



This is an Accepted Manuscript of an article published by Taylor & Francis in Journal of Applied Animal Welfare Science on 15 Mar 2018, available online:

<http://www.tandfonline.com/10.1080/10888705.2018.1443816>.

1 **Does the location of enrichment material affect behavior and dirtiness in growing**
2 **female pigs?**

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19 **Running head: Enrichment material and exploration in pigs**

20

21 **Abstract**

22 The objective was to investigate if female growing pigs spend similar amounts of time
23 exploring a wooden stick as enrichment material regardless of its proximity to the
24 feeder. Forty-eight pigs 18 to 26 weeks old allocated to 16 pens with three animals per
25 pen were studied. Fifty percent of the pens had a wooden stick beside the feeder, and the
26 rest had a similar stick opposite to the feeder. Two observers assessed the animals by
27 means of scan (nine per session at five minute-intervals) and focal sampling (eight per
28 session per 4 minutes each) three times a day, three days a week for seven weeks. The
29 pigs spent more time ($P < 0.0001$) exploring the wood during the first week than during
30 the rest of the study (10.9% vs 3.6%). The animals with the wood close to the feeder
31 spent less ($P = 0.0001$) time resting (29.9%) and more ($P < 0.0001$) time exploring
32 (6.3%) the wood than animals with the wood opposite to the feeder (32.4% and 2.5%,
33 respectively). In conclusion, a wooden stick placed close to the feeder was associated
34 with more exploratory behavior in growing female pigs than a similar stick placed
35 opposite to the feeder.

36 **Key words:** enrichment material, exploratory behavior, pigs, social behavior, wood

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38 **1. Introduction**

39 Environmental enrichment can be defined as the modification of a barren captive
40 environment to improve the biological functioning of animals (Newberry, 1995). The
41 main goals of environmental enrichment are to increase behavioral diversity, reduce
42 abnormal behavior, increase normal behavior patterns, increase the positive utilization
43 of the environment and increase the ability to cope with challenges (Young, 2003). Pigs
44 reared in barren conditions present limitations in the expression of foraging behavior,

45 which is considered a necessity for pigs' welfare (Studnitz, Jensen, & Pedersen, 2007).
46 The thwarting of this exploratory behavior, which they have an innate motivation to
47 express, can lead to frustration (van de Weerd & Day, 2009) and abnormal redirection
48 of exploratory behavior toward pen mates such as tail biting (Beattie, O'Connell, &
49 Moss, 2000; Beattie, Walker, & Sneddon, 1995; De Jong, Prella, et al., 1998). The
50 utilization of environmental enrichment, by means of the provision of either bedding
51 material or point-source objects, is therefore considered a way to enhance the welfare of
52 pigs (EFSA, 2007). In fact, environmental enrichment has been demonstrated to reduce
53 blood glucocorticoid levels and abnormal behaviors in comparison to more barren
54 environments (De Jong, Ekkel, et al., 2000; Roy, Belzung, Delarue, & Chapillon, 2001).
55 Such is the importance of the environmental enrichment for the wellbeing of pigs that it
56 is a requirement in the European Union, as stated in the EU Directive 2008/120/EC. In
57 accordance with the Directive, "pigs must have permanent access to a sufficient
58 quantity of material to enable proper investigation and manipulation activities, such as
59 straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such, which does
60 not compromise the health of the animals".
61 To provide the opportunity for proper manipulation, the enrichment materials should be
62 edible, chewable, rootable and destructible (Studnitz, Jensen, & Pedersen, 2007). One of
63 the materials currently in common use with pigs in intensive housing is a soft wooden
64 stick. This object might promote manipulation behavior as it is edible, chewable and
65 destructible (www.euwelnet.eu; 2017). Furthermore, this enrichment material is
66 purported to fulfill the four requirements suggested by van de Weerd & Day (2009)
67 when defining the criteria for the success of enrichment material: it should increase
68 species-specific behavior, it should maintain or improve levels of health, it should
69 improve the economics of the production system, and finally, it should be practical to

70 employ. However, the location of the enrichment material within the pen has not been
71 considered in previous studies. In fact, pigs utilize the pen space in two main ways, the
72 active area (with the feeder) and the resting area (usually opposite to the feeder) (Ekkel,
73 Spoolder, Hulsegge & Hopster, 2003). As enrichment material is provided to satisfy
74 foraging behavior, pigs might interact more with the material when it is located close to
75 the feeder than in the resting area. The objective of the present work was to ascertain the
76 effect of the position of the enrichment material (next to or opposite to the feeder) on
77 the amount of time that pigs spend interacting with it, and the hypothesis is that pigs
78 spend more time manipulating a piece of wood when it is located close to the feeder
79 than when it is opposite to the feeder. In addition, Broom & Fraser (2015) described that
80 the resources in a pen, such as a feeder, can result in competition and conflicts among
81 animals. Therefore, social interactions and the presence of tail biting (abnormal
82 behaviour) in relation to the position of the enrichment material will be studied. Finally,
83 as some farmers have suggested that the location of the stick of wood could also
84 interfere with the location of the dunging area, the dirtiness of the pen floors and pigs
85 will be also considered.

86 **2. Materials and methods**

87 **2.1 Animals and experimental procedure**

88 Forty-eight growing female pigs (Landrace x Large White x Pietrain) were housed in
89 groups of 3 in 16 slatted pens (2.5 x 2.5 m; 2 m² per animal) situated in two different
90 rooms of 8 pens each under natural light conditions at a temperature from 17 to 29°C
91 (with a mean maximum temperature during the study of 24.6°C). Each pen was provided
92 with 1 steel drinker bowl (15-16 cm) connected to a nipple and a concrete feeder (58 cm
93 length x 34 cm deep) with 4 feeding places. The pigs had water and food ad libitum. The

94 animals were inspected daily, and no health problems were observed during the
95 experimental period, lasting from the 18 to the 26 weeks old. The animals had been
96 housed in stable groups for two months before the beginning of the study, weaned at 28
97 days old and not provided with enrichment material previously.

98 The enrichment material consisted of a stick of Scots pine (*Pinus sylvestris*) wood, 100
99 x 4.5 x 4.5 cm, located in an iron tube bolted to the wall. The wood touched the floor,
100 and the segment from the floor to a height of 20 cm was available for manipulation by
101 the pigs (Figure 1). The study lasted seven weeks (pig live weight from 49.2 ± 2.8 to
102 108 ± 6.9 kg). The wooden stick was introduced at day 0 of the study (the first day of
103 observation, one hour before the first observation), 30-40 cm from the feeder in 8 pens
104 (four pens per room) and at the other side of the pen, opposite to the feeder, in the other
105 8 (Figure 1).

106 Each pen was visually divided into four areas: left front (FL), right front (FR), left back
107 (BL) and right back (BR; Figure 1). The feeder was in FL in four pens per room and in
108 FR in the other four. The enrichment material was placed in FL, FR, BL and BR in four
109 pens each (two pens per room).

110 After a one-week training period to ensure a good consistency between observers, two
111 observers assessed the behavior of the animals three times per day (morning, from
112 09:00 to 11:00 h; noon, from 12:00 to 14:00 h; and afternoon, from 15:00 to 17:00 h),
113 three days a week (Mondays, Wednesdays and Fridays) during the mentioned seven
114 weeks (from September to November 2015). During each observational session (63 in
115 total), an observer assessed the eight pens of one of the two rooms. The designation of
116 the room to the observer was randomized for each observational session. Each session
117 consisted of nine scan samples of all eight pens at five-minute intervals and eight focal
118 samples (one for each pen) between scan samples (40 minutes in total per session). Each

119 focal sample lasted four minutes (in which the three pigs per pen, not individually
120 identified, were continuously observed), and the order of the pens was randomly
121 selected during each session. In total, 1134 scan samples (9 per session x 2 rooms x 3
122 times x 3 days x 7 weeks) and 1008 focal sample of four minutes each (8 per session x 2
123 rooms x 3 times x 3 days x 7 weeks) were carried out.

124 2.2 Behavioral measurements

125 During the scan samples, the numbers of animals performing the behaviors shown in
126 Table 1 were scored. The behaviors assessed with focal sampling are also showed in
127 Table 1. For focal sampling, the pens were visually divided into front areas at the left
128 (FL) and right (FR) and back areas at the left (BL) and right (BR; Figure 1) for the
129 assessment. In all cases, a new event was considered to begin when there was a time
130 lapse of 10 s from the previous one. The number of events and not the duration of these
131 events was considered.

132 2.3. Dirtiness of the animals and the pen

133 Each experimental day, before the first scan sample of the noon session, all the animals
134 were assessed for dirtiness according to the Welfare Quality protocol for pigs (Welfare
135 Quality, 2009). The area covered with feces on one side of each animal was assessed.
136 This site was randomly selected for each animal during each observation. The animal
137 was scored as 0 if the area covered with feces was less than 20%, 1 if 20 to 50% of the
138 sampled side was covered with feces (partially dirty) and 2 if more than 50% of the
139 sampled side was covered with feces (dirty). In addition, the dirtiness of the pen was
140 assessed in the four areas (FL, FR, BL and BR) separately according to the following
141 scale: 0—less than 25% of the area dirty; 1—from 25% to 50% of the area dirty; 2—
142 more than 50% of the area dirty.

2.4. Statistical Analysis

The statistical analysis was carried out with PROC GENMOD using Statistical Analysis System software (SAS; SAS Institute Inc., Cary, NC; 1999-2001). The data recorded during the scan sample (number of resting, exploration of the pen or enrichment material, positive or negative social interaction, eating and other active behaviors) were analyzed by means of a binomial distribution. The fixed effects were location of the wooden stick, room, time of day and the interactions between the location of the wood and time of day and room. In addition, for the measures of exploration of the pen and exploration of enrichment material, a week effect (from 1 to 7) and the interaction between week and location of the stick of wood were included in the models. Single fixed effects were maintained in models if $P < 0.80$, but in the case of interactions they were only maintained if $P < 0.20$. The residual maximum likelihood was used as a method of estimation in all cases. The least-squares means of fixed effects (LSMEANS) adjusted to Tukey's honestly significant difference (HSD) were compared when the analysis of variance indicated significant differences. The data recorded during the focal sample (presence of positive and negative social behavior, fighting, tail biting) and dirtiness of the animals and the pens were assessed with a multinomial distribution. The fixed effects considered were the locations of the wooden stick and the feeder, the room and the area of the pen (FL, FR, BL and BR). The significance level was fixed in all cases at $P < 0.05$.

2.5 Ethical approval

The experiment was approved by the Institutional Animal Care and Use Committee of Institut de Recerca i tecnologies agroalimentàries (IRTA).

3. Results

3.1 Scan sample

According to the scan sample, the animals spent their time on three main activities:

resting (31.2% of the observations), exploratory behavior (29.6% of the observations,

including 25.2% exploration of the pen and 4.4% exploration of the enrichment

material) and other behaviors (30.4%), such as walking or gazing (animal sitting or

standing without any activity). Social behavior occupied 8.6% of the observations

(consisting of 7.3% positive social behavior and 1.3% negative social behavior), and

eating occupied 0.2% of the observations. The time of day (morning, noon or afternoon)

had effects on resting ($\chi^2 = 52.47$; D.F. = 2; $P < 0.0001$), exploration of the pen ($\chi^2 =$

97.22; D.F. = 2; $P < 0.0001$), exploration of the enrichment material ($\chi^2 = 12.23$; D.F. =

2; $P = 0.0105$), positive social behavior ($\chi^2 = 9.48$; D.F. = 2; $P = 0.0087$), negative social

behavior ($\chi^2 = 15.72$; D.F. = 2; $P = 0.0004$) and other behaviors ($\chi^2 = 52.29$; D.F. = 2; P

< 0.0001 ; Figure 2). The room had effects on exploration of the pen ($\chi^2 = 26.71$; D.F. =

1; $P < 0.0001$), exploration of enrichment material ($\chi^2 = 22.38$; D.F. = 1; $P < 0.0001$)

and other behaviors ($\chi^2 = 9.95$; D.F. = 1; $P = 0.0016$; Figure 3).

The position of the enrichment material had effects on four behaviors: resting ($\chi^2 =$

200.11; D.F. = 1; $P < 0.0001$), exploration of enrichment material ($\chi^2 = 15.97$; D.F. = 1;

$P < 0.0001$), positive social behavior ($\chi^2 = 4.05$; D.F. = 1; $P = 0.0443$) and other

behaviors ($\chi^2 = 7.22$; D.F. = 1; $P = 0.0072$). Less resting behavior occurred in the pens

with the piece of wood close to the feeder (29.9%) than in those with the wood opposite

to the feeder (32.4%, $P < 0.0001$). The animals interacted more times (exploration of

enrichment material) with the piece of the wood when it was close to the feeder (6.3%)

than when it was opposite to the feeder (2.5%, $P < 0.0001$). Positive social behavior was

higher ($P = 0.0443$) with the wood close (7.33%) than opposite to the feeder (6.97%).

192 Finally, other behaviors were found at a lower percentage of the time ($P = 0.0072$) when
193 the wood was close (29.6%) than opposite (31.3%) to the feeder.

194 On the other hand, the time dedicated to the exploration of other elements of the pen
195 (25.1%) was not affected by the location of the enrichment material. Consequently, the
196 animals with the piece of wood close to the feeder spent more time exploring than
197 resting (31.4% and 29.9% of observations, respectively), while the pigs with the wood
198 opposite to the feeder spent more time resting than exploring (32.4% and 27.8% of
199 observations, respectively).

200 When exploratory behavior was assessed during the seven weeks of the study, both
201 exploration of the pen and exploration of enrichment material showed a statistical effect
202 of time ($\chi^2 = 17.48$; D.F. = 6; $P = 0.0077$ and $\chi^2 = 369.00$; D.F. = 6; $P < 0.0001$
203 respectively). In the case of exploration of the pen, a reduction of the behavior ($P <$
204 0.0001) was found in week 4 in comparison to weeks 1, 2, 6, and 7. However, the
205 highest percentage of animals showing exploratory behavior of the pen was found in
206 week 7 and was significantly higher ($P < 0.0001$) than the percentages found in weeks
207 1, 2, 3, 4 and 5. The interaction between week and location of the wood was only
208 significant for exploration of enrichment material ($\chi^2 = 29.98$; D.F. = 6; $P < 0.0001$). In
209 both cases (wood beside or opposite to the feeder), a very clear reduction of the time
210 spent exploring the enrichment material was found after the first week of the study
211 (Figure 4). In addition, in all weeks except the last one (week 7), animals explored the
212 wood for a higher percentage of time ($P < 0.001$ in all cases) when it was close to the
213 feeder than opposite to the feeder.

214 3.2 Focal sample

215 During the focal sample, a total of 4102 positive social interactions were observed (1.36
216 per pen in each observation period). The other behaviors assessed added up to a total of
217 1928 events, 1694 negative social interactions (0.56 per pen and observation period),
218 125 fights (0.04 per pen and observation period) and 109 instances of tail biting
219 behavior (0.04 per pen and observation period). An effect of area of the pen was found
220 for positive social behavior ($\chi^2 = 89.98$; D.F. = 3; $P < 0.0001$), negative social behavior
221 ($\chi^2 = 88.01$; D.F. = 3; $P < 0.0001$) and fighting ($\chi^2 = 8.51$; D.F. = 3; $P = 0.0365$). The
222 prevalence rates of both positive and negative social behaviors were higher ($P < 0.0001$)
223 in front (FL and FR) than in back areas (BL and BR), and fighting was also higher in
224 front areas (FL and FR) than in BL (Figure 5).

225 In all cases (areas FL, FR, BL and BR), the presence or absence of the stick had an
226 effect on the activity of the animals. In FL, positive social behavior was more common
227 ($\chi^2 = 5.70$; D.F. = 1; $P = 0.0170$) when the stick was present (1.73) than when it was
228 absent (1.40 events per period); negative social behavior was more common ($\chi^2 = 9.16$;
229 D.F. = 1; $P = 0.0025$) when the stick was present (1.03) than absent (0.66 events per
230 period); and fighting was also more common ($\chi^2 = 4.10$; D.F. = 1; $P = 0.0428$) when the
231 stick was present (0.11) than absent (0.04 events per period). In FR, positive social
232 behavior was more common ($\chi^2 = 3.94$; D.F. = 1; $P = 0.0472$) when the stick was
233 present (1.88) than absent (1.68 events per period); negative social behavior was more
234 common ($\chi^2 = 4.78$; D.F. = 1; $P = 0.0289$) when the stick was present (0.95) than absent
235 (0.67 events per period); and fighting was also more common ($\chi^2 = 13.83$; D.F. = 1; $P =$
236 0.0002) when the stick was present (0.11) than absent (0.02 events per period). In BL,
237 positive social behavior was more common ($\chi^2 = 18.71$; D.F. = 1; $P < 0.0001$) when the
238 stick was present (1.37) than absent (0.87 events per period), and negative social
239 behavior was also higher ($\chi^2 = 17.83$; D.F. = 1; $P < 0.0001$) when the stick was present

240 (0.56) than absent (0.26 events per period). Finally, in BR, positive social behavior was
241 higher ($\chi^2 = 9.90$; D.F. = 1; $P = 0.0017$) when the stick was present (1.47) than absent
242 (1.18 events per period).

243 The presence of the feeder in the area affected both the FL and FR areas. In FL, positive
244 social behavior was more common ($\chi^2 = 4.55$; D.F. = 1; $P = 0.0330$) when the feeder
245 was present (1.59) than absent (1.37 events per period). In FR, positive social behavior
246 was less common ($\chi^2 = 8.04$; D.F. = 1; $P = 0.0046$) when the feeder was present (1.46)
247 than absent (1.99 events per period), and fighting was more common ($\chi^2 = 5.56$; D.F. =
248 1; $P = 0.0184$) when the feeder was present (0.07) than absent (0.02 events per period).

249 3.3 Dirtiness of the animals and the pen

250 Pigs were clean in 46%, partially dirty in 34% and very dirty in 20% of the cases in
251 which they were assessed. The FL area was significantly dirtier than BL and BR ($P =$
252 0.0288 ; Figure 6). However, no effect of the location of the wood or the feeder was
253 found on the dirtiness of the pigs or the pen.

254 4. Discussion

255 Authors such as Beattie, O'Connell, & Moss (2000); Beattie, Walker, & Sneddon
256 (1995); and Bolhuis, Schouten, Schrama, & Wiegant (2005) have already reported that
257 environmental enrichment reduces the percentage of time pigs are inactive and increases
258 the amount of time they spend performing exploratory behavior. Although it is argued
259 that bedding material is better as enrichment material than a point-source object (Van de
260 Weerd & Day, 2009), such as the wooden stick used in the present study, Cornale,
261 Macchi, et al. (2015) still reported an increase in exploratory behavior when pieces of
262 wood are used as enrichment. In addition, the meta-analysis carried out by Averós,
263 Brossard, et al. (2010) reported that point-source objects also promote the expression of

264 exploratory and rooting behavior when no bedding material is provided. Furthermore, in
265 the work of Averós, Brossard, et al. (2010), it is concluded that, rather than the presence
266 of point-source objects per se, it is their quantity (number of point source objects
267 available to the pigs) and diversity that stimulate exploratory behavior in pigs.
268 However, the effect of the location of the object inside the pen is not reported, probably
269 because no such data were available for the meta-analysis. The results of the present
270 study confirm the initial hypothesis that exploratory behavior increases and inactivity
271 decreases when the wooden stick is located close to the feeder compared with when it is
272 opposite to the feeder. Specifically, the increase in exploratory behavior was focused on
273 the enrichment material rather than the other elements in the pen, whose exploration
274 time remained the same. As consequence, the most frequent behavior in pigs housed in
275 pens with the wood close to the feeder was exploration (enrichment + other areas of the
276 pen), whereas in pigs housed in pens with the wood opposite to the feeder, the most
277 frequent behavior was resting. When the use of the stick was assessed during the 7
278 weeks of the study, a clear decrease was found in its use from the first to the second
279 week. Docking, Van der Weerd, Day & Edwards (2008) found as well that object use
280 decreased over time as the animals habituated to the objects provided. This decline
281 highlights the importance of novelty for the enrichment material (Averós, Brossard, et
282 al., 2010), as the percentage of animals using the wood in this first week was never
283 recovered during the 7 weeks of the study. In addition, the location of the wood beside
284 or opposite to the feeder did not change this tendency.

285 The area with the feeder is considered an active area, and competition during feeding
286 time (i.e., food, space) is expected (Spinka, 2009). In fact, social behavior (positive,
287 negative and fighting) was more frequent in the front areas of the pen than in the rear
288 areas. Furthermore, a positive relationship was found between fighting and the presence

289 of a feeder in the area assessed (FR). This is not surprising, as the feeder, even with
290 only three animals per pen, is an important source of competition and conflicts (Broom
291 & Fraser, 2015), and the results obtained show that the wooden stick could have a
292 similar effect. In fact, in all four areas studied, social interactions increased with the
293 presence of the piece of wood. Therefore, although it is stated that the presence of point-
294 source objects decreases the time engaged in negative social interactions in comparison
295 to a barren environment (Blackshaw, Thomas, & Lee, 1997; Averós, Brossard, et al.,
296 2010), it also stimulates social interactions (positive, negative and fighting) in the area
297 of the pen where the material is located. In this respect, what constitutes positive and
298 negative social behavior should be carefully considered. In fact, the definition of
299 positive or negative social behavior is based on the Welfare Quality® standards
300 (Welfare Quality, 2009), where positive is defined as any contact between animals
301 without an aggressive or flight reaction and negative as an aggressive behavior,
302 including biting or social behavior with a response from the disturbed animal. However,
303 Temple, Manteca, Velarde, & Dalmau (2011), using the same definitions, found that
304 positive and negative social behavior were highly correlated, and they also found a
305 higher presence of positive and negative social behavior in intensive than extensive
306 conditions in the same breed of pigs. Their conclusion was that, in intensive conditions,
307 part of this positive social behavior is in fact a prelude to negative social behavior and
308 should probably not be considered wholly positive. In the present study, carried out in
309 intensive conditions, it should be similarly assumed that the barrier between positivity
310 and negativity is not entirely clear; therefore, the terms must be considered only as
311 definitions of the types of social interactions according to the Welfare Quality®
312 standards.

313 In any case, if the aim is to stimulate exploratory behavior by means of a single point-
314 source object, we suggest that it be placed in the active area of the pen (close to the
315 feeder) according to the results obtained in the present study. In addition, the presence
316 of several point-source objects might reduce negative social behavior caused by
317 competition within the pen. In fact, according to Docking, Van de Weerd, Day, &
318 Edwards (2008), due to behavioral synchronization, object availability should be taken
319 into account when providing appropriate amount of enrichment in order to reduce
320 competition. In fact, the differences in activity budgets found in the morning, noon and
321 afternoon sessions (Figure 2) confirm this synchronization in the present study.

322 In the current study, the front areas of the pens were dirtier than the back areas,
323 confirming that with enough space allowance (2.00 m² per pig), pigs prefer to maintain
324 clean resting areas (Blackell, 2004). However, the high number of dirty animals (20%
325 with more than 50% of the body soiled) suggests that they also rested in the dunging
326 area. This might be due to the mean maximum temperature of 24.6°C to which the
327 animals were exposed. Therefore, at some points during the study, the animals might
328 have experienced moderate thermal stress that would explain their dirtiness. Although
329 some farmers have suggested that the location of the stick of wood could also interfere
330 with the location of the dunging area, we did not find any relationship between the
331 dirtiness of the floor or the animals and the location of the wood.

332 Finally, the activity budget reported in the present study is in accordance with previous
333 studies on behavior of pigs, with animals spending approximately 30% of the scans
334 resting, 30% of the scans exploring and a 30% of scans showing active behaviors other
335 than social behavior (Temple, Manteca, Velarde, Dalmau, 2011). Although the
336 behavioral pattern differed between the morning (from 09:00 to 11:00 h) and the
337 afternoon (from 15:00 to 17:00 h), no interaction was found with the location of the

338 wood. In addition, although the behavioral patterns were slightly different between the
339 two rooms, no interaction with the location of the wood was encountered; therefore, the
340 results are equally applicable to both rooms.

341 **5. Conclusions**

342 A wooden stick close to the feeder was associated with more exploratory behavior in
343 growing female pigs than a similar stick placed opposite to the feeder, resulting in
344 animals spending more time exploring and less time resting. A single wooden stick
345 stimulated social interactions in the area where it was placed in comparison with the
346 absence of the stick. The time spent exploring the wood was by far higher during the
347 first week than in the following weeks, without a clear effect on this trend related to the
348 position of the piece of wood in the pen.

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421 Table 1. Behaviors assessed by means of scan sampling and focal sampling (based on
422 Welfare Quality, 2009)

Parameter	Definition
Scan sampling	

Resting	Animal lying down without any activity (with eyes open or closed)
Exploration of the pen	Animal licking or sniffing any part of the pen except the food or the stick of wood
Exploration of enrichment material	Animal touching/manipulating the wooden stick with its mouth or nose
Positive social behavior	Interaction between pigs in which the recipient only react to the contact of conspecifics according to the definition in the Welfare Quality protocols: sniffing, nosing, licking, and moving gently away from the animal without aggressive or flight reaction from this individual
Negative social behavior	Interaction between pigs in which the recipient changes its behavior (i.e., fight or flight reaction) as result of contact with a conspecific and according to the Welfare Quality protocols: aggressive behavior, including biting, or aggressive social behavior with a response from the disturbed animal
Eating	Animal with the snout or the mouth into the feed
Other behaviors	Any active behavior not considered previously, such as gazing (animal sitting or standing without any activity), walking, running, or drinking
Focal Sampling	
Positive social behavior	Interaction between pigs in which the recipient only react to the contact of conspecifics in the way is described previously
Negative social behavior	Interaction between pigs that produced a change in the behavior of the recipient in the way is described previously
Fighting	Negative social interaction that leads to a second negative social interaction where the receptor becomes the actor and the actor the receptor. Fighting and negative social behavior are mutually exclusive
Tail biting	Animal with the tail of another pig in its mouth

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428 Figure 1. Distribution of the pens in room 1 and 2 (both with exactly the same)

429 according to the location of the feeder and the enrichment material. The black box

430 represents the feeder, and the square in the circle represents the wood. For focal

431 sampling, the pen was divided with two imaginary lines into four areas: front left and
432 right (FL and FR, respectively) and back left and right (BL and BR, respectively).

433 Figure 2. Mean percentages of pigs observed resting, exploring the pen (Expl pen);
434 exploring the enrichment material (Expl wood); and showing positive social behavior
435 (Social pos), negative social behavior (Social neg) and other active behaviors (Others)
436 during the scan sample carried out in the morning (09:00 to 11:00 h), at noon (12:00 to
437 14:00 h) and in the afternoon (15:00 to 17:00 h).

438 Figure 3. Mean percentage of pigs observed resting, exploring the pen (Expl pen),
439 exploring enrichment material (Expl wood), showing positive social behavior (Social
440 pos), negative social behavior (Social neg) and other active behaviors (Others) during
441 the scan sample carried out at room 1 and room 2.

442 Figure 4. Mean percentage of pigs observed exploring the enrichment material when the
443 stick was beside or opposite to the feeder by week during the 7 weeks of the study.

444 Figure 5. Mean number of positive social (Social pos) or negative social (Social neg)
445 behaviors recorded during 4 minutes of focal sampling in different areas of the pen: the
446 front left area (FL), front right area (FR), back left area (BL) and back right area (BR).

447 Figure 6. Percentage of time when the floor was classified as clean (less than 25% of the
448 surface soiled with feces) in the different areas of the pen: the front left area (FL), front
449 right area (FR), back left area (BL) and back right area (BR).