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Neigh-bours: Why every young horse needs good friends. A pilot study during the breaking-in period

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22 **Abstract**

23

24 In natural conditions, horses (*Equus caballus*) are social animals that live in stable groups. However,
25 horses are often housed in individual stalls from the moment they begin their initial training, also
26 called *breaking-in*. Individual stabling induces social isolation and confinement, and is a source of
27 particularly stressful events for the young horse alongside the breaking-in process. These experiences
28 can lead to behavioural disorders in individual stalls and dangerous defensive behaviours in human-
29 horse interactions. This study aimed to evaluate how the maintenance of social contacts impacts the
30 behaviour of young horses during breaking-in. The comparison involved 12 young horses all housed
31 in individual stalls for one month: six individuals had the opportunity to interact socially in pairs for
32 two hours a day (hereafter called “Social Condition”) in a “social box”, and six individuals had no
33 access to a social partner (hereafter called “Isolated Condition”). We collected data for various
34 behavioural variables during training sessions (body tension, conflict behaviours, cooperation and ear
35 positions used as an indicator of the emotional state) and activities in the individual stalls. We found
36 that horses in the Social Condition expressed fewer abnormal behaviours ($p < 0.001$) and stayed still
37 more often ($p < 0.01$) in the individual stall compared to horses in the Isolated Condition. During
38 training, we did not find any difference in ear positions ($p = 0.068$) and cooperation ($p = 0.766$) between
39 the two groups of horses. However, horses in the Social Condition adopted a more relaxed attitude
40 ($p < 0.01$) than those that were isolated. Although more stress-related behaviours like defecation
41 ($p < 0.001$) and a tense attitude were observed in isolated horses ($p < 0.001$), these horses reacted less to
42 the discomfort associated with training by head-tossing behaviour ($p = 0.026$) and tail switching
43 ($p = 0.033$) than horses in the Social Condition. The latter would remain capable of reacting during the
44 sessions. Our results indicate a possible beneficial impact of this socially enriched context on the first
45 training experience of horses in the Social Condition. Finally, the device we used will promote the
46 welfare of horses in equestrian facilities and will be in line with changes in society regarding respect
47 for our domestic companions.

48 Keywords: welfare, social, *equus caballus*, housing, horse-human relationship, training

49

50 **Introduction**

51 Sociality plays an important role in the horse's life (*Equus caballus*): in wild conditions, horses live in
52 stable social groups where daily activities are shared and practiced together (Feh, 2005). The most
53 common social structure is the familial herd composed of one or two stallions, a few mares and their
54 young (Waring, 2003). More transitional herd structures can be joined by young horses aged between
55 1 and 4 years old when they leave their initial family group (Boyd and Keiper, 2005). These groups
56 are composed of males and females or exclusively of males, and individuals can remain in them for
57 several years (Heitor and Vicente, 2010). In bachelor groups, the age range of the stallions can vary
58 (Briefer Freymond et al., 2013). Young males will acquire social codes with other juveniles and older
59 conspecifics, and will particularly learn to express ritual and aggressive behaviors, especially through
60 playful fights (Briefer Freymond et al., 2013; Søndergaard, 2003). The young horse's development is
61 highly influenced by social relationships (Søndergaard, 2003) and strong affinities can emerge
62 between individuals of the same age: playing and sharing activities in proximity of others strengthens
63 this bond and contributes to social skill development (Waring, 2003). In domestic conditions, group
64 living could be limited to the early stages of life. After weaning at around 6-9 months, foals are
65 separated from their mother and are commonly housed in groups of individuals the same age
66 (Hartmann et al., 2012; Waran et al. 2008). Although this approach allows the development of strong
67 bonds, the absence of adults can lead to more inter-individual aggressiveness (Bourjade et al., 2009;
68 Jansson and Malin, 1998). In most European countries, the horse is permanently housed in an
69 individual box (Bachmann and Stauffacher, 2002; Popescu et al., 2019; Søndergaard and Christensen,
70 2002) from the age of 2-3 years, i.e. generally from the breaking-in period onwards. This change is
71 drastic and stressful (Harewood and McGowan, 2005). Many authors have reported the harmful
72 consequences of the individual stall on health problems such as respiratory problems or colic (Cohen,
73 2003; Yngvesson et al., 2019) and on behaviour, leading to the appearance of disorders (Fureix et al.,

74 2012, 2010; Ruet et al., 2019) from a very young age (Waters et al., 2002). Indeed, Visser et al.
75 (2008b) found that more than two thirds of young horses developed stereotypies during this initial
76 transition from group to individual housing, with 22% of individuals performing cribbing, 22% box
77 walking and 44% weaving, which is often associated to the lack of social contact (Benhajali et al.
78 2010; McAfee et al. 2002). Many other risk factors are also linked to the appearance of stereotypical
79 behaviours, including restricted free movement (Lesimple et al. 2020) or a low-fibre diet (Cooper and
80 McGreevy, 2007). Interestingly, in this study comparing horses stabled individually or in pairs, none
81 of the paired horses developed stereotypical behaviours. This suggests that a poor social environment
82 strongly influences the development of these behaviours. Restrictions related to confinement in
83 individual stalls, *i.e.* limited space without physical social contact, can also lead to aggression towards
84 humans, causing dangerous situations (Fureix et al., 2010; McGreevy, 2004) and a deteriorated
85 relationship with humans (Ruet et al., 2020). Breaking-in *per se* is a particularly stressful period for
86 the young horse in conventional practices that involve daily training by humans following a period
87 during which the horse had experienced very little constraint (Kędzierski et al. 2014; Rivera et al.
88 2002; Waran et al. 2007). These interactions, traditionally based on negative reinforcement or even
89 punishment, can be a negative experience for the horse (Hall et al., 2008; McGreevy, 2007). The
90 relationship between the horse and the human is built up through repeated interactions, and the valence
91 of these repeated interactions, whether positive or negative, can have a profound and lasting effect on
92 the developing relationship (see review Hausberger et al., 2008). The improvement of housing
93 conditions, especially through social enrichment, has been shown to have a positive influence on the
94 behaviour of young horses towards humans. Indeed, Søndergaard and Ladewig, (2004) have
95 demonstrated that horses housed in groups expressed fewer aggressive behaviours towards humans
96 during training than horses housed in individual stalls. Furthermore, horses housed in conditions that
97 allow them to interact are easier to handle than those that are socially isolated (Yarnell et al., 2015).
98 These studies have tested different housing methods comparing group-housed individuals to isolated
99 individuals. The present study seeks to compare the welfare and also cooperative and conflict
100 behaviours of young horses during the breaking-in period. The horses are housed individually, but half

101 of the stock have access to a social partner for two hours per day. This paradigm avoids the
102 confounding effects of a group living in pastures and the subsequent combination of social life and
103 ranging freely in an open environment. In our study, the only parameter that varied was the daily
104 access to a social partner for half of the individuals. In this context, we predict that maintaining social
105 interactions should promote the well-being of young horses and increase their receptiveness to
106 interactions with humans.

107

108 **Material and methods**

109 **Study site**

110 The study took place at the stud farm of Rosières-aux-Salines, France (48° 35' 47" N, 6° 20' 15" E).
111 The site covers 12 hectares with 60 stalls, two indoor arenas, three outdoor sand arenas and other
112 facilities for horses at rest, at training and for breeding.

113

114 **Animals**

115 We studied 12 young horses (females: n = 6, males: n = 6) aged 24-36 months (in average 26 ± 5
116 months) of Selle Français (n = 4) and Thoroughbred (n = 8) breeds. All animals came from different
117 farms and had been group-housed in pasture without any experience of the individual stable before the
118 study began.

119

120 **Procedure**

121 The 12 horses were equally and semi-randomly divided into two conditions: the Social Condition
122 horses (n = 6, three females and three males; three Thoroughbred and three Selle Français) and the
123 Isolated Condition horses (n = 6, three females, three males, five Thoroughbred and one Selle
124 Français). All horses were housed in individual stalls but the horses in the Social Condition were
125 allowed to interact with a partner in a "social box" (Fig. 1) for two consecutive hours/day and five

126 times per week, while the isolated horses had no opportunity for social interaction. As the horses had
127 arrived in the facility just two days before breaking-in began, we decided to assign pairs randomly and
128 only assign individuals who did not know each other before the experiment in order to ensure that
129 each individual created a new relationship with its social partner, which remained the same throughout
130 the experimental period. Each resulting pair was composed of a female and a male. The study was
131 conducted from November 2, 2019 to February 17, 2020 as three one-month replicate periods due to
132 the organisation of breaking-in sessions. As a result, four horses were studied per month with two
133 individuals per condition.

134

135 *Housing conditions*

136 All horses were housed in 4*3 meter stalls with solid walls and a grid on the door that allowed only
137 visual contact with the horses in the opposite stalls. The horses in the Social Condition had no visual
138 contact with their partner, and their physical and visual interactions only occurred during encounters in
139 the social box. In each period, the four horses were housed in the same aisle of the same stable and
140 were randomly assigned to one of the four stalls (whilst a horse of the other condition was always
141 installed in the opposite stall). During each replicate, eight unstudied horses were also housed in the
142 same stable but in a different aisle and had no physical or visual interactions with the horses of the
143 study. All horses were fed pellets twice a day (morning and evening) and had free access to hay and
144 water. Straw bedding was provided daily and cleaned out once a week. Horses were allowed
145 individual free movement in the indoor riding arena for less than one hour per week. These regular
146 tasks were carried out by the same two grooms for each replicate.

147

148 *Social box*

149 The horses in the Social Condition met in pairs in the social box, a device allowing contact between
150 two horses in a secure manner. The social box was composed of two adjacent 4*3 stalls which could
151 communicate via a 2 m-high partition with two central 25 cm-wide vertical openings, allowing each
152 individual to pass its head and neck to the shoulders through to the other stall to interact with the horse

153 in the adjacent stall. The central part of the partition and each side of the two openings were padded
154 with foam covered with a rubber mat, ensuring the complete safety of the horses. The remainder of the
155 partition was composed of pine boards (Fig. 1). This device was located in another stable between the
156 riding arena where the training sessions took place and the stable where the studied horses were
157 housed. Each pair was handled by the same two professional riders (randomly assigned for each
158 encounter) during the experiment and for each replicate.

159

160

161 *Training sessions*

162 The training sessions took place in an indoor arena measuring 50 x 20 m with a sand floor. Each
163 period was carried out over 4 weeks with five sessions each, with a total of 20 sessions per horse. Five
164 riders (four women and one man) accustomed to training young horses were involved and one female
165 expert supervised all of the sessions. During the first week, the horses were lunged at all three gaits
166 with an increasing amount of equipment (roller, then bridle and bit, then saddle). From the second
167 week, the horses were ridden with standard equipment (single bridle, simple bit, mixed saddle) by a
168 rider and held with the lanyard by the expert in breaking-in. During the third week, the horse was
169 expected to be ridden alone by a rider without being held. At the end of the fourth week, the objective
170 was that each horse could be ridden calmly and independently at all three gaits (see details in Table 6
171 of the Supplementary Material).

172

173 **Data collection**

174 **Behavioural data**

175 *Individual stall*

176 The behaviour of individuals was recorded every 5 min for two one-hour sessions held each day at
177 different times (between 7:30 and 18:30) and outside of meal times. To take account of the potential
178 effect of training for both conditions, an equal number of observation sessions in the individual stalls

179 were carried out before and after each session. Data were collected by an experienced observer (AF, 5
180 years of experience in horse behaviour) using the *scan sampling* method (Altmann, 1974) and
181 following the protocol used by Ruet et al. (2019). All the behaviours expressed by horses were
182 recorded and classified according to functional categories mostly adapted from the ethogram of
183 Lesimple et al. (2019), McDonnell (2003), Ruet et al. (2020) and Yarnell et al. (2015). The study
184 sought to understand whether there was a change in the distribution of daily activities of horses with
185 social contact compared with that of horses that were socially isolated. The list of behaviours is shown
186 below in Table 1. Since the overall distribution of activities was of interest, certain categories were
187 grouped together, such as elimination and comfort behaviour, under the heading 'maintenance' or 'rest',
188 which includes various behaviours related to rest (e.g. standing, and sternal or lateral rest). We also
189 chose to differentiate observation from vigilance, a behaviour that the horse adopts when it detects a
190 potential threat and which is characterised by a specific posture and a different level of body tension
191 (see "vigilance" in the ethogram Table 1). An "abnormal behaviours" category was created including
192 common indicators of a compromised state of welfare (Ruet et al. 2019). The latter can be expressed
193 by a variety of behaviours depending on the horse concerned (agressivity towards humans (Normando
194 et al. 2011), apathy (Fureix et al. 2012), stereotypies (Waters et al. 2002) or other signs of troubles
195 (Lesimple et al. 2019)). Some of these behaviours expressed in the stall seem to result from multiple
196 unsatisfied fundamental needs (Popescu et al. 2019; Sarrafchi et al. 2013) rather than being related to a
197 unique causation. We considered the different forms of expression of poor welfare as a whole to
198 investigate the effect of social contact on all these behaviours, without focusing on the detailed
199 expression of each one. The hypothesis was that satisfying the need for social contact would be
200 beneficial to the general mental state of the horses and potentially reduce the appearance or expression
201 of behavioural disorders.

202 Ear position during foraging was also scored according to the three modalities described in Table 2.

203 Ear position is a useful indicator of welfare, as it has been shown that the time spent with ears facing
204 backwards during foraging or when eating hay is related to an impaired state of welfare (Lesimple

205 2020). We therefore investigated whether the possibility of social contact for horses housed in stalls
206 could have an influence on their emotional state in the individual stall.

207 *Training*

208 Observation of the horses during the training sessions alternated randomly between the morning and
209 the afternoon each day. For each daily session, the order of the horses was randomly selected. The
210 same procedure was repeated for each replicate. Each session (average session length = 26 minutes 47
211 seconds) was filmed by one experimenter using a GoPro camera (GoPro Hero9) held in a GoPro
212 harness in order to record all behaviours. Recording was carried out from behind a fence to ensure the
213 safety of the experimenter. The video recordings were then analysed through continuous focal
214 sampling using Boris software (Friard and Gamba, 2016). To obtain an overview of the effects of
215 social contact on the behaviour and emotional state of horses at training, we decided to collect a
216 certain number of behavioural variables (postures, ear positions and isolated behaviours). We also
217 analysed the latency to respond to a rider command, as a measure of the cooperation of the horse
218 (Visser et al. 2008a).

219 We collected data relating to overall body tension – referred to hereafter as attitude – and described it
220 on a 4-level scale adapted from Hall et al. (2014) (Table 3). Additional details were incorporated into
221 the original scale concerning head carriage, as the latter is a relevant indicator for assessing the tension
222 of horses during training (Hall et al. 2013). In order to have a finer measure of emotional state, we
223 observed the time spent in each ear position to investigate whether social contact had an effect on the
224 distribution of the three different positions (forward, asymmetric, backward) (Table 2). The main
225 hypotheses were that horses with social contact would spend more time in a relaxed attitude and less
226 time with their ears back than socially isolated horses. The time spent in each attitude and for the
227 different ear positions was recorded as durations.

228 The ethogram of ridden horse behaviours was adapted mostly from König von Borstel and Glibman
229 (2014) and Rivera et al. (2002) (Table 4). It includes stress behaviours such as defecation or
230 vocalisations (Wilk and Janczarek, 2015) and common defence behaviours, also called conflict
231 behaviours. The latter are defined as "responses exhibited by animals that experience difficulty coping

232 with mental or physical discomfort, and most often demonstrated as some form of resistance to
233 handling or training cues and/or equipment" (Górecka-Bruzda et al., 2015). Data relating to these
234 behaviours were collected in order to assess whether the possibility of social contact for the Social
235 Condition had an effect on the frequency of expression of these behaviours during the training of the
236 horse.

237

238 **Statistical analysis**

239 All data from the individual stalls and training sessions were analysed using generalized linear mixed
240 models (GLMM) with the "glmmTMB" package (Brooks et al., 2017). For each model, we used the
241 variance inflation factor (VIF) with the "check_collinearity" function of the "performance" package to
242 check for collinearity of the selected predictors (Lüdecke et al., 2021), retaining all predictors with
243 values below 3 (Zuur et al., 2009). We also tested the uniformity and dispersion of residuals, the
244 homoscedasticity and possible zero-inflation with model diagnostics of the "DHARMA" package
245 (Hartig, 2020). We selected the best-fitting model using the "dredge" function of the "MuMIn"
246 package (Bartoń, 2022). We chose the best explanatory model from the two AICc units that have the
247 lowest value, based on the corrected Akaike information criterion (Burnham and Anderson, 2004).
248 Due to the small sample size, the factors included in the model were limited to reduce statistical
249 instability and the risk of overfitting. Consequently, several factors were considered similar between
250 conditions (age, sex and replicate) and were excluded from the models. Moreover, the effect of the
251 rider was tested independently to evaluate whether this factor needed to be integrated to the models.
252 The number of commands made by each rider was analysed. There were no significant differences
253 between the riders for the commands (Kruskal-Wallis test, $\chi^2 = 4$, $df = 4$, $p = 0,406$). Based on these
254 findings, rider effect was not included as a factor in the analysis.

255 The condition (Social or Isolated), the target variable, the interaction between these two predictors and
256 the pair to which each individual belongs in the Social Condition were included as fixed factors in all
257 analyses. For all proportions data, given that the response variable was a continuous proportion, we

258 fitted GLMMs with an ordered beta family and a logit link function. Whenever the interaction of the
259 condition and the target variable was significant, post-hoc comparisons were conducted by calculating
260 estimated marginal means using the "emmeans" package (Lenth, 2022). To account for the
261 repeatability of the measurements on individuals according to the observation days, individuals were
262 set as random intercept terms and days were nested within individuals.
263 All analyses were performed in R 4.0.2 (R Core Team, 2023) and significance was set at $p < 0.05$.

264

265 *Data analysis in individual stalls*

266 1. Distribution of the behavioural categories

267 We compared the distribution of behavioural categories between the Social and Isolated conditions.
268 We calculated the frequency as a proportion (i.e. number of scans for each category out of the total
269 number of scans) per individual and per daily session as a response variable in the GLMM analysis.
270 The “vocalisation - whinnying” category was not retained in the analyses because this behaviour was
271 seldom observed (only two observations were made out of the total number of observations).

272

273 2. Ear positions during foraging

274 We compared the distribution of ear positions while foraging according to three modalities (forward,
275 asymmetrical, backward) between the Social or Isolated Conditions. The response variable was the
276 ratio of each ear position to the total number of ear positions observed.

277

278 *Data analysis during training*

279 1. Attitude

280 We used the proportion of the duration of each attitude to the duration of the session as a response
281 variable.

282

283 2. Ear position

284 Ear position during sessions was categorised in the same way as for the ear position in individual
285 stalls. We used the proportion of the duration of each ear position to the duration of the session as a
286 response variable.

287

288 3. Conflict behaviours

289 As the duration of sessions varied slightly each day, we calculated the number of behaviours per hour
290 to allow comparison on the same time basis. In order to analyse frequency, we fitted a GLMM
291 assuming a Poisson error distribution with a log link.

292

293 4. Cooperation

294 Given that the response variable was expressed as a continuous variable (latency to respond to each
295 rider command), we fitted a GLMM using a Gaussian distribution and an “identity” link function.

296

297 **Ethics Statement**

298 This experiment complies the ethical policy of the International Society for Applied Ethology and has
299 been approved by the ethical committee of Val de Loire (N° CE19 – 2022-0601 – 1).

300

301 **Results**

302 *Behaviour in individual stalls*

303 1. Distribution of the behavioural categories

304 The ratio of behavioral categories was compared between the two conditions (Social and Isolated).

305 The best-fitting model included the behavioural category, the condition and the interaction between
306 behavioural category and condition (see Supplementary Material, Table 7 and Table 8 for model

307 selection and predicted means \pm SE). Post-hoc comparisons of the interaction showed that there were

308 significant differences in the distribution of behavioral categories between the two conditions: horses

309 in the Social Condition expressed fewer abnormal behaviors (emm contrast: $\beta \pm$ SE = -0.429 ± 0.124 ,

310 $z = -3.46$, $p < 0.001$) and were immobile more often (emm contrast: $\beta \pm$ SE = 0.329 ± 0.106 , $z = 3.11$,

311 $p < 0.01$) than horses in the Isolated Condition. For the other behavioural categories, no significant
312 difference was found (Supplementary Material, Table 9).

313

314 2. Ear positions during foraging

315 The ratio of the three ear positions was compared between the two conditions (Social or Isolated) and
316 then within each condition. The best-fitting model included ear position, condition and the interaction
317 between ear position and condition (see Supplementary Material for model selection, Table 10). Post-
318 hoc tests showed that there was no significant difference between the Social Condition and the
319 Isolated Condition for the three positions of the ears (emm contrast: asymmetrical position : $\beta \pm SE = -$
320 0.108 ± 0.059 , $z = -1.82$, $p = 0.068$; backward position : $\beta \pm SE = -0.020 \pm 0.071$, $z = -0.273$, $p = 0.785$;
321 forward position : $\beta \pm SE = 0.100 \pm 0.058$, $z = 1.69$, $p = 0.092$). For the Social Condition, there is a
322 significant difference in the frequency of the three ear positions: horses have their ears facing forward
323 more often than in asymmetric positions (emm contrast: $\beta \pm SE = -0.550 \pm 0.060$, $z = -9.32$, $p < 0.001$), in
324 asymmetric positions more often than facing backward (emm contrast: $\beta \pm SE = 0.613 \pm 0.066$, $z = 9.28$,
325 $p < 0.001$) and face forward more often than they do backward (emm contrast: $\beta \pm SE = -1.16 \pm 0.066$,
326 $z = -17.70$, $p < 0.001$). The same result was found for horses in the Isolated Condition (emm contrast:
327 forward vs. asymmetric: $\beta \pm SE = -0.344 \pm 0.059$, $z = -5.85$, $p < 0.001$; asymmetric vs. backward: $0.701 \pm$
328 0.066 , $z = 10.69$, $p < 0.001$; forward vs. backward: -1.05 ± 0.066 , $z = -15.90$, $p < 0.001$).

329

330

331 *Behaviours during training*

332 1. Attitude

333 The proportion of the four types of attitude was compared between the two conditions (Social or
334 Isolated). The best-fitting model included the types of attitude, condition and the interaction between
335 types of attitude and condition (see Supplementary Material, Table 11). Post-hoc analysis revealed that
336 horses in the Social Condition spent significantly more time in a relaxed attitude (emm contrast: $\beta \pm$
337 $SE = 0.532 \pm 0.142$, $z = 3.76$, $p < 0.01$; Fig. 2) and less time in a tense attitude (emm contrast: $\beta \pm SE = -$

338 0.546±0.141, $z=-3.89$, $p<0.001$) than the horses in the Isolated Condition. There was no significant
339 difference between the two conditions for the attentive attitude (emm contrast: $\beta \pm SE= 0.158\pm0.163$,
340 $z=0.971$, $p=0.332$) and the extremely tense attitude (emm contrast: $\beta \pm SE= -0.425 \pm0.241$, $z=-1.76$,
341 $p=0.079$).

342

343 2. Ear position

344 The ratio of the three ear positions was compared between the two conditions (Social or Isolated), then
345 the distribution of positions was analysed for each condition. The best explanatory model included
346 condition and ear position and the interaction of these two variables (see Supplementary Material,
347 Table 12). However, post-hoc analysis revealed no significant effect of the condition on ear positions
348 (emm contrast: asymmetric position: $\beta \pm SE= -0.134\pm0.093$, $z=-1.444$, $p=0.149$; backward position: β
349 $\pm SE= 0.093\pm0.115$, $z=0.805$, $p=0.421$; forward position: $\beta \pm SE= 0.171\pm0.102$, $z=1.68$, $p=0.092$). The
350 analysis within each condition showed that horses in the Social Condition spent significantly more
351 time with their ears in an asymmetric position than facing forward ($\beta \pm SE= -1.78 \pm0.090$, $z=-19.88$,
352 $p<0.0001$) or backward ($\beta \pm SE= -2.42 \pm0.098$, $z=-24.77$, $p<0.001$), and they also spent more time
353 with their ears facing forward than facing backward ($\beta \pm SE= -0.640\pm0.099$, $z=-6.46$, $p<0.001$). The
354 exact same distribution was found in isolated horses (emm contrast: asymmetric position vs forward
355 position: $\beta \pm SE= -2.09\pm0.107$, $z=-19.44$, $p<0.001$; asymmetric position vs backward position: $\beta \pm$
356 $SE= -2.65\pm0.116$, $z=-22.86$, $p<0.001$; forward position vs backward position: $\beta \pm SE= -0.560\pm0.118$,
357 $z=-4.74$, $p<0.001$).

358

359 3. Conflict behaviours

360 The best-fitting model included the behaviour, the condition and the interaction of both terms (see
361 Supplementary Material, Table 13). Horses in the Social condition defecated significantly less than
362 horses in the Isolated Condition (emm contrast: $\beta \pm SE= -0.871\pm0.215$, $z=-4.05$, $p<0.001$) and they
363 also tended to grind their teeth less than horses in the Isolated Condition (emm contrast: $\beta \pm SE= -$

364 2.00±1.08, $z=-1.85$, $p=0.065$). On the other hand, horses in the Social Condition expressed
365 significantly more tail switching (emm contrast: $\beta \pm SE= 0.529\pm0.247$, $z=2.14$, $p=0.033$) and head
366 tossing (emm contrast: $\beta \pm SE= 0.500 \pm 0.224$, $z=2.23$, $p=0.026$) than those in the Isolated Condition.
367 There are no significant differences for other behaviours (Table 5).

368

369 4. Cooperation

370 As the condition was the only fixed effect in this analysis, the best-fitting model was also one of the
371 two with the lowest AICc value (Supplementary Material, Table 14). The response latency for a rider
372 command was not affected by the condition (Social or Isolated) (GLMM: $\beta \pm SE = 0.085 \pm 0.284$,
373 $z=0.297$, $p=0.766$).

374

375 **Discussion**

376 Our results show that horses that have access to a social partner during the breaking-in period
377 expressed fewer abnormal behaviours and stayed still more often in the individual stall than isolated
378 horses. Moreover, during training sessions, they spent more time in a relaxed attitude and less time
379 showing a tense attitude, and defecated less often but expressed more head tossing and tail switching
380 than horses in the Isolated Condition. We did not find any difference in ear positions and cooperation
381 between the two groups of horses.

382

383 *Behaviours in individual stalls*

384 Horses in the Social Condition expressed abnormal behaviours less frequently than horses in the
385 Isolated Condition. Similar results have been found across studies that compare the behaviours of
386 young horses in individual stalls with those of counterparts in a socially enriched condition (Heleski et
387 al., 2002; Hoffman et al., 1995; Visser et al. 2008b) or counterparts in environments that provide more
388 global enrichment (Lansade et al., 2014). Thus, our results suggest that reducing the time spent in
389 social isolation could reduce the development of these abnormal behaviours. These behaviours are

390 recognised as reliable indicators of poor welfare linked to past or present unfavourable housing
391 conditions (Hall et al., 2008). In young animals with no previous experience of restrictive housing, this
392 low frequency of abnormal behaviours expressed by the individuals in the Social Condition therefore
393 indicates better welfare in comparison to horses in the Isolated Condition due to current social
394 enrichment. Indeed, being able to interact, to express the species' behaviours and to be more stimulated
395 through this social environment may reduce the need for coping strategies (Søndergaard and
396 Christensen, 2007). Furthermore, social interactions in young horses (including play) contribute to
397 their overall development, particularly in terms of cognitive development, by increasing their capacity
398 for behavioural adaptability and flexibility (Rivera et al., 2002). This cognitive development could
399 enable horses that have access to social contacts to better adapt to the challenges of their environment.

400 The percentage of time that the horses in our experiment spent standing still (Social Condition: 9,3%;
401 Isolated Condition: 6,9%) is lower than that of feral horses or group housing horses, which spent 15 to
402 50% of their time-budget standing (Budiansky, 1997; Duncan, 1980). However, the latter seems to
403 indicate that spending time standing still is a behaviour that is also expressed in conditions closer to
404 natural contexts and is therefore not specific to the confinement of the stall. The lower value of
405 immobility found for isolated horses may be explained the higher levels of stress or frustration
406 experienced by the latter, as illustrated by the frequency of abnormal behaviours they expressed,
407 compared to the horses in the Social Condition. According to some authors, abnormal behaviours such
408 as stereotypies could be a means for the horse of attempting to adapt to a challenging environment
409 (Arena et al., 2021; Budzyńska, 2014). Cooper and Albentosa (2005) refer to how the horse seeks
410 control over its environment, where stereotypies could reduce arousal, and regulate stress or certain
411 physiological functions. However, actual adaptation is unlikely to be effective, given the negative
412 consequences these behaviours can have on health (Cabib and Bonaventura, 1997; Krueger et al.,
413 2021; Nicol et al., 2002; Nisticò et al., 1981; Powell et al., 1999). Horses can display a wide range of
414 abnormal behaviours in response to an unsuitable environment causing chronic stress (Ruet et al.
415 2019). Horses are less active in stalls than in pasture due to the lack of space and stimulation (Chaplin
416 and Gretgrix, 2010). Consequently, the appearance of stereotypic abnormal behaviours could be

417 related to the horses' motivation to be active, and this physical and social restriction could lead to
418 frustration or boredom (Cooper and McGreevy, 2007).

419 Moreover, resting time did not differ between the horses of the two conditions in our study. In other
420 studies conducted on the influence of the social environment on young horses after weaning
421 (Søndergaard, 2003) and at breaking-in (Visser et al., 2008b), isolated horses spent more time lying
422 down than those housed in groups during the first days, but differences between the two groups
423 disappeared after two weeks. This finding suggests that social interaction, while stimulating for the
424 horse, does not increase tiredness or the need for rest.

425

426 *Behaviour during training*

427 During training sessions, the level of tension that we recorded according to a four-level grade of
428 intensity showed that horses that had access to social contact were less tense than those who were
429 isolated. The horse's posture is an indicator that is often used as a score in addition to other measures
430 to assess the horse's stress level in a specific situation (Hall et al., 2014; Polito et al., 2007; Wulf et al.,
431 2013; Yarnell et al., 2015). Indeed, a tense posture with the neck raised is linked to a higher eye
432 temperature, indicating a stress response (Hall et al., 2014). We used this indicator because it seemed
433 relevant during breaking-in, where the horse is not constrained by harnesses imposing a certain
434 posture or head carriage, as the case may be with adult horses (Smiet et al., 2014). The rider's requests
435 are limited to basic changes of directions or transitions with little pressure on the horse's mouth and
436 head, which made it possible to observe the horse's free neck carriage during interaction with the
437 human and use this observation as an indicator. Visser et al. (2009) used this body tension to compare
438 different breaking-in methods and showed a positive correlation with an elevated heart rate. In our
439 study, this tense posture was expressed for longer periods by horses in the Isolated Condition, possibly
440 indicating higher stress levels during training sessions. In addition, these horses also defecated more
441 often than horses in the Social Condition, another stress-related indicator confirming this stressful state
442 (Hall and Heleski, 2017). Conversely, horses that had access to social contact adopted a low-head

443 posture for longer periods than those in the Isolated Condition, indicating a state of relaxation. The
444 low-head, relaxed posture is known to lower arterial blood pressure and is quite similar to the resting
445 or grazing postures assumed naturally by horses (Warren-Smith and McGreevy, 2005); this seems to
446 indicate that training is apparently a less negative experience for horses in Social Condition, with a
447 more serene attitude.

448 However, horses in the Social Condition expressed head tossing and tail switching more often than
449 horses in the Isolated Condition. Conflict behaviours are common during breaking-in, which is by
450 nature a stressful event for the animal (Rivera et al., 2002). The aim of breaking-in, regardless of the
451 method used, is to train the horse to accept carrying a human and equipment on its back and allow the
452 rider to decide on its gait and direction. The horse subsequently loses control, which can lead to the
453 expression of defensive behaviours. The change in relationship with the human and the difficulty in
454 adapting to this new relationship may be another important factor in the expression of these conflict
455 behaviours (Sankey et al., 2010). The latter can disappear as training progresses, due to habituation but
456 also to what is known as acquired resignation: the horse learns that whatever its response, it will not be
457 able to escape the constraint and discomfort (Hall et al., 2008). The loss of control of horses in the
458 Isolated Condition, both through their housing conditions and training with humans, may have led to a
459 rapid extinction of resistance behaviours in comparison to those in the Social Condition, which resist
460 occasionally, i.e. in response to a rider's command. The control an animal has on its environment is an
461 important and frequently discussed feature (Cooper and McGreevy, 2007; Schork et al., 2018).

462 Allowing animals to retain some control over their environment and the choices they can make, like
463 interacting with each other as they do in social groups, may reduce anxiety (Hall et al., 2008). The
464 social device used in this study enabled horses in the Social Condition to regain some form of choice
465 of interaction with a conspecific without human intervention. This social break is particularly
466 important during breaking-in, when the horse is quite brutally deprived of free movement, interaction
467 and expression. These daily moments of regaining social control can lead to an improvement in
468 welfare, which could also explain the general attitude observed at training. Additionally, this social
469 interaction could explain why these resistance behaviours persist: the opportunity to express social

470 behaviours on a daily basis could have strongly preserved the horses' capacity to express themselves
471 in other contexts. However, we cannot ignore the possibility that these results may partly reflect a
472 more general effect due to other factors related to the entire procedure. Although the two stables were
473 very close and handling time was reduced, horses in the Social Condition had a little more experience
474 with humans than those in the Isolated Condition and spent time in a different environment than their
475 usual stall, which may have an impact.

476

477 **Conclusion**

478 Individual stabling and breaking-in are particularly stressful events for the young horse. They can
479 cause behavioural disorders in individual stalls and dangerous defensive behaviours in human-horse
480 interactions. In the stall, the prevalence of abnormal behaviour in both social and isolated horses raises
481 questions about the ongoing use of this type of housing. The individual stall, which results in social
482 isolation and confinement, leads to a distinct change in the activity budget of the horse and depletes its
483 environment compared with outdoor housing (Cooper and McGreevy, 2007). We suggest that the
484 enriched context (i.e. social interactions) offered to the horses in the Social Condition of our study had
485 a positive impact on their first experience of training. The social box we used for this study is a very
486 simple and secure solution. Using such facilities could reduce abnormal behaviours in stalls, allow
487 horses to be more expressive, improve overall welfare and thus contribute to a better human-horse
488 relationship. More generally, this easy-to-install device will promote the welfare of horses in
489 equestrian facilities and will be in line with changes in society regarding respect for our domestic
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491

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499

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742 **Figures**

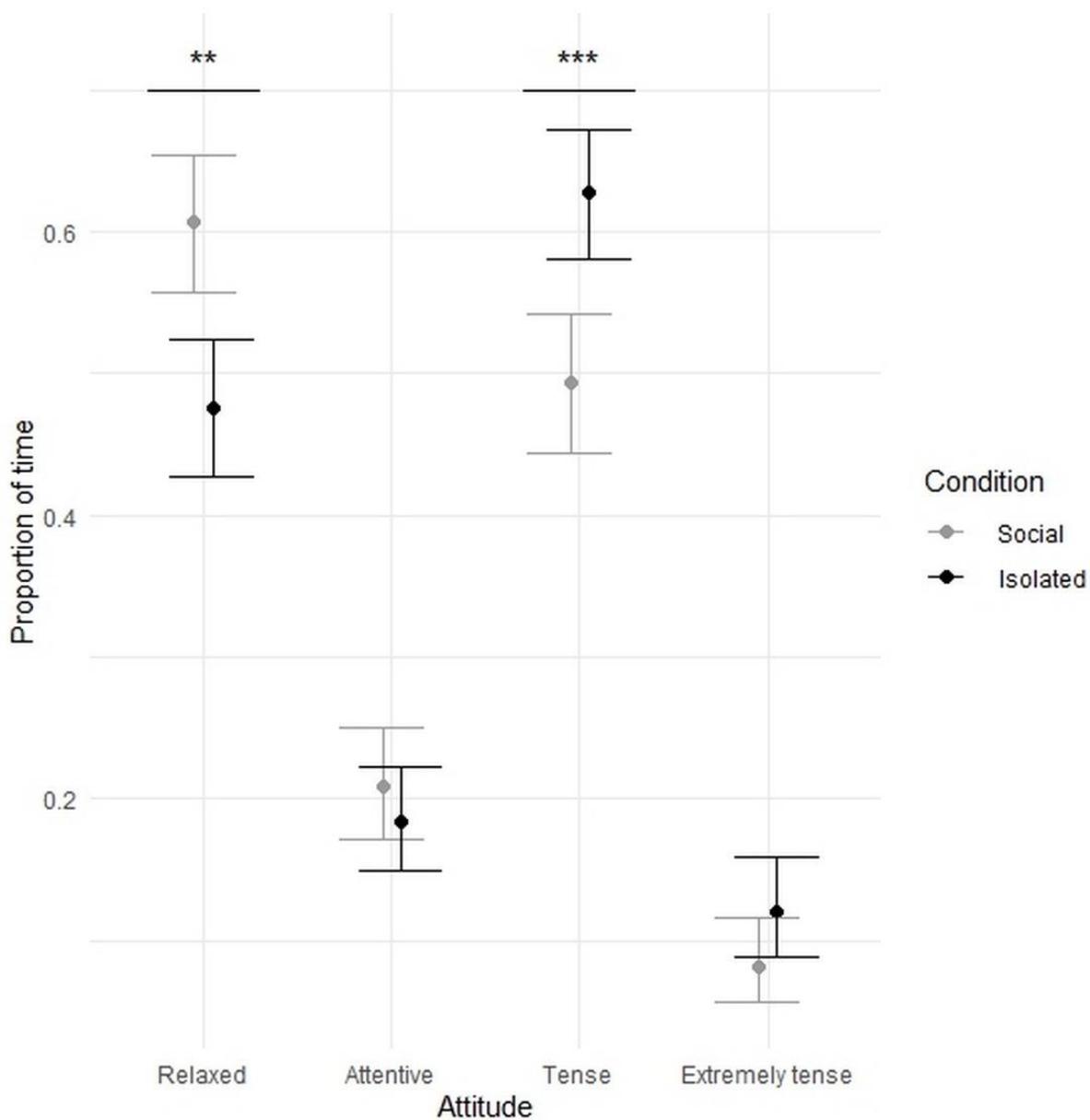
743 Figure 1: Pictures of the social box: empty (on the left) and during a social interaction (on the right)



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746 Figure 2: Proportion of time spent in the four attitudes of the Social Condition and the Isolated
747 Condition. Estimated means \pm SE (standard errors) from the GLMM analysis. **: $p < 0.01$, ***:
748 $p < 0.001$



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Tables

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755 Table 1: Ethogram of the behavioural categories collected in the individual stall

Behaviour	Description	Behaviours collected in other related publications
Abnormal behaviours	<p>The horse expresses one of the following behaviours :</p> <ul style="list-style-type: none"> • Aggressiveness toward humans: pins its ears back, threatens with its head and/or mouth or bites the grid when the observer walks in front of its stall • Apathy: stands still with the neck at the same height as the back, fixed ears, a fixed gaze with opened eyes, and unresponsive to the environment (Fureix et al. 2012) • Signs of agitation without any perceptible perturbation : trots, gallops, snores, blows, tosses its head, paws repeatedly in contexts other than investigation or foraging • Stereotypic and abnormal repetitive behaviours : <ul style="list-style-type: none"> Weaving: Abbreviated pacing involving rhythmic, repeated side-to-side shifting of the weight on the forelegs (McDonnell, 2003) Box walking: repetitive tracing a route within the stable (Lesimple et al. 2020) Cribbing/Wind sucking: grasping of surface with incisors while arching the neck, repeated rhythmically in bouts (McDonnell, 2003) Head-shaking: Repetitive vertical head movements 	<p>Ruet et al. 2020</p> <p>Sénèque et al. 2019</p> <p>Lesimple et al. 2020</p>

	<p>Repetitive licking: licking of the same object in its environment (except the trough) (Sénèque et al. 2019)</p> <p>Repetitive biting: biting of the same object in its environment (except the trough) (Sénèque et al. 2019)</p> <p>Wood chewing: Chewing and/or ingesting wooden objects such as fences or stall construction materials (McDonnell, 2003)</p> <p>Clapping of lips: repetitive movement of the lips (Ruet et al. 2020)</p> <p>Tongue movements outside of the mouth (Ruet et al. 2019)</p> <p>Wall kicking: Deliberate extension of the hind leg to contact barriers, using one or both hind legs alternately or simultaneously (McDonnell, 2003)</p> <ul style="list-style-type: none"> • Vigilance: stands alert, neck raised and nostrils dilated, eyes wide opened and ears held stiffly without any perceptible perturbation in the environment 	
Foraging	The horse ingests hay or straw, with or without movement.	<p>Cooper et al. 2000</p> <p>Lesimple et al. 2019</p> <p>Visser et al. 2008b</p> <p>Yarnell et al. 2015</p>
Investigation	The horse smells its environment (litter, wall or door), with its nostrils in contact with the surface, sometimes moving its head and neck within or towards the area of interest.	Heleski et al. 2002

Locomotion	The horse walks from one point to another.	Visser et al. 2008b Cooper et al. 2000
Maintenance	The horse performs elimination behaviours (urinates, defecates) or comfort behaviours (rolls, shakes, scratches on a surface or grooms itself).	Lesimple et al. 2020 Visser et al. 2008b
Observation	The horse scans its surroundings.	Lesimple et al. 2020
Resting	The horse stands at rest (head slightly lowered, eyes partly or nearly closed, lips relaxed and often bearing weight on three legs) or lies down with its head up or with its legs and head outstretched (McDonnell, 2003).	Cooper et al. 2000 Lesimple et al. 2020 Visser et al. 2008b Yarnell et al. 2015
Standing still	The horse is awake and stays immobile.	Cooper et al. 2000
Vocalisation - Whinnying	The horse produces a loud, prolonged call, typically of 1 to 3 seconds, beginning high pitched and ending lower pitched. The head is elevated and the mouth slightly opened during the whinny (Mc Donnell, 2003).	Heleski et al. 2002 Visser et al. 2008b

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758 Table 2: Description of the ear positions

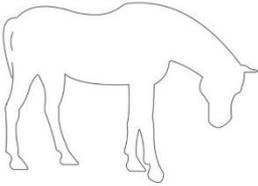
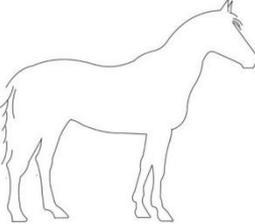
Position	Description (Ruet et al., 2020)	Behaviours collected in other publications
Ears forward	Both ears are oriented forward. When recorded from behind, the inside of the auricle of both ears is completely invisible.	Ruet et al. 2020 Sénèque et al. 2019 Lesimple et al. 2020

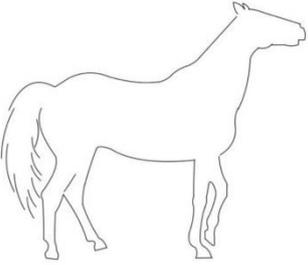
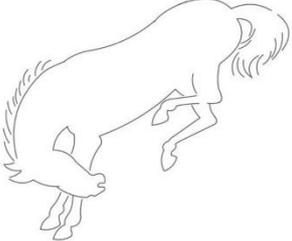
Ears asymmetric	Both ears are not pointed in the same direction. When recorded from behind, only the inside of the auricle of one ear is visible, and the inside of the auricle of the other ear is completely invisible.	
Ears backward	Both ears are oriented backward. When recorded from behind, the inside of the auricle of both ears is visible.	

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761 Table 3: Description of attitudes during breaking-in sessions

Attitude	Description (adapted from Hall et al. 2014)
 <p>Relaxed</p>	No sign of tension of the ears or body, no sudden or rapid movement, neck less than 30 degrees above horizontal, no attempt to refuse the rider's commands.
 <p>Attentive</p>	Ears pointed forward, neck raised between 30 and 45 degrees above horizontal, eyes fixed, unhurried gait, no attempt to avoid the procedure.

 <p style="text-align: center;">Tense</p>	<p>Ears mobile, asymmetric or backwards, neck raised above 45 degrees or unstable (height of neck changes within 5 sec). May be accompanied by movement of the head, horse tries to avoid the rider's commands.</p>
 <p style="text-align: center;">Extremely tense</p>	<p>Ears back or flattened, quick and abrupt movement of the head and/or body, repeated attempts to avoid the rider's commands.</p>

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773 Table 4: Ethogram of the behaviours during the breaking sessions

Behaviour	Description	Behaviours collected in other related publications
Bucking, jumping	The horse suddenly humps or arches its back with the head and neck lowered, usually kicking out with the hindlegs or jumping/bounding forwards/sideways with an arched back and ears laid back (Waring, 2003).	König von Borstel & Glißman 2014 Rivera et al. 2002
Change of direction	The horse suddenly modifies its trajectory against the demand of the rider (quarter or half turn).	Dyson & Pollard 2020
Change of gait	The horse modifies its pace, moving faster (e.g.: from walk to trot) or slower (e.g.: from walk to stop).	König von Borstel & Glißman 2014
Defecation	The horse expels faeces with its tail raised.	Søndergaard & Ladewig 2004
Discomfort caused by the equipment	When the equipment is put on, the horse makes a facial grimace (tightening of the nostrils and mouth, contraction of the masticatory muscles, Dalla Costa et al. 2014) or tries to remove the equipment (twitches, or scratches the equipment on its back against any available surface or with its hindlegs; tries to remove the bit; scratches its head on its forelegs to move the equipment on its head).	Dyson & Pollard 2020 Stange et al. 2023
Evasive behaviours	The horse expresses a startled reaction or attempts to flee (turning the head; moving one to four legs in the opposite direction to the rider, the pressure of the rider's command or the equipment).	König von Borstel & Glißman 2014

Head tossing	The horse attempts to move the head in a quick forward-upward motion (Minero et al., 2003) that is usually restricted by the reins held by the rider (Waring, 2003).	König von Borstel & Glißman 2014
Rearing	The horse suddenly changes its posture so that it stands only on its hindlegs (McGreevy, 2005).	Dyson & Pollard 2020
Snoring	The horse produces a short raspy inhalation sound (Waring, 2003).	Scopa et al. 2018
Tail switching	The horse moves its tail with lateral and dorsoventral movements (McGreevy, 2005).	König von Borstel & Glißman 2014
Teeth grinding	With jaws clenched, the horse moves the jaws back and forth and rubs the upper and lower teeth (McDonnell, 2003).	König von Borstel & Glißman 2014
Threat	The horse attempts to bite or kick the rider.	Søndergaard & Ladewig 2004
Vocalisation (Whinnying)	The horse produces a loud, prolonged call, typically of 1 to 3 seconds, beginning high pitched and ending lower pitched. The head is elevated and the mouth slightly opened during the whinny (Mc Donnell, 2003).	Wilk & Janczarek 2015

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776 Table 5: Post hoc tests of the GLMM analysis with the number of behaviours as a response

777 variable. Significant results are in bold.

Predictor	β	SE	z	p
Bucking	0.033	0.236	0.138	0.890

Change of direction	0.096	0.313	0.307	0.759
Change of gait	-0.144	0.184	-0.785	0.433
Defecation	-0.871	0.215	-4.05	≤0.001
Discomfort caused by the equipment	0.344	0.234	1.47	0.142
Evasive behaviours	0.178	0.235	0.758	0.449
Head tossing	0.500	0.224	2.23	0.026
Rearing	-0.403	0.395	-1.02	0.308
Snoring	-0.098	0.351	-0.28	0.778
Tail switching	0.529	0.247	2.14	0.033
Teeth grinding	-1.996	1.08	-1.85	0.064
Threat	-0.466	0.482	-0.966	0.334
Vocalisation	-0.155	0.438	-0.355	0.723

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