estimated birth date	Age–sex category	Mother’s name
NB	1962	Adult female	–

OK	1996±1 year	Adult female	–
FL	1979	Adult female	–
KL	1979±1 year	Adult female	–
KU	1979	Adult female	–
KW	1981	Adult female	–
ZF	1982±6 months	Adult male	BN
JN	1984±1 year	Adult female	–
TJ	1984±5 years	Adult female	–
SQ	1991±1 year	Adult male	BC
MS	1992±6 months	Adult male	NB
HW	1993±1 year)	Adult male	HT
KT	1993	Adult male	KU
SM	1993±1 year	Adult male	SE
KZ	1995	Adult male	KW
ZL	1995	Adult male	ZN
PS	1998± 1 year	Adult male	PL
RS	1997	Adult female	RH
FK	1999±1 year	Adult male	FL
RM	2002	Adult female	RH
ZD	2003	Adult male	ZN
DL	2002±1 year	Adult female	–
CD	2003±1 year	Adult female	–
KS	2003	Adult male	KU
EV	2004±1 year	Adult female	–
JS	2006	Sub-adult male	JN
KC	2006	Sub-adult male	KL
KX	2007	Sub-adult female	KY
MB	2009	Sub-adult male	ML
TW	2010	Juvenile female	TJ
KF	2014	Juvenile male	KU
KO	2014	Infant male	KL
IS	2017	Infant female	IR
RN	2018	Infant male	RS
DB	2018	Infant female	DL

25 –, unknown.

26 Age–sex classes are based on Reynolds (2005).

27

28 ***Vocal data collection***

29 Call production was recorded by one observer (M.L.), accompanied by a field assistant, using

30 a Marantz PMD661 mk3 handheld digital audio recorder (Marantz, Japan) (sample rate 44.1

31 kHz, resolution 32 bits, .wav format) connected to a directional Sennheiser ME66/K6

32 microphone (Sennheiser, Germany). Call recordings were made on a focal sampling basis for

33 adult individuals and *ad libitum* for sub-adults, juveniles and infants (Altmann, 1974)

34 throughout the day between 07:00 and 16:30. Recording sessions lasted 2 h per day, at a

35 maximum distance of 15 m (average 10 m, up to 15 m when individuals were moving through
36 the canopy).
37 The 1305 calls recorded corresponded to 44 h 34 min of recording. Due to poor quality (e.g.
38 emitter too far from recorder, or background forest noise), 3% (41/1305) of calls were
39 discarded. Among the remaining calls, 44% (562/1264) were removed from our analyses due
40 to uncertainty in caller identity. The remaining 702 calls were used in analyses.
41 Given that turn-taking and avoidance of overlap are expected to be associated with peaceful
42 interactions and affiliation, while high arousal and conflict lead to frequent call overlap (e.g.
43 Levréro *et al.*, 2019; Pognault *et al.*, 2020a), we distinguished calls emitted within peaceful
44 contexts (e.g. resting, foraging periods, and affiliative social interactions such as grooming)
45 from calls recorded in agonistic interactions (e.g. conflict characterised by chasing, hitting and
46 biting behaviours) or given in response to external disturbances (e.g. falling tree). Thus, from
47 the initial 702 calls, we extracted 71% (495/702) of calls produced in peaceful contexts. To
48 determine call types, we used the criteria of Pognault *et al.* (in press) (see Table S2).

49
50 **Table S2.** Distribution of call types recorded in this study.

	Adult females	Adult males	Sub-adult female	Sub-adult males	Juvenile females	Juvenile males	Infants
Bark	0	10	0	0	0	0	0
Cough	0	1	0	0	0	0	0
Grunt	220	112	0	11	0	4	3
Huu	0	0	0	0	0	0	0
Laugh	0	0	0	0	0	0	0
Mixed calls	5	44	0	4	0	0	0
Pant	4	0	0	1	0	0	0
Pant-grunt	22	15	1	6	2	1	1
Pant-hoot	11	26	1	1	0	1	0
Rough grunt	0	3	0	0	0	0	0
Scream	18	18	0	7	0	0	16
Squeak	17	0	0	0	0	0	0
Waa-bark	2	0	0	0	0	0	0
Whimper	5	49	0	0	0	0	30
Hoo	14	13	0	3	0	0	0

51

52 *Vocal data processing*

53 The following analyses were performed both for calls emitted in all contexts ($N_{\text{All contexts}} =$
54 702) and for calls only produced in peaceful contexts ($N_{\text{Peaceful contexts}} = 495$).

55 We investigated the temporal organisation of call production by measuring all inter-call
56 durations using call spectrograms generated by PRAAT software version 6.1.09 using a
57 Gaussian window. Inter-call durations corresponded to a silent gap between two consecutive
58 calls of any call type emitted by two different callers, from the end of the first call to the onset
59 of the second call (see Lemasson *et al.*, 2018). To define a call as belonging to a vocal
60 interaction (i.e. as part of a sequence of at least two successive calls of alternating individuals
61 with a short or negative inter-call delay), we used a graphical method applied previously to
62 define the maximum response delay for a vocal interaction in other primates [Campbell's
63 monkey *Cercopithecus campbelli* (Lemasson *et al.*, 2010a); gorilla (Lemasson *et al.*, 2018);
64 bonobo (Levréro *et al.*, 2019)]. We defined a temporal window of a maximum of 10 s after
65 the onset of the first call, which was deemed long enough to include all patterns of vocal
66 interaction, based on a broad range of species. We then used the distribution of inter-call
67 delays and defined a maximum response delay for vocal interaction (temporal threshold) to
68 classify whether a call belonged to a vocal interaction or not. The temporal threshold was
69 placed at the point where inter-call delays start to increase above a baseline representing the
70 background level of inter-call delays outside vocal interactions. We removed choruses (i.e.
71 more than two individuals calling at the same time; Yoshida & Okanoya, 2005) from our
72 analyses where it was not possible to identify the callers individually, retaining only
73 overlapping calls involving two identified callers. When several calls overlapped (i.e. had
74 negative inter-call durations), we again retained only the sequences for which callers were
75 identified.

76 We quantified the proportions of: (i) calls produced during vocal interactions, and (ii) calls
77 emitted in the absence of vocal interaction, i.e. calls emitted independently from the
78 vocalisations of other group members (see also Bouchet *et al.*, 2010; Levréro *et al.*, 2019).
79 Calls occurring outside vocal interactions were of two temporal patterns: an isolated single
80 call or a repeated sequence of one call type (i.e. a series of calls separated by short silent
81 gaps). We applied the same temporal threshold described above to classify whether a call was
82 emitted alone or repeated (Koda, 2004; Lemasson *et al.*, 2013, 2018). Note that for pant, pant-
83 hoot and pant-grunt vocalisations, isolated calls could be composed of several unmerged
84 sound units because pants, pant-hoots and pant-grunts are, by definition, multi-unit calls
85 incorporating noisy inhalation phases (Gros-Louis & Mitani, 1998; Laporte & Zuberbühler,
86 2010).
87 Finally, we calculated the hourly production rates of the different call patterns according to
88 the sex of adult individuals.

89

90 **Results**

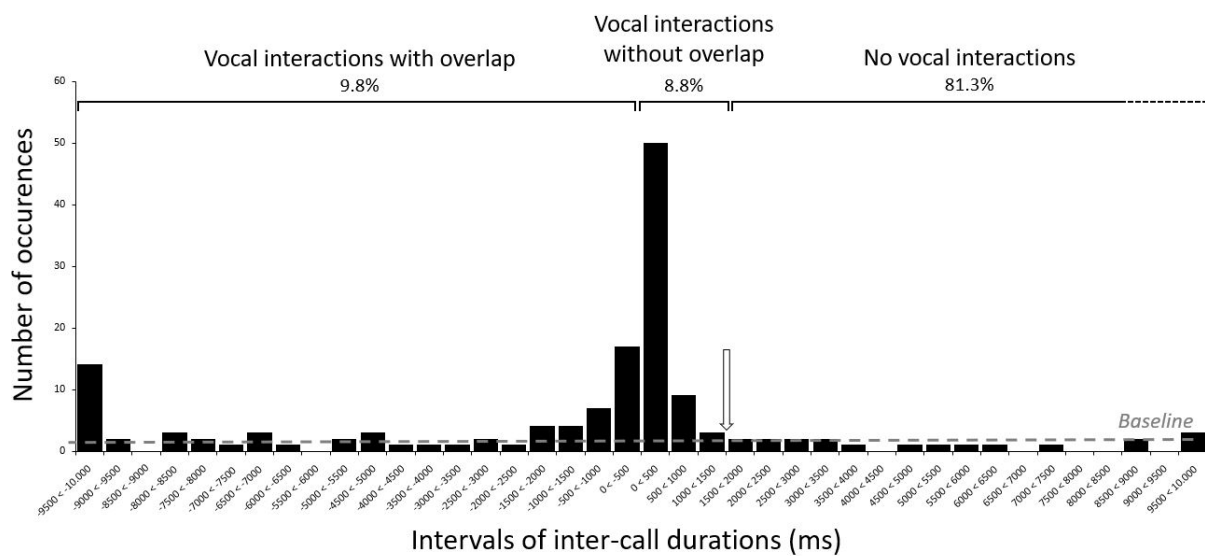
91 From the 702 recorded calls, 150 calls from 35 individuals occurred within our temporal
92 window of 10 s from the onset of the preceding call. For these 150 calls, we plotted the
93 distribution of inter-call duration ($N = 75$ inter-call durations) (Fig. S1), and used this to
94 define a vocal interaction as two successive calls emitted by two different individuals,
95 separated by a maximum of 1.5 s. Only 18.7% (131/702) of calls were classified in this way
96 as vocal interactions.

97 Among the vocal interactions, we found some negative inter-call durations that corresponded
98 to call overlaps. Overlapping calls occurred in 52.7% (69/131) of vocal interactions. Calls
99 produced outside vocal interactions ($N = 571$) comprised 11% (63/571) isolated calls and 89%
100 (508/571) repeated calls.

101 Analysis of calls only emitted in peaceful contexts ($N = 495$) gave similar results. Only 7.9%
 102 (39/495) of calls were produced in vocal interactions. Overlapping calls represented 64.1% of
 103 these cases (25/39), while vocal interactions without overlap (i.e. turn-taking) represented
 104 35.9% (14/39). Calls produced outside vocal interactions ($N = 456$) comprised 13.6%
 105 (62/456) isolated calls and 86.4% (394/456) repeated calls.

106

107



108

109 **Fig. S1.** Distribution of inter-call durations between two successive calls from different individuals for 150 calls
 110 from 35 individuals ($N = 75$ inter-call durations recorded in a time window of 10 s after a preceding call). The
 111 grey dotted line corresponds to the baseline level of positive inter-call duration. The white arrow corresponds to
 112 the threshold indicating the maximum response delay for a vocal interaction; this was placed at the location
 113 where inter-calls delays start to rise above the baseline to reach a peak observed frequency of occurrence at
 114 around 1.5 s.

115

116 Adult males were more vocally active than adult females during vocal interactions, with an
 117 equivalent proportion of interactions with or without overlap in each sex (all contexts:
 118 $\chi^2=60.2$, $ddl=1$, $P<0.001$; peaceful contexts: $\chi^2=24$, $ddl=1$, $P<0.001$, Table S3). Isolated and
 119 repeated calls produced at similar rates by females and males in all contexts, with a higher
 120 production of repeated calls ($\chi^2=0.64$, $ddl=1$, $P=0.42$). In peaceful contexts, females were
 121 more vocally active than males in calls made outside vocal interactions, particularly for
 122 repeated calls ($\chi^2=6.47$ $ddl=1$, $P=0.01$).

123

124 **Table S3.** Vocal production rate per hour for adult females and males in all contexts and in
 125 peaceful contexts alone. Values are means \pm SD. Sample size is given in brackets.

	All contexts					Peaceful contexts				
	All calls	Calls in vocal interactions		Calls outside vocal interactions		All calls	Calls in vocal interactions		Calls outside vocal interactions	
		With overlap	Without overlap	Isolated	Repeated		With overlap	Without overlap	Isolated	Repeated
Adult females (N=13)	2.3 \pm 3.6 (318)	0.08 \pm 0.11 (13)	0.10 \pm 0.14 (15)	0.24 \pm 0.31 (34)	1.9 \pm 3.3 (256)	2.1 \pm 3.6 (293)	0.05 \pm 0.06 (7)	0.08 \pm 1.0 (11)	0.23 \pm 0.32 (32)	1.7 \pm 3.4 (243)
Adult males (N=12)	2.3 \pm 2.7 (290)	0.39 \pm 0.47 (49)	0.4 \pm 0.59 (51)	0.21 \pm 0.23 (27)	1.9 \pm 1.7 (163)	1.1 \pm 1.5 (135)	0.11 \pm 0.13 (14)	0.13 \pm 0.13 (16)	0.18 \pm 0.22 (23)	0.73 \pm 1.2 (82)

126

127 *Conclusions*

128 In all contexts and in only peaceful contexts, four calling patterns were identified: call
 129 overlap, vocal responses without overlap and (the vast majority) calls emitted outside vocal
 130 interactions composed of isolated and repeated calls. Among vocal interactions, overlapping
 131 calls and vocal turn-taking were equivalently represented., Adult males appeared the most
 132 vocally active during vocal interactions in all contexts and in only peaceful contexts, while
 133 adult females seemed to produce more isolated and repeated calls in peaceful contexts.

134

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- 168

169 **Appendix S2. Details of new data for wild free-ranging bonobos**

170 Detailed knowledge of the production rate of calls of wild bonobos (*Pan pansicus*) is lacking.
171 Most available studies have focused on descriptions of the bonobo's vocal repertoire [in
172 captivity (De Waal, 1988); in the wild (Bermejo & Omedes, 1999)] and on the acoustic
173 structure and functions of specific call types [in captivity (e.g. Clay & Zuberbühler, 2009,
174 2011; Clay *et al.*, 2011, 2015; White *et al.*, 2015; Keenan *et al.*, 2020)]. Levréro *et al.* (2019)
175 investigated captive bonobo vocal exchanges in the framework of conversation-like
176 communication. There is growing interest in the role of inter-group vocal communication
177 among wild bonobo sub-groups (Schamberg *et al.*, 2016, 2017) in the inter-party
178 coordination of movement. Bonobos live in a fission–fusion society and form temporary
179 sub-groups for hours or days whose composition changes over time (van Elsacker *et al.*,
180 1995) and sub-groups merge and separate to form different groups. Here, we contribute to
181 knowledge about the vocal behaviour of wild bonobos by assessing their hourly vocal
182 production rate. In this field study, we focused on intra-sub-group vocal behaviour and we
183 report the vocal production within these sub-groups.

184

185 ***Compliance with ethical standards***

186 All fieldwork was carried out in accordance with the relevant guidelines and regulations and
187 was approved by the Institutional Animal Ethical Committee of the University of Lyon/Saint-
188 Etienne [authorisation no. 42-218-0901-38 SV 09 (Lab ENES)] and the host institutions
189 WWF-DRC, WWF-Belgium and the NGO Mbou-Mon-Tour. The study involved behavioural
190 observations and recording of spontaneous calls of animals in their natural social groups and
191 in their natural environment. No experimental protocols or invasive methods were used in this
192 study.

193

194 ***Group composition***

195 The study was conducted on the free-ranging bonobo community of Nkala forest (2°36'10"S,
196 16°27'17"E), located in the Forest Concession of Local Communities of the Mbali River
197 (previously 'Malebo'), in the Lac Tumba landscape, Mai-Ndombe province, Democratic
198 Republic of Congo (DRC), co-led by the Congolese NGO Mbou-Mon-Tour (MMT) and
199 WWF-DRC. The habitat in this area is a forest–savannah mosaic with 60% lowland tropical
200 rainforest and 40% savannah (survey block of 1993 km²; Inogwabini *et al.*, 2008). The
201 studied group comprised 19 identified individuals (six adult males, six adult females, two
202 immature males, two immature females and three immature individuals of unknown sex). The
203 group also contained several unidentified individuals: we observed up to 22 different
204 individuals at the same time.

205 The study was conducted from January 27 to April 13 2012 (L.D. and F.L.) and from October
206 27 2012 to December 30 2012 (FD). The size of this group's home range is unknown. We
207 attempted to locate the nest site from the night before, then waited in proximity of this site
208 early in the next morning. The group usually split into several sub-groups and we followed
209 the largest sub-group. The average size of monitored subgroups was 11.3 individuals, ranging
210 from three to 22.

211

212 ***Vocal data collection***

213 All calls produced by the monitored sub-group were recorded *ad libitum* in the forest between
214 05:30 and 18:00 by one of the researchers (F.D., L.D. or F.L.; average time in forest 4 h 49
215 min per day), accompanied by 1–3 field assistants, using a field notebook and a SONY voice
216 recorder. Audio recordings of calls were not made systematically since the bonobos were
217 often in movement and our own progression in the forest made high-quality recordings very
218 difficult to obtain. We noted all call production that we could hear at a distance of 15 m to

219 nearly 100 m. In total, we were in visual and/or audio contact with the bonobos for 64 days
220 (91 h 24 min) out of 98 days (473 h) spent in the forest. Over the 64 days, we heard the
221 bonobos calling on 56 days. We spent on average 1 h 18 min per day in contact with the
222 bonobos.

223

224 ***Vocal data processing***

225 We isolated ‘vocal events’ from our observations, independently of the number of callers. A
226 vocal event corresponded to an isolated call, with no other call produced within the next 3 s,
227 or a series of calls produced within 3 s of each other. When the number of calls emitted in
228 series exceeded five, we stopped counting them (see Fig. S2). Two distinct vocal events were
229 thus separated by more than 3 s. This temporal threshold was chosen based on field
230 experience but matches the temporal threshold derived in a study of captive bonobos from the
231 analysis of the distribution of all inter-call intervals (Levréro *et al.*, 2019).

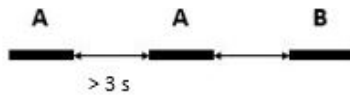
232 When events were composed of more than one call (see Fig. S2), we investigated possible
233 vocal interactions. We recorded the number of different callers by visual observations or
234 when they could be identified individually by their position relative to that of the observers
235 (the number of callers may thus be underestimated if two or more callers were in close
236 proximity).

237 We focused only on calls from our focal sub-group and did not include calls from other sub-
238 groups that could be heard (either in response to the calls of our focus group or spontaneous
239 calls).

240

3 vocal events:

3 unique calls (here produced by two individuals, A and B)



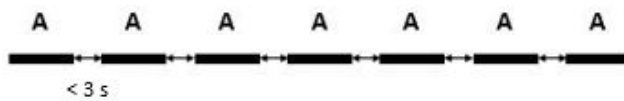
3 vocal events:

1 vocal event with repeated calls (2 to 5 calls) produced by 1 individual (A)
Followed by 1 vocal event (2-5 calls) produced by 3 individuals (A, B and C)
Followed by 1 vocal event with repeated calls (2-5 calls) produced by 1 individual (B)



1 vocal event:

1 individual, more than 5 calls



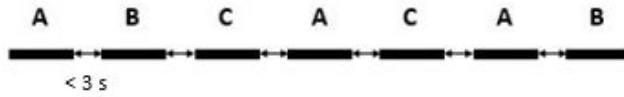
1 vocal event:

2 individuals, more than 5 calls



1 vocal event:

More than 2 individuals, more than 5 calls



241

242 **Fig. S2.** Illustration of different vocal events recorded for bonobos.

243

244 **Results**

245 In total, 2166 vocal events were recorded; we discarded 34 events, which may have been
246 reactions to external disturbances such as our presence between two sub-groups or to gunshots
247 in the neighbouring forest. We thus analysed a total of 2132 vocal events.

248 The hourly rate of vocal events was 23.31 vocal events per hour. Most vocal events were
249 produced by a single caller (74%; Table S4). Vocal events produced by two interlocutors were
250 rare (5%), while 21% involved more than two callers. Most vocal events comprised several
251 consecutive calls (2–5 calls, 48%, see Table S4), 29% were constituted by more than five
252 calls and 16% by a single call.

253

254 **Table S4.** Distribution of vocal events according to the number of callers involved and the
255 number of calls.

Number of callers				Total vocal events
1	2	>2	Not known	
1579	104	346	103	2132

Number of calls				Total vocal events
1	2-5	>5	Not known	
338	1013	624	157	2132

256

257 **Conclusions**

258 Here we report the first assessment of the hourly rate of vocalisations in a free-ranging
259 bonobo community. The tolerance of bonobos to our presence was very good (only 29 cases
260 out of 2132 vocal events were thought to be due to our presence). The frequent presence of
261 observers in forest throughout the year makes it unlikely that our values are overestimates due
262 to a lack of habituation of this community.

263 On the contrary, our methods may lead to underestimates since we may have failed to detect
264 soft vocal interactions due to the forest habitat and our minimum distance to the bonobos. Our
265 data do show that bonobos appear highly vocally active, with most vocal events involving a
266 single caller producing repeated calls.

267

268 **References**

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301

302

303 **Appendix S3. Details of new data for captive orang-utans**

304 There are few data available regarding vocal interactions in Bornean orang-utans (*Pongo*
305 *pygmaeus*). We therefore conducted a study on two captive populations of orang-utans using a
306 methodology established for other non-human great apes [gorillas (Lemasson *et al.*, 2018);
307 bonobos (Levréro *et al.*, 2019); chimpanzees (Pougnault *et al.*, in press)] to investigate vocal
308 interaction patterns in this species.

309

310 ***Compliance with ethical standards***

311 All international, national, and/or institutional guidelines for the care and use of animals were
312 followed. The study was conducted in accordance with the current laws in France (in
313 agreement with 2010/63/UE). Animal husbandry and care were under the management of the
314 animal caregivers of the ZooParc de Beauval, France. Our study was based on non-invasive
315 observations and was approved by the ethics committee “Comité Rennais d’Ethique en
316 matière d’Expérimentation Animale” (Rennes Ethical committee for experiments using
317 animals; CNREEA 2018041710224608-APAFIS#14920).

318

319 ***Group composition***

320 The study was conducted on two captive populations of Bornean orang-utans housed in the
321 ZooParc de Beauval (ZPB), France, and in the Ouweland Dierenpark (OD), Netherlands. Both
322 populations were composed of eight individuals. In ZPB, all individuals (one adult flanged
323 male, three adult females, two adolescent males, and two infants; see Table S5) were housed
324 together in an indoor enclosure (165 m², 5.30 m tall) with an access to a 1000 m² outdoor
325 enclosure. In OD individuals were distributed in four sub-groups according to kinship (1, one
326 flanged adult male; 2, one adult female and one adolescent male; 3, one adult female and one
327 infant; 4, one adult female and two infants; see Table S5). Each sub-group had an indoor

328 enclosure (~110 m² × 7 m) with audio-visual access to all other conspecifics, and alternating
 329 access to a 750 m² outdoor enclosure throughout the day. The adult females were unrelated
 330 and all immature individuals were sired by the current adult male in each zoo. All indoor
 331 enclosures were composed of glass walls, a wire roof, and contained straw litter and wood
 332 perches and were temperature and humidity controlled. All outdoor enclosures contained
 333 grass, bush and wood perches. Vegetables, fruit and dry food was provided six times a day
 334 and water was available *ad libitum*.

335

336 **Table S5.** Details of the orang-utans in this study.

Subject name	Birth date – arrival date	Age–sex category	Mother’s name (all fathered by the adult male of the group)	Zoo	Sub-group number
Muda	29/05/1983 – 20/07/1994	Adult flanged male		ZPB	
Christina	1985 ^a – 26/11/1993	Adult female		ZPB	
Manis	24/09/1990 – 13/04/2010	Adult female		ZPB	
Janah	15/02/1991 – 18/06/1992	Adult female		ZPB	
Dayak	04/03/2009	Adolescent male	Manis	ZPB	
Belayan	22/09/2009	Adolescent male	Janah	ZPB	
Sabah	06/08/2015	Infant female	Manis	ZPB	
Kayan	06/05/2017	Infant male	Janah	ZPB	
Bako	21/03/1996	Adult flanged male		OD	1
Anak	09/03/1976	Adult female		OD	2
Tjintah	01/05/1984 – 19/08/2005	Adult female		OD	3
Jewel	1987 ^a – 13/04/1992	Adult female		OD	4
Jingga	22/10/2007	Adolescent male	Jewel	OD	2
Daya	27/05/2012	Infant female	Jewel	OD	4
Sabar	11/05/2016	Infant male	Jewel	OD	4
Minggu	10/03/2019	Infant female	Tjintah	OD	3

337 ^a Uncertainty regarding the date of birth of these individuals, estimated ± 1 year.

338 Age classes based on Wich *et al.* (2004).

339

340 **Vocal data collection**

341 Call production of the two groups was recorded by one observer (L.P.) on an all occurrence
 342 basis (Altmann, 1974) using a Marantz PMD660 handheld digital audio recorder (Marantz,
 343 Japan) (sample rate 44.1 kHz, resolution 32 bits, .wav format) connected to a directional
 344 Sennheiser MKH70-1 microphone (Sennheiser, Germany), and to a directional AV-JEFE
 345 TCM 160 LAVALIER tie microphone (AV-JEFE, Singapore) for the experimenter's
 346 comments. At OD, the four sub-groups could be recorded together due to the layout of the
 347 enclosures. Calls were recorded in 1h 30 min sessions randomly distributed throughout the
 348 day between 09:00 and 18:00, with a maximal distance to subject of 10 m. Orang-utans were
 349 habituated to the presence of the observer and recording equipment for seven days before data
 350 collection began.

351 A total of 72 calls were recorded in 17 h between July and November 2018 (excluding nine
 352 weeks during the summer to avoid the season with the highest visitor presence) at ZPB, and
 353 398 calls were collected (with one call discarded due to uncertainty in caller identity) in 25 h
 354 of recording in November 2019 at OD. Call types were classified according to Hardus *et al.*
 355 (2009) (Table S6).

356

357 **Table S6.** Distribution of call types recorded in this study.

		Ahh	Bark	Cry	Fast long call	Grunt	Grumph	Grumble	Kiss squeak
ZPB	Adult flanged male	0	0	0	3	1	0	1	0
	Adult females	0	0	0	0	0	0	0	0
	Adolescent males	0	0	0	0	1	0	0	0
	Infants	0	0	55	0	0	11	0	0
OD	Adult flanged male	0	0	0	4	29	0	2	0
	Adult females	0	2	0	0	60	0	92	3
	Adolescent male	7	0	0	0	116	0	10	0
	Infants	0	0	61	0	1	10	0	0

358

359 *Vocal data processing*

360 We investigated the temporal organisation of call production within each population by
361 measuring all inter-call durations using spectrograms generated by PRAAT software version
362 6.1.09 using a Gaussian window. Inter-call duration was defined as a silent gap between two
363 consecutive calls of any call type emitted by two different identified callers, from the end of
364 the first call to the onset of the second call (see Lemasson *et al.*, 2018). We defined a temporal
365 window of a maximum of 10 s after the onset of the first call, which was deemed long enough
366 to include all patterns of vocal interaction based on other findings in multiple species
367 [Campbell's monkey (Lemasson *et al.*, 2010a); gorilla (Lemasson *et al.*, 2018); bonobo
368 (Levréro *et al.*, 2019)].

369 We quantified the proportions of: (i) calls produced during vocal interactions, and (ii) calls
370 emitted in the absence of vocal interactions, i.e. calls emitted independently from the vocal
371 vocalisations of other group members (see also Bouchet *et al.*, 2010; Levréro *et al.*, 2019).
372 Calls occurring outside vocal interactions were of two temporal calling patterns: an isolated
373 single call or a repeated sequence of one call type. We applied the same temporal window (10
374 s after the onset of the first call) to classify a call as repeated or isolated, but applied it to
375 inter-call durations involving single callers. Indeed we did not record multiple callers in any
376 of the two groups of orang-utans. We plotted the distribution of inter-call delays and defined
377 the temporal threshold to classify whether a call belonged to a series of repeated calls or was
378 an isolated call. The temporal threshold (maximum delay for call repetition) was placed at the
379 point where inter-call delays start to increase above a baseline representing the background
380 noise of inter-call delays for call repetition (Fig. S3). We calculated the proportion of isolated
381 and repeated calls for both studied populations.

382 Finally, we compared the hourly production rates of different calls according to age–sex
383 classes for both populations. No statistical tests were run because of the small sample size.

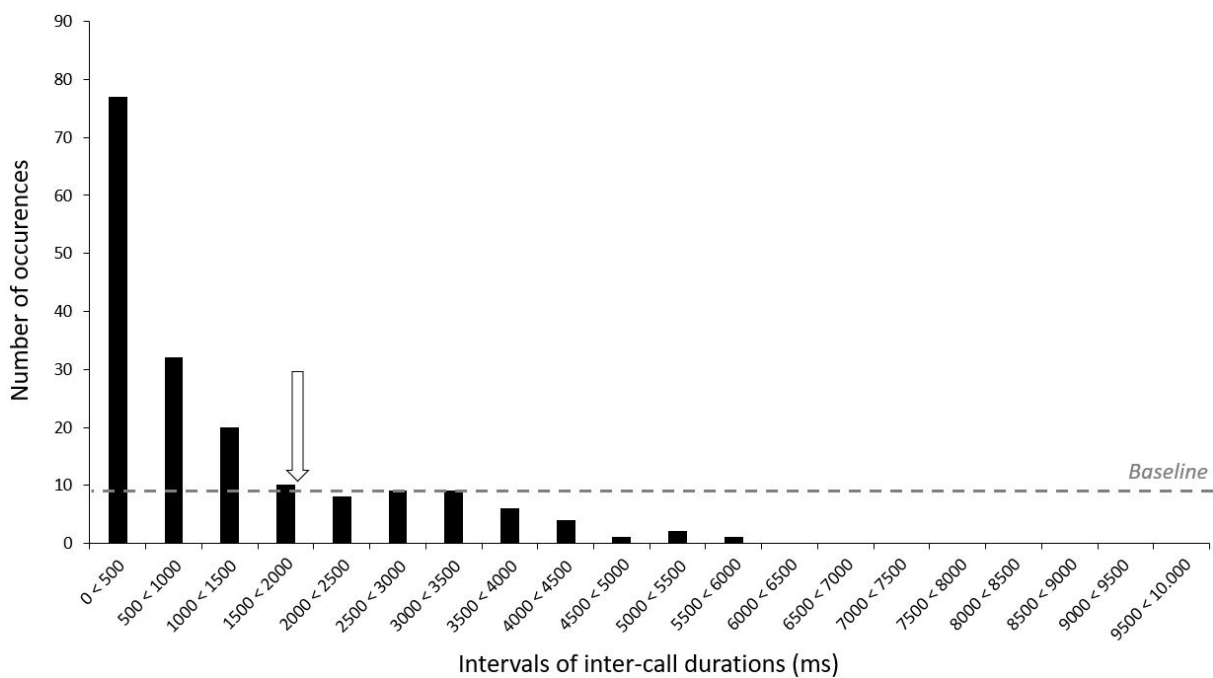
384

385 **Results**

386 From all 469 recorded calls, only two calls from two different individuals occurred within a
387 time window of 10 s with an inter-call delay of 1.3 s; the remaining 447 calls were made with
388 much longer delays (>53 s) relative to a previous call. For calls made by a single individual
389 level, 179 inter-call delays ($N = 358$ calls) were recorded within the 10s-time window.

390 Plotting these inter-call durations allowed us to define a repeated call as two calls from the
391 same individual separated by a maximum of 2 s (Fig. S3). Using this criterion, isolated calls
392 represented 11.1% (8/72) of total call production at ZPB and 49.6% (197/397) at OD, while
393 repeated calls represented 88.9% (64/72) at ZPB and 50.4% (200/397) at OD.

394



395

396 **Fig. S3.** Distribution of inter-call duration between two successive calls from the same individual for 358 calls
397 from 16 individuals ($N = 179$ inter-call durations recorded in a time window of 10 s after the previous call). The
398 grey dotted line corresponds to the baseline level of the occurrence of positive inter-call durations. The white
399 arrow corresponds to the threshold indicating the maximum response delay for repeated calls; this was placed at
400 the location where inter-call delays start to rise above the baseline to reach a peak frequency of occurrence.

401

402 The mean \pm SD hourly rate of call production appeared higher in the group from the OD than
 403 in the ZPB, respectively 1.9 ± 1.9 and 0.7 ± 1.9 . At ZPB, infants seemed the most vocally active
 404 individuals and produced all the repeated calls. At OD the hourly rate of call production was
 405 highest for the single adolescent male at OD for both isolated and repeated calls (see Table
 406 S7).

407

408 **Table S7.** Rate of vocal production per hour for each age-sex category of callers from ZPB
 409 and OD populations. Values are means with sample size in brackets.

		Adult flanged males	Adult females	Adolescent males	Infants
All calls	ZooParc de Beauval	0.29 (5)	0 (0)	0.029 (1)	1.9 (66)
	Ouwehand	1.4 (35)	2.1 (157)	5.3 (133)	0.96 (72)
	Direnpark				
Isolated calls	ZooParc de Beauval	0.29 (5)	0 (0)	0.029 (1)	0.041 (14)
	Ouwehand	1.1 (24)	1.3 (81)	4.0 (78)	0.2 (11)
	Direnpark				
Repeated calls	ZooParc de Beauval	0 (0)	0 (0)	0 (0)	1.5 (52)
	Ouwehand	0.28 (11)	0.84 ± 1.4 (76)	1.28 (55)	0.76 (61)
	Direnpark				

410

411 *Conclusions*

412 Our results show a clear absence of vocal interactions in captive Bornean orang-utans. The
 413 population at OD appears to be more vocally active than that at ZPB. This difference may be
 414 due to their visual access to the caregivers' kitchen. At OD, orang-utans solicit caregivers by
 415 using gestures or grunt/grumble vocalisations to obtain food or to start a medical training
 416 protocol accompanied by food rewards.

417

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