PART-TIME GROUP HOUSING OF FAMILIAR RABBIT DOES IN LARGE PARTITIONNED SPACE: EFFECTS ON PERFORMANCE AND BEHAVIOUR

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ABSTRACT

The aim of this work was to study the effect of a part-time collective housing of females raised together since their birth on their performance, use of space and behaviour. We used 40 females born on the same day (D0) and being suckled by 8 females until D35 (8 litters of 5 'sisters of milk'). The 'sisters of milk' were housed together, by litter, in the same housing until D84 and were followed during two reproductive cycles (from D84 to D245). At D84, 8 young females (1 per litter) were separated to be individually housed until D245 (I group; n=8 females). The others 32 females were housed in 8 modules of 4 individual housing that could be linked together via connection hatches between two housing (G group), inducing a large and partitioned habitat (36 388 cm² against 9 097 cm²). In G group, females were isolated from 4 days before to 17 days after the birth (D171 to D191 and D213 à D233 in 1st and 2nd cycle) and were grouped the rest of the time. Space use and social interactions were measured by direct observation twice a day and two days a week from D84 to D245 and by 40-min video recordings at D120 and D168. Behaviour along the day was measured at D151 by 26 direct observations throughout the day. Housing system had no effect on live weight nor fertility, but female mortality was higher in the G compared to I group (34 *vs* 0%; $P<0.05$). Group housing allowed the observation of positive social interactions (11% of total behavioural observations) but we also observed injuries (68% of females of G females throughout the experiment of which 19% had middle or severe injury scores). The number of positive interactions was high and the number of injuries low at young ages (from D84 to D170; $P<0.05$). On the opposite, the number of injuries in grouped females was higher during reproductive life than before first kindling (27 and 19% of severe wounds in 1st and 2nd cycle *vs* 2% before D170; $P>0.05$). Although in both groups, females were observed mainly on the floor (70% of observations), the number of vertical movements of grouped females was 3 times higher than isolated ones (1.8 and 1.2 *vs* 0.6 and 0.4 no./h in G *vs* I group at D120 and D168; $P<0.05$). These results suggested that the group housing of young females that knowns each other in a large partitioned space before their first kindling is a promising way to improve animal welfare. On the opposite, collective housing in lactating does is detrimental to animal health and should be avoided, even among females raised together since birth.

Key words: littermate, group housing, rabbit females, behaviour, *Oryctolagus cuniculus*.

INTRODUCTION

The management of group housing in rabbit females has been subjected to numerous studies (Szendrö et al., 2019). Their purpose is to allow adults express positive social interactions (allo-grooming, resting in body contact; Seaman et al., 2008; Stauffacher, 1992) and increased physical activity thanks to a more spacious living space. However, group housing also creates the opportunity to the expression of agonistic interactions, resulting in injuries, stress and even the death of the animal (Ruis and Coenen, 2004), as well as negative effects on the reproductive performance (Rommers et al., 2006). Part-time group housing has been shown to reduce these disadvantages, compared to full-time group housing, without eliminating negative interaction (Maertens and Buijs, 2016a and 2016b).

Albonetti *et al*. (1990) showed that aggressions were more frequent among unfamiliar females, getting less frequent after the establishment of a stable social hierarchy. Graf *et al*. (2011) showed that, independently on the environment (familiar *vs* novel housing), agonistic interactions occurred at a similar frequency when reproductive females were grouped, suggesting that agonistic interaction to define hierarchical dominance are more important than territorial aggression. In this context, we aimed to compare the space use, the behaviour, the health and the reproductive performance of females that were reared together from birth and then housed individually or part-time grouped during their reproductive life.

MATERIAL AND METHODS

Animal and experimental design

The experiments received French agreement (experiment permit number 16330-2018072716211212).
We followed 40 crossbreed females (♀INRA 1777 x ♂PS59, n=20 or ♀ Hypharm 6719 x ♂PS59, n=20) from birth (D0) to the weaning of their second litter (D245). They have being suckled by 8 females until D35 (8 litters of 5 'sisters of milk'), being collectively housed with their littermates in the same housing until D84. At D84, 8 females (1 from each litter) were separated to be individually housed (I group, n=8 females) and the remaining four 'sisters of milk' of each litters were housed in groups of four females in adjacent individual housing connected together to form large collective housing (G group, n=32 females = 8 groups of 4 'sisters of milk'). The housing was made of wire mesh (102 × 47 × 60 cm, w × l × h) and contained an L-shaped upper floor formed by a platform (38 × 45 cm, w × l) and a corridor (21.5 × 62 cm, w × l) both made with plastic-mesh fixed at 30 cm from the ground. Each housing was equipped with a compacted forage block and a wood stick (20 cm), both as gnawing blocks. A box (28 × 45 × 32 cm, w × l × h) was located on the front of housing to form a burrow which was equipped with nest box 4 days before until 21 days after parturition. Adjacent individual housing (9 097 cm²) could be linked together via connection hatches located at the upper floor level (Huang *et al*., 2020) to form a large collective pen (36 388 cm²).
In G group, females were housed individually from 4 days before to 17 days after parturitions 1 and 2 (D171 to D191 and D213 to D233, respectively) being re-grouped, in groups of 4 sisters, the rest of the time (D0 to D170, D192 to D212 and D234 to D245). The two artificial inseminations were performed at D144 and D186 with PS59 semen (Hypharm, 49450 Roussay, France). At the first and second parturitions, the litter size was set to 9 and 11 kits, respectively. Litters were weaned at 35 days of age. The animals had *ad libitum* access to commercial pelleted diet (12.0 MJ DE/kg, 19.5% CP) and fresh water through nipple drinkers in each individual housing throughout the experimental period.

Performance measurements

Live weight of females and feed intake in each individual housing (females and litters if applicable) were controlled at D84, D98, D126 and at each AI (D144 and D186), at each parturition (D176 and D217) and at each weaning (D203 and D245). Size and weight of litters were controlled at birth, at 11 days and at weaning. Mortality (females and kits) was controlled daily. During the grouping periods, the presence of injuries were recorded daily on all animals using a 4 point scale to evaluate their severity (0 = no damage, 1 = minor injury with scratching on the ear or torn hairs, 2 = moderate injury with torn nail, or scratch on the eye or on the back, or damaged epidermis, or hair torn off by tufts, 3 = serious injury with damaged dermis, raw flesh, or rapid evolution of a wound that passes from class 1 to class 2 within 24 hours).

Space use and behaviour

Space use (ground, upper floor, burrow) and positive social interactions (contact, grooming, sniffing) were measured by direct observation twice a day (around 10h00 and 15h00) and two days a week from D84 to D245. The dynamic of space use was evaluated through two 40-minutes video recordings at D120 and D168 (starting around h 10:00 and 16:00). We assessed the passage from one individual housing to another within the collective housing, the number of jumping (ground to floor) as well as the number, the duration and the position (ground, floor, burrow) of positive social interactions (contact, grooming, sniffing). Diurnal behaviour of each female was measured at D151 by 26 direct observations throughout the day (every 15 min).

Statistical analyses

Analyses were performed using the software R version 3.6.0 (R Core Team, 2019) considering 5 group-housing periods: G1 (D84 to D118), G2 (D119 to D144), G3 (D145 to D170), G4 (D192 to D212) and G5 (D234 to D245) and two individual housing periods: I1 (D171 to D191) and I2 (D213 to D233). Quantitative data were analysed using a linear model including housing (I or G) and genotype (crossbred females with INRA1777 or Hypharm lines, data not shown here), as well as their interaction. The model included the reproductive cycle, the physiological state or period, when applicable, as fixed effects. Qualitative data (mortality, injuries, space use, and social interactions) were analysed using logistic regression using same effects as above.

RESULTS AND DISCUSSION

Performance, mortality and injuries

Live weight of females was similar between groups along the experiment (4622 g). Feed intake was higher in I than G group during periods G1 (+20.8 g/d), G2 (+31.5 g/d), I1 (+40.7 g/d) and I2 (+44.6 g/d, P<0.05). Fertility rate was similar between groups at first and second parturition. In the first cycle, litter size was higher in I than G group at birth (+2.6 kits) and weaning (+1.3 kits; *P*<0.05; Table 1). The weight of kits was lower in I than G group at birth (-16%; *P*<0.05) but similar at weaning (688 g). In second cycle, litter size and weight were similar between groups at birth and at weaning. The 11 females dead during the experiment (27.5% of the total females) all belonged to the G group (3 losses at the first and 8 losses at the second cycle). Through the experiment, 18% of the females had significant injuries (type 2 or 3), 51% had slight injuries (type 1) and 31% had none. The percentage of females with type 3 injuries was low (0 to 3%; Figure 1) in G1 to G3 periods and high in G4 and G5 periods (27 and 19%, respectively). The percentage of females showing no injuries was the highest during the G3 period (69%).

Table 1: Effects of housing system on reproductive performance of females during the 2 reproductive cycles (C1 and C2)

	I group	G group	SEM	*P value*
Initial No. females	8	32	-	
Fertility rate at C1 (%)	100	83.3	-	NS
Litter size at C1 birth	11.0	8.4	0.5	<0.05
Litter size at C1 weaning	6.8	8.1	0.4	<0.05
Kits weight at C1 birth (g)	518	616	1.9	<0.05
Kits weight at C1 weaning (g)	689	689	14	NS
Fertility rate at C2 (%)	87.5	71.4	-	NS
Litter size at C2 birth	11.3	11.0	0.8	NS
Litter size at C2 weaning	8.0	8.9	0.5	NS
Kits weight at C2 birth (g)	65	63	2.1	NS

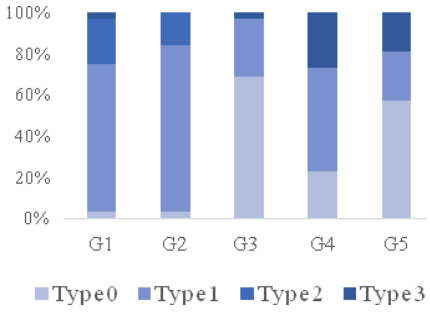

Figure 1: Evolution frequency and severity of injuries in G group during the grouping periods (G1 to G5).

Table 2: Effect of housing system on behaviour of females at D151.

Frequency[1] (%)	I group	G group	*P value*
Resting	78.9	70.9	<0.05
Feeding	5.8	3.6	NS
Grooming	7.7	16.7	<0.05
Moving	0.5	1.8	NS
Standing up	0.0	0.6	NS
Sniffing or gnawing	5.8	4.0	NS
Stereotypy	2.4	2.6	NS
Social interactions[2]	-	24.6	

[1] the number of times a rabbit does expressed the specific behaviour/26 (26 = number of total observation per females at D151. [2]Took place at the same time as one of the other activities mentioned above: resting (86%),

Space use and behaviour

Througout the experiment, females were observed more often on the ground (+5%) and less often on the upper floor (-5.7%) in G than I group (*P*<0.05). Use of burrow was low (<4%) compared to the presence of females on the ground (>70%) or upper floor (around 25% of observations). The number

of vertical movements per female was 3 times higher in G than in I group (1.8 and 1.2 *vs* 0.6 and 0.4 no./h in G vs I group at D120 and D168; $P<0.05$). Grouped females visited, on average, 3.0 or 2.2 other housing units within a collective housing per h at D120 and D168, respectively.

The frequency of positive social interactions increased between D84 and D119 (9% to 19% in G1 *vs* G2 periods) and decreased thereafter (16%, 7% and 5% in G3, G4 and G5 periods; $P<0.05$). Video recordings showed an average number of 4.6 positive interactions/h/female and an average duration of 13.8 min each hour of positive interaction in the G group. The majority (92%) of these interactions took place on the ground floor.

At D151 (26 observations per female within the diurnal period), the frequency (number of times observed / 26) of resting was higher (+7 percentage units) whereas the frequency of grooming was lower (-9 percentage units) for females in I compared to G group ($P<0.05$) (Table 2). The frequency of other behaviours was similar between females of I and G groups. Grouped females showed several positive social interactions (24.6% of all observations), expressed along with other behaviours: resting (86%), grooming (11%) and other (3%).

CONCLUSIONS

The grouping of familiar females in a collective partitioned space enabled frequent positive social interactions and increased the activity rate of females. It also diversified the behavioural repertoire of animals. However, the familiarity of females since birth does not prevent the expression of aggressive behaviours. The antagonistic behaviour resulted in moderate injuries from puberty to first kindling and severe injuries after females are re-grouped 17 days after first parturition. In addition, the necessary renewal of females makes the maintenance of familiar and stable groups a difficult practice. Thus, females grouping seem not to have a promising application at intensive farms. Favouring the grouping of females outside their reproductive life (from weaning to first parturition) or even during unproductive periods, seems a most effective way to favour the social life of reproductive females without affecting their physical integrity and health.

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