Feeding, resting and social behaviour in ewes housed in two different group sizes.

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Abstract

The aim of this experiment was to investigate the effects of increased group size on eating- and resting behaviour, aggression and feed intake in housed ewes. During an initial period of 14 days 36 adult (2-6 years old) ewes of the domestic Norwegian Dala breed were divided into four groups of 9. In the second period (14 days), these ewes were merged into one group of 36 ewes. This experiment was repeated with a second batch of ewes, but this time starting with a group of 36 individuals in the first period, then splitting them up into four groups of 9 ewes in the second period. From 24 hour video recordings we scored activity behaviours using instantaneous sampling every 10 minutes. Aggressive interactions were continuously observed the first 10 minutes every hour during the 24 hours (4 hours in total). A mixed statistical procedure with group size, day, batch and the interactions between them were included as fixed effects, whereas individual and group were specified as random effects. Ewes in large groups (36) had a larger variation in lying time at day one (P<0.01), less synchronized lying (P<0.05) and eating behaviour (P<0.01), and spent less time queuing at the feed barrier (P<0.001) compared to in the small group size (9). There were no effects of group size on aggressive interactions or feed intake. In conclusion, a larger group size decreased synchrony in resting and feeding behaviour and reduced the time spent queuing in front of the feed barrier. It is possible that the aggression level in sheep is more sensitive to changes in space allowance than to changes in group size per se.

Keywords: group size, ewes, feeding, resting, queuing, synchrony

1. Introduction

Group size varies to a large extent in wild populations of sheep, but the most frequent group sizes are between 7 and 49 individuals for Soay sheep and up to 61 individual for Bighorns, with an average of approximately 8 (Grubb and Jewell, 1966; Woolf et al, 1970). Larger groups may divide into subgroups during migration and grazing (Festa-Bianchet, 1988; Boissy and Dumont, 2002). In free-ranging Soay sheep group size mainly depend on the need for anti-predatory vigilance (Hopewell et al., 2005). Larger group sizes in periods with higher predation risk is also revealed for several other species (review: Lima and Dill, 1990; wallabies: Blumstein et al., 1999; lizards: Downes and Hoefer, 2004).

Aggressive interactions have been documented to decrease with increasing group sizes in domestic fowl (Lindberg and Nicol, 1996; Hughes et al., 1997; Estevez et al., 1997, 2003, 2007), turkeys (Buchwalder and Huber-Eicher, 2005) and pigs (Nielsen et al., 1995; Turner et al., 2001; Andersen et al., 2004). Similar results have also recently been found in goats (Andersen et al., unpublished). In weaned pigs, a larger proportion of animals will change towards more defensive strategies with increasing group size, but a few individuals with a high competition capacity appear to engage in fights that last longer and are more intensive (Andersen et al., 2004). Furthermore, it appears that when animals originate from large groups and grow up experiencing a low aggression level over a long time period, these animals will behave less aggressively when introduced to new group members. The latter has been shown both in weaned pigs (Turner et al., 2001) and young turkeys (Buchwalder and Huber-Eicher, 2005), but these effects may depend on the length of the period that the animals are members of a large group.

For animals with a low level of aggression, such as young calves, an increased group size is associated with fewer displacements, higher activity, and an increased tolerance towards group mates (i.e. resting in a closer proximity to neighbouring calves) (Færevik et al., 2007). Displacements from the feed barrier and the resting area are also more commonly seen in adult sheep than the more intensive butting (Bøe et al., 2006). The increased locomotion with increasing group size may both be explained by an increased level of social stimuli in larger groups, but also that individuals are moving more to avoid others. Social complexity increases with increasing group size, and as suggested by Croney and Newberry (2007), this may create higher cognitive demands on each individual in the group. Individual recognition appears to be essential for group functioning. Sheep is able to visually recognize at least 50 other individuals (Kendrick et al., 2001), which is a number close to the upper limit group size reported in wild populations (e.g. Grubb and Jewell, 1966; Woolf et al, 1970).

The overall aim of this experiment was to study activity pattern, social interactions and feed intake of ewes housed in a small (9) vs. large group (36). Based on previous results in other farm animal species, we predict that the amount of agonistic interactions, including displacements from feed or resting area, will be lower in the largest group size. One way to reduce competition in larger groups is that more individuals will choose to perform important activities less simultaneously (e.g. Nielsen et al., 1995; Boissy and Dumont, 2002). Thus, we predicted to find a lower incidence of queuing in front of the feed barrier and less synchronous feeding and resting behaviour in the largest group size.

2. Materials and methods

2.1 Experimental design

The effect of group size was investigated in two batches. In batch 1, thirty-six ewes were divided into four groups of 9 ewes (small group size) in the first period (14 days) and then merged into one group of 36 ewes (large group size) in the second period (14 days). In batch 2, 36 ewes were kept as one group in the first period and then split into four groups of 9 ewes in the second period.

2.2 Experimental pens

The experimental pens had a space allowance of 1.5 m^2 per ewe. When the ewes were split into groups of 9, the experimental pens were divided into four, maintaining the same space allowance per animal. In each of the four pens there was a water bowl and a feeding barrier with three separate openings (allowing three animals to feed simultaneously). This means that there were three ewes per feeding place, irrespective of group size. Approximately 2/3 of the pen was deep straw bedding, whereas the area in the front at the feed barrier was bare concrete. Total available perimeter length (pen wall length minus feed barrier length) in the pens with 9 ewes was 1.4 m/ewe, and 0.6 m/ewe in the pen with 36 ewes. Additional straw material was provided twice a week to maintain a dry lying surface.

2.3 Animals and feeding

In each of the two batches, 36 pregnant (2 – 6 years old), medium sized ewes of the Dala breed were randomly chosen from the resident herd at the Norwegian University of Life Sciences in January and February, respectively. The ewes are normally kept indoors in pens with expanded metal flooring (October to April) and were shorn and mated in the beginning of November. Before entering the experiment, the ewes were individually marked with numbers on the back and weighed (weight range batch1: 75-85 kg, batch 2: 85-95 kg).

A ration of 0.2 kg per ewe of standard concentrate was offered every morning at 08:00. Good quality hay ([1]DM: 90.4 %; NDF: 587.5 g/kg; CP: 65.8 g/kg) was offered *ad libitum* so that the amount of hay supplied every morning was 120 % of the feed intake the last day. The daily ration of hay and the leftovers were weighed on an electronic balance, and the quality of the hay did not change during the experiment.

2.4 Behavioural observations

The ewes were video recorded for 24 hours on day 1 and 14 in each two-week period. Two wide-angled video cameras covered the experimental pens, so that two small groups were

[1] Hay quality measures, DM= dry matter, NDF= neutral detergent fibre, CP= crude protein.

recorded by one camera and the large group pen was recorded by two cameras. The cameras were connected to a multiplexer (Robot MV99P) and a time-lapse video recorder (Panasonic AG 6720), and mounted 3 to 4 meters above the floor. The following behaviours were scored for each individual during the 24 hours, using instantaneous sampling at 10-minute intervals:

- Eating hay (head trough feed barrier)
- Lying
- Queuing (standing <1.5 m away from the feed barrier, with head directing towards it)
- Walking/standing (except for queuing)
- Other behaviours (drinking water, eating concentrate)

The number of ewes lying by the wall (<15 cm from the wall) and in the middle of the pen (>15 cm from the wall) were scored within the same time period, also at 10-minute intervals.

All instances of aggressive interactions were scored continuously for the first 10 minutes of each hour during the 24 hour video recording (a total of four hours) in a similar way as in Bøe et al (2006). The initiator and receiver of the aggressive behaviour were also recorded;

- Pushing another ewe/forcing past another ewe
- Mounting (jumping on another ewes back)
- Kicking another ewe with front leg
- Butting another ewe, head to head or butting with the head towards other parts of the receivers body
- Threatening another ewe by walking towards her, and the other ewe moves away
- Displacements (physically forcing another ewe to leave their place at the feed barrier or resting place)

The behaviours pushing, mounting, kicking, butting and threatening were summed into other aggressive interactions (displacements not included).

2.5 Statistical analysis

The effect of group size on feed intake was analyzed using a mixed model of analysis of variances with the following class variables: group size (9, 36), batch (1, 2) and the interaction between group size and batch. Batch was specified as a random effect (Hatcher and Stepanski, 1994).

In order to test the effects of group size on general activity and number of social interactions we used a mixed model (MIXED) procedure of Statistical Analysis System (SAS). The model included group size (9, 36), batch (1, 2), day (1, 14), the interaction between group size and batch, and the interaction between group size and day as fixed effects. Individual ewe and group were specified as random effects in the model. To ensure a conservative test we set the maximum number of degrees of freedom to 31.

In order to test the effect of group size on synchrony and CV for lying and feeding behaviour within day 1 or day 14 in the treatment, we used a mixed model of analysis of variance with the following class variables: group size (9, 36) and batch (1, 2). Batch was specified as a random effect.

The same model was used to test the effect of group size on mean number of ewes lying against the wall of ewes lying.

A Student Newman Keuls test was used to find differences between means.

3. Results

On day 1 (the day of grouping), the ewes were resting significantly less when kept in a large compared to in a small group, but this effect was no longer significant on day 14 (Table 1). A significant interaction effect between group size and day was detected ($F_{1,31}$=5.7, P<0.05). In both batches, as much as 50 % (18 animals) to 73 % (26 animals) of the ewes spent less time resting when kept in the large compared to in the small group size.

The variation in individual resting time (CV) was significantly larger in group size 36 on day 1 (range 38.9 to 76.4 %) than in group size 9 (range 54.1 to 78.5 %), but not on day 14 (group size 36: range 47.2 to 77.7 %; group size 9: range 51.4 to 76.4 %; Table 1).

Mean proportion of observations resting simultaneously were significantly higher when the ewes were kept in small than in large groups (Figure 1).

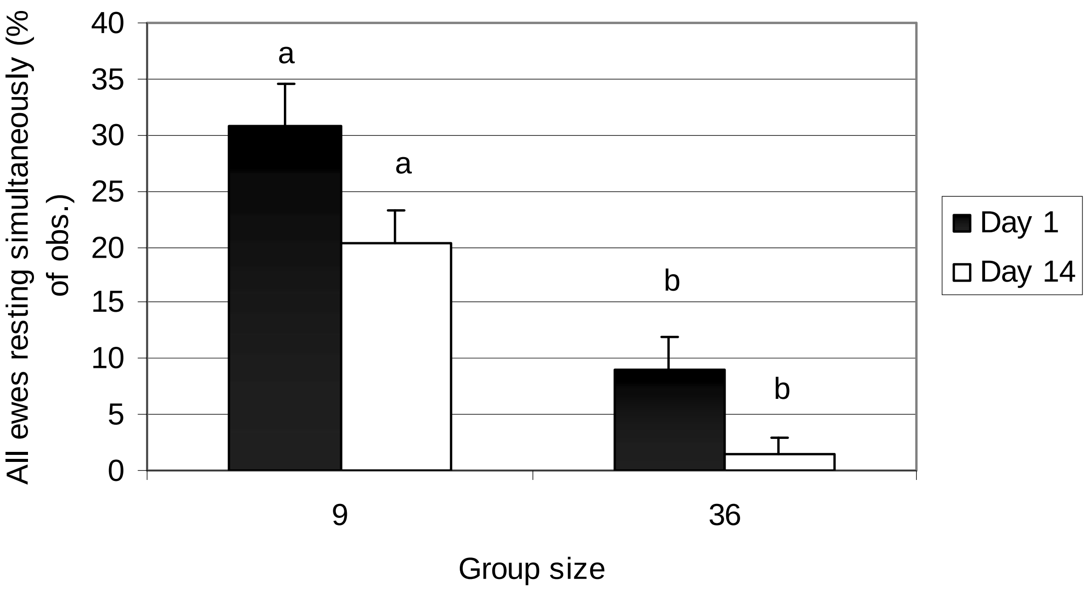

Figure 1. Percent of observations where all ewes were resting at the same time (means + SE). Bars with different superscripts [a,b] differ significantly, P<0.05.

Table 1. Differences in behavioural measures between the two group sizes on the day of grouping and 14 days after grouping (activity variables are given as mean % of tot. obs. ± SE, whereas displacements and aggressive interactions are given as mean number of incidents per ewe). Means with different superscripts differ significantly.

	Day 1		Day 14		Group size		Day	
	9 ewes	36 ewes	9 ewes	36 ewes	F-value	P-value	F-value	P-value
Eating roughage	19.4 ± 0.5 [a]	18.6 ± 0.6 [a]	18.6 ± 0.6 [b]	20.6 ± 0.5 [c]	0.98	ns	1.44	ns
CV eating roughage	24.1 ± 2.0	22.9 ± 1.8	28.8 ± 2.4	20.6 ± 4.2	0.04*	ns	0.65*	ns
Resting	66.0 ± 0.6 [a]	61.9 ± 0.9 [b]	63.8 ± 0.6 [c]	62.8 ± 0.6 [c]	6.6	<0.05	1.01	ns
CV resting	6.9 ± 0.5 [a]	12.2 ± 0.1 [b]	8.4 ± 0.6 [c]	8.6 ± 0.8 [c]	10.08*	<0.01	1.46*	ns
Queuing	3.8 ± 0.3 [a]	2.8 ± 0.2 [b]	4.4 ± 0.3 [c]	3.0 ± 0.3 [d]	11.3	<0.01	2.0	ns
Standing/walking	9.8 ± 0.4 [a]	15.5 ± 0.7 [b]	11.7 ± 0.4 [c]	12.5 ± 0.5 [c]	29.5	<0.0001	0.88	ns
Displacements	6.0 ± 0.5	6.3 ± 0.5	8.2 ± 0.7	8.6 ± 0.6	0.14	ns	16.3	<0.001
Other aggressive interactions**	11.6 ± 0.8	10.8 ± 0.8	12.4 ± 0.9	13.6 ± 0.8	0.05	ns	5.4	<0.015

Df = 1, 31 for most variables. *Df = 1, 19. CV for eating roughage and CV for resting are values calculated per group and were therefore analyzed separately.
**Other aggressive interactions included pushing, mounting, kicking, butting and threatening.

Of the ewes that were resting, significantly more animals were lying against a wall in the small than the large group size (Figure 2).

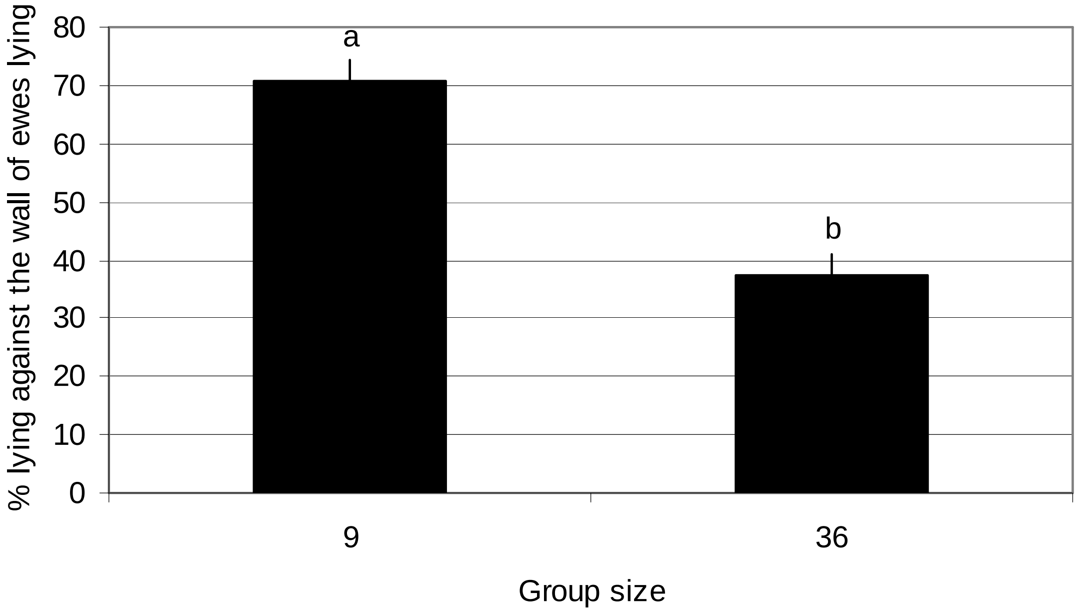

Figure 2. Percent of ewes lying against a wall (means + SE). Bars with different superscripts [a,b] differ significantly, *P*<0.0001.

Time spent standing or walking was significantly higher in the large than in the small groups on day 1, but not on day 14 (Table 1). This could be explained by a significant interaction effect between group size and day ($F_{1,31}$=21.3, *P*<0.0001).

On day 1, there were no significant differences in time spent eating roughage in large and small groups (Table 1). However, on day 14 the ewes spent significantly more time feeding in the large groups, than in the small groups (interaction effect between group size and day: $F_{1,31}$=7.6, *P*<0.01). The interaction between batch and group size was also significant for this behaviour ($F_{1,31}$=6.9, *P*<0.05).

The individual variation in feeding time (CV eating roughage) did not differ significantly between the large and small group size on any of the observation days (Table 1). However, the mean proportion of observations where all feeding places were occupied was significantly higher in groups of 9 than 36 ewes (Figure 3).

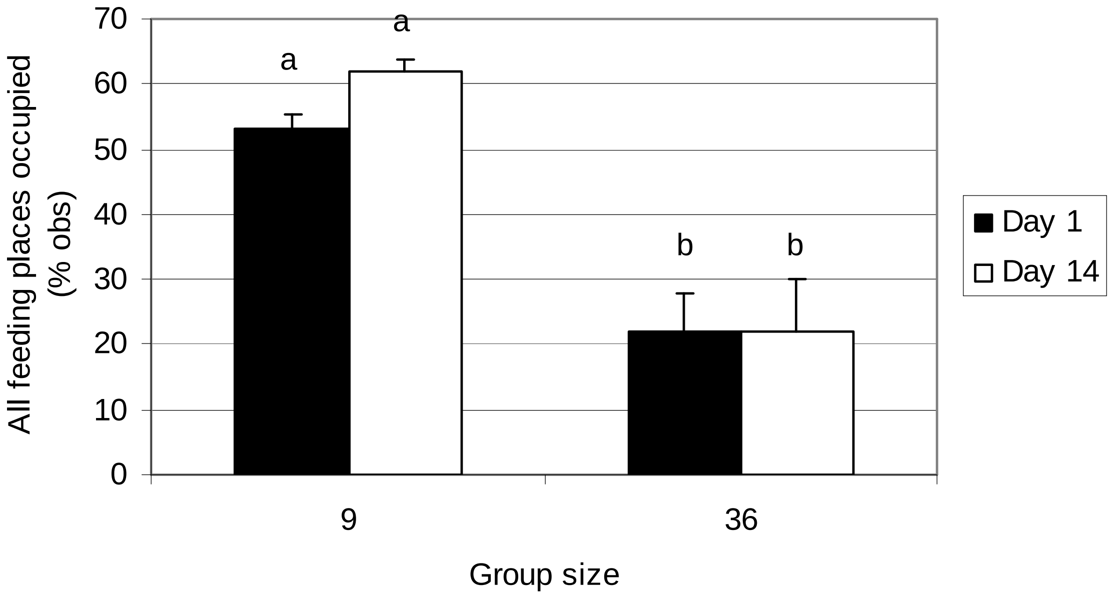

Figure 3. Percent of observations when all feeding places were occupied (means + SE). Bars with different superscripts [a,b] differ significantly, *P*<0.01.

On average, the ewes spent significantly less time queuing at the feed barrier in the large compared to in the small groups on both days (Table 1). However, this was only significant in batch 2 (large: 3.1 ± 0.2 % vs. small: 4.5 ± 0.3 %; P<0.001) and not in batch 1 (large: 3.2 ± 0.2 % vs. small: 3.7 ± 0.2 %). There only tended to be an interaction effect between group size and batch: $F_{1,31}$=3.5, *P*=0.072).

Daily feed intake did not differ significantly between group size 9 and 36 (mean ± SE per ewe: group size 9: 1.7 ± 0.1 kg, group size 36: 1.8 ± 0.1 kg, $F_{1,12}$=0.46). Overall, the ewes in batch 2 had a significantly higher feed intake (1.9 ± 0.02 kg) than the ewes in batch 1 (1.5 ± 0.03 kg; $F_{1,12}$= 42.7, *P*<0.0001).

Mean number of aggressive interactions per ewe were similar in both group sizes (Table 1). The most prevalent aggressive behaviour was pushing another ewe (mean 6.2 ± 0.5 % of total observations), but there was no significant difference between the two treatments concerning this behaviour. Furthermore, all the ewes were observed performing displacements, but there was no effect of group size on number of displacements and other aggressive interactions in general (Table 1). No interaction effects were found for displacements and other aggressive interactions.

4. Discussion

As predicted, ewes in large groups had a larger variation in resting time, rested and fed less synchronously, spent less time resting on day one and spent less time queuing at the feeding barrier. However, in contrast to similar experiments in pigs (e.g. Nielsen et al., 1995; Turner et al. 2001, Andersen et al., 2004), dairy calves (Færevik, et al., 2007) and fowl (e.g. Estevez et al., 1997, Hughes et al., 1997), the ewes in the present experiment did not behave less aggressively in a larger group size.

The most prevalent aggressive interaction was pushing, used to displace another ewe from the feed barrier or a resting place. In general, the level of aggression in sheep is relatively low compared to other female ungulates (Fournier and Festa-Bianchet, 1995), but it is documented that the level of aggression in ewes is sensitive to changes in space allowance, especially in the resting area (Bøe et al., 2006). It is possible that the decrease in perimeter length per ewe in the largest group size contributed to increased competition for attractive resting places, and thus diminished the predicted group size effect on aggression. This is in accordance with

Færevik et al. (2005) and Bøe et al. (2006) who showed that ewes had a distinct preference for lying next to a wall. Hence, wall space in the resting area might be regarded as an important source of competition in ewes. Furthermore, since we observed the first 10 minutes of every hour in the entire 24-hour period rather than concentrating on the most active period around the time of feeding, it is most likely that we have underestimated the amount of aggressive interactions in this study.

Similar to other species (cattle: Benham, 1982; horses: Sweeting et al., 1985; Rifa, 1990), sheep synchronize their activities at pasture (Rook and Penning, 1991). This synchronisation of maintenance behaviours is used to increase predator avoidance (Pulliam, 1973; Pulliam and Caraco, 1984). Both individual vigilance (Roberts, 1996) and behavioural synchrony (Boissy and Dumont, 2002) declines as group size increases, making more time available for feeding and resting. This is in accordance with the results of the present experiment, showing that the individual variation in resting time was higher in the largest group size. Low-ranked animals may thus show a substantial decrease in resting time, as earlier found in goats (Andersen et al., 2007). A lower perimeter length in the largest group size may have strengthened this effect further since the competition for attractive resting places with access to a wall increased.

As expected, the ewes spent more time feeding in large groups, which is in accordance with earlier observations on sheep at pasture (Penning et al., 1993) and dairy calves kept indoors (Færevik et al., 2007). A change in feeding strategy to maintain the feed intake is also documented in large groups of weaned pigs (Nielsen et al., 1995). However, the actual feed intake in the present experiment did not differ between the two group sizes. Ewes in batch 2 had a higher feed intake than the ewes in batch 1, which may be due to a larger mean body weight. The lower incidence of queuing at the feed barrier can be explained by the reduced synchronisation of feeding in the largest group size.

The significant interaction between batch (rotation of treatments) and group size in resting and queuing behaviour shows that the effect of group size is dependent on the order of treatments (from small to large group size vs. from large to small group size). To start with the largest group size (24) and change towards smaller (6) generally reduce the conflict level in goats, compared to the opposite order (Andersen et al., unpublished). Experience from being in a large group also appear to reduce the aggression level in later group situations in weaned pigs (Turner et al., 2001) and young turkeys (Buchwalder and Huber-Eicher, 2005). This has to be further investigated.

In conclusion, a larger group size decreased synchrony in resting and feeding and reduced the time spent queuing in front of the feed barrier. However, in contrast to what was predicted from results in other species, the number of aggressive interactions in ewes was not affected by the increased group size. This can be due to a much lower aggression level in sheep than for other comparable ungulates. Furthermore, it is possible that aggression in sheep is more sensitive to changes in space allowance, and especially wall space in the resting area, than to changes in group size.

Acknowledgements

The authors would like to thank research technician Kari Eikanger for her excellent assistance. We also thank Dr. Geir Steinheim for statistical advice. This experiment was funded by the Norwegian Food Safety Authority (Mattilsynet).

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