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Does the ewe nutrition during pregnancy affect the behaviour of ewe lambs at 1 and 2 years of age?

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ABSTRACT

The effects of the dam's nutrition during pregnancy on her lambs' behaviour in the days after birth has been examined but the longer term effects on lamb behaviour and mothering ability are not known. The behaviour of twin and triplet ewes born to ewes offered herbage with an average sward height of 2 or 6 cm from day 64 to 132 of pregnancy was recorded at 1 year of age in an arena test and at 2 years of age post lambing. A significantly ($P < 0.05$) greater proportion of the progeny born to dams offered 6 cm sward heights bleated in a high pitch during a 5 minute arena test. However there were no differences in minimum, median and maximum distance of the ewe from the observer or on the frequency of low- and high-pitched bleats. In addition there was no difference in the behaviour of twin- and triplet-born ewes in the arena test. At 2 years of age twin-born ewes had a significantly greater maternal behaviour score than their triplet-born counterparts. Ewe nutrition during pregnancy did not affect the maternal behaviour score of their ewe lambs after lambing at 2 years of age. These results suggest that feeding levels during pregnancy are less important than the birth rank in terms of the intergenerational effects on behaviour.

Keywords: ewe nutrition; lamb; behaviour; twin; triplet.

INTRODUCTION

The effects of ewe nutrition during pregnancy on the behaviour of their lambs in the 2-3 days after birth have been examined (Thomson & Thomson, 1949; Moore *et al.*, 1986; Dwyer *et al.*, 2003) but the longer term effects of nutrition during pregnancy on the maternal behaviour of the progeny as adult ewes are not well known. Dwyer *et al.* (2003) reported that lamb birth weight, not maternal nutrition influenced lamb behaviour while Moore and Power (1986) concluded that maternal undernutrition reduced lamb vigour. Erhard *et al.* (2004) found that at 18 months of age the offspring of ewes undernourished for the first 95 days of pregnancy were more active when restrained but approached a novel stimulus more slowly than progeny of ewes fed maintenance requirements. The long-term effect of ewe nutrition during pregnancy on the behaviour of their offspring has received little attention to date.

The intergenerational effect of nutrition during pregnancy on the maternal behaviour of offspring is of interest in terms of long-term ewe reproductive success. It is not known if the behavioural differences seen just after birth are still present in the mature ewe during the post-parturition period. If the maternal behaviour of female offspring is affected by their dams' nutrition during pregnancy this could be used to improve mothering ability and success in rearing lambs to weaning.

The behaviour of sheep can be measured in many ways. The arena test provides information on an animal's response to a conflict situation (Kilgour & Szantar-Coddington, 1995, 1997) and provides information on the nervousness and emotivity of the ewe. This may predict future mothering ability (Kilgour,

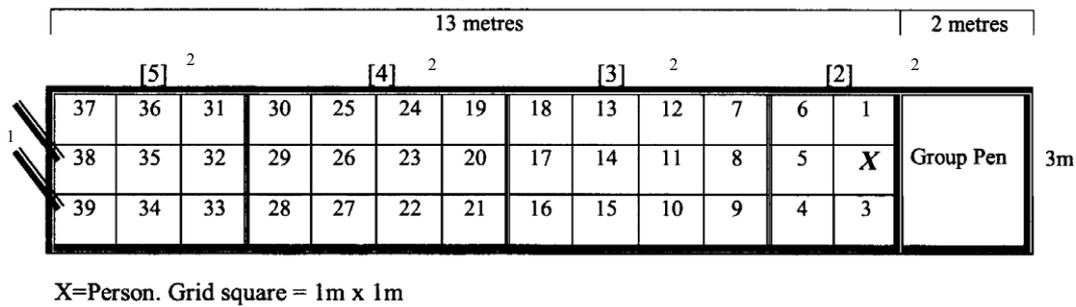
1998). The maternal behaviour score (MBS) measures the interaction of the ewe and lamb after birth (O'Connor *et al.*, 1985). High maternal behaviour scores are related to increased lamb survival and weaning weight (O'Connor *et al.*, 1985; Parker & Nicol, 1993) and behaviour in the arena test has been linked to subsequent maternal behaviour (Everett-Hincks, 2003).

In 2000, ewes scanned as bearing twin and triplet fetuses were offered a sward at a height of 2 or 6 cm from day 64 to 132 of pregnancy. At birth lambs born to ewes offered the 2 cm sward were significantly lighter than those offered 6 cm sward (Morris & Kenyon, 2004). Behavioural observations were made of the lambs 6 to 12 hours after birth. Triplet lambs were less likely to bleat, make contact with the ewe and stand after being separated from their dam than twin lambs (Everett-Hincks, 2003).

The aim of this study was to determine the effect of ewe nutrition and lamb birth rank on the behaviour of ewe progeny in an arena test at 1 year of age and after parturition at 2 years of age.

METHODS AND MATERIALS

At 1 year of age 28 twin and 28 triplet Romney ewes born to Romney ewes offered a sward height of 2 cm ($n = 33$) or 6cm ($n = 23$) (Morris & Kenyon, 2004) were observed in an arena test as described by Everett-Hincks (2003). The arena was a 13 x 3 m pen marked into a 1 x 1 m grid (Figure 1). A group of 10 sheep (group sheep) were held in a pen separated from the test arena by a wire gate which allowed visual contact with the test sheep (Figure 1). An observer stood directly in front of the group sheep (Figure 1). A single test sheep entered the arena at the end opposite

FIGURE 1: Diagram of the arena showing dimensions of the arena, grid layout and zones (Everett-Hincks, 2003).

¹ Entrance to the arena

² Arena zone

to the group sheep and its position was recorded every 15 seconds for 5 minutes. The position of the test sheep was defined as the grid square the left front foot rested in which provided information on the movements of the sheep. Vocalisation, urination, defaecation and sniffs of group sheep were also recorded during the 5 minute period.

Ewe vocalisations were classified as low and high pitched bleats. Three measures of ewe position in the arena were calculated: minimum (the distance closest to observer), median (midpoint between the minimum and maximum distance from observer) and maximum (the distance furthest from observer) distance of the test sheep from the observer during the 5 minute observation period. The estimated total distance that the test sheep travelled in the test period was also calculated. In addition the arena was divided into 4 zones (Figure 1) and the proportion of time the test sheep spent in each zone was determined.

Between 6 and 12 hours after parturition the MBS of the 2 year old primiparous twin-born ($n = 22$) and triplet-born ($n = 26$) ewes born to dams offered herbage of 2cm ($n = 25$) or 6cm ($n = 21$) sward heights was recorded. Lambs were separated from their dam for tagging purposes and during this period a maternal behaviour score similar to that described by O'Connor *et al.* (1985) was recorded on a 5-point scale (1, poor to 5, very good).

Statistical analysis

The records of 4 ewes in the arena test were excluded because of incomplete data due to test sheep jumping out of the arena before completion of the test. All data from the arena test were not normally distributed and the methods tried failed to normalise the data. Therefore non-parametric methods such as Kruskal-Wallis and Chi-squared tests were used (Minitab, 2003). The effect of the dam sward height (2 cm vs 6 cm) and birth rank (twin vs triplet) on the minimum, median and maximum distance from the observer, total distance travelled, proportion of time spent in each zone, the frequency of sniffs of the group sheep and bleats (low or high pitched) was tested using the Kruskal-Wallis test. In addition the presence and absence of behaviours such as bleats (low, high and

total), urination, defaecation and sniffing group sheep was analysed using a Chi² analysis.

The MBS was normally distributed and therefore the effect of dam sward height and birth rank was analysed using a general linear model (GLM). The number of ewes in each MBS category was analysed using Chi² test. Correlations between MBS and arena data were analysed using the Pearson product moment correlation coefficient.

RESULTS

In the arena test the maximum distance from the observer (X) ranged from 4 to 13 metres and the minimum distance of 1 to 7 metres with the median distance being 1 to 11 metres. There were no significant effects of dam nutrition or birth rank on either the distance of the test sheep from the observer (minimum, median and maximum) or the estimated total distance travelled during the recording period (Table 1).

Ewes spent the greatest proportion of time in zone 3 (median = 0.5) and least in zone 2 (median = 0). No significant differences in the proportion of time spent in each zone was found between dam nutrition or birth ranks (Table 1).

Of the test sheep, 43.6% urinated, 10.9% defaecated, 38.2% sniffed group sheep and 85.5% bleated during the 5 minute observation period. Of the sheep that bleated, 31.9% emitted only high pitched bleats, 8.5% only low pitched and 59.6% emitted both high and low pitched bleats. A significantly ($P < 0.05$) greater proportion of sheep born to ewes offered 6cm high swards bleated with a high pitch compared with those born to ewes offered 2 cm. No other differences between dam nutrition or birth rank were identified in sheep arena behaviours (Table 2).

Maternal behaviour scores of 2-year-old primiparous ewes ranged from 1 (poor) to 4 (good) with no ewes classified as 5 (very good). Most ewes were classified as a 2 (34.8%) or 3 (34.8%) with fewer classified as 1 (19.6%) and 4 (10.9%). The mean MBS for twin-born ewes was significantly ($P < 0.05$) greater than for triplet-born ewes. However, no significant differences were seen in the frequency of ewes within

TABLE 1: The median of the minimum, median and maximum distance from the observer in the arena test and the median proportion of time spent in each zone, for birth rank (twin- or triplet-born) and dam treatment (ewes offered 2 or 6 cm sward heights from mid-pregnancy). Data analysed using Kruskal-Wallis test of medians.

	Birth rank		Dam treatment	
	Twin	Triplet	2 cm ¹	6 cm ²
(n)	28	28	33	23
Minimum distance from X	2.0	2.0	2.0	2.0
Median distance from X	4.0	5.0	5.0	4.0
Maximum distance from X	12.0	11.0	12.0	11.0
Total distance travelled	26.5	29.0	26.0	30.0
Proportion of time in zone 2	0.0	0.0	0.0	0.0
Proportion of time in zone 3	0.5	0.5	0.5	0.45
Proportion of time in zone 4	0.08	0.15	0.1	0.1
Proportion of time in zone 5	0.05	0.1	0.05	0.1

¹ Ewes offered a 2 cm sward height in mid-late pregnancy

² Ewes offered a 6 cm sward height in mid-late pregnancy

TABLE 2: The number (and percentage) of hoggets that displayed each behaviour in the arena test, for birth rank (twin- or triplet-born) and dam treatment (ewes offered 2 or 6 cm sward heights from mid-pregnancy). Data analysed using Kruskal-Wallis test of medians. Frequencies or medians within treatments with different superscripts are significantly different (P < 0.05).

	Birth rank		Dam treatment	
	Twin	Triplet	2cm ³	6cm ⁴
(n)	28	28	33	23
Urination ¹	10 (37.0)	14 (50.0)	14 (43.8)	10 (43.5)
Defaecation ¹	4 (14.8)	2 (7.1)	4 (12.5)	2 (8.7)
High bleats ¹	22 (81.5)	21 (75.0)	22 ^a (68.8)	21 ^b (91.3)
Number of high bleats ²	2.0	6.0	3.5	5.0
Low bleats ¹	17 (63.0)	15 (53.6)	19 (59.4)	13 (56.5)
Number of low bleats ²	1.0	1.0	1.0	1.0
Bleated ¹	25 (92.6)	22 (78.6)	26 (81.3)	21 (91.3)
Total number of bleats ²	4.0	7.5	6.0	6.0
Sniffed group sheep ¹	11 (40.7)	10 (35.7)	14 (43.8)	7 (30.4)
Number of sniffs ²	0.0	0.0	0.0	0.0

¹ Chi² test showing number (and percentage)

² Kruskal-Wallis test showing median

³ Dams fed 2 cm sward height in mid-late pregnancy

⁴ Dams fed 6 cm sward height in mid-late pregnancy

TABLE 3: The number (and percentage) of ewes in each maternal behaviour category at 6-12 hours after parturition and the mean (± SE) for ewe birth rank (twin or triplet) or dam treatment group (ewes offered 2 or 6 cm sward height from mid-pregnancy). Means within treatments with different superscripts are significantly different (P < 0.05).

Birth rank	(n)	Maternal behaviour score					Mean ± SE
		1	2	3	4	5	
Twin	22	2 (9.9)	7 (31.8)	10 (45.5)	3 (13.6)	0 (0)	2.6 ^b ± 0.20
Triplet	26	7 (29.2)	9 (37.5)	6 (25.0)	2 (8.3)	0 (0)	2.1 ^a ± 0.20
Dam treatment							
2	25	4 (16.0)	9 (36.0)	10 (40.0)	2 (8.0)	0 (0)	2.4 ± 0.19
6	21	5 (23.8)	7 (33.3)	6 (28.6)	3 (14.3)	0 (0)	2.3 ± 0.21

each of the maternal behaviour scores between dam nutrition and birth ranks (Table 3). MBS was significantly correlated with urination ($r = -0.36$, $P = 0.017$) but with no other variables measured in the arena test.

DISCUSSION

This study was conducted to investigate the intergenerational effects of maternal nutrition on ewe progeny behaviour at 1 and 2 years of age using an arena test and maternal behaviour score. Behaviour of ewes in the arena test has previously been correlated with maternal behaviour (Everett-Hincks, 2003). The behaviour of the ewe progeny in the arena test and after parturition can be used as an indicator of mothering ability and success in rearing lambs to weaning.

In this study the proportion of ewes that bleated with a high pitch during the arena test was greater for those ewes whose dam was offered a herbage height of 6 cm compared with those offered 2 cm. The high pitched bleat is considered to be a protest bleat (Dwyer *et al.*, 1998). Therefore progeny born to well-fed ewes appear to be less at ease in the arena test at 1 year of age. This is not in agreement with the findings of Erhard *et al.* (2004) who concluded that undernutrition during pregnancy increased emotional reactivity of the progeny at 18 months of age. Interestingly Erhard *et al.* (2004) did not find a birth weight difference between the lambs born to ewes in the control group or ewes underfed for the first 95 days of pregnancy but in this study there was significant difference in lamb birth weight (Morris & Kenyon, 2004). Undernutrition during early pregnancy may have a greater impact on long-term behaviour of ewe lambs than in mid- to late-pregnancy.

As primiparous 2-year-old ewes the mean maternal behaviour score was significantly greater in twin than triplet-born ewes although no differences were observed between twin and triplet-born ewes during the arena test. O'Connor *et al.* (1985) found that with each unit increase in maternal behaviour score there was a 6% increase in lamb survival. This suggests that the survival of lambs born to twin-born ewes may be greater than of lambs born to triplet-born ewes. However in this trial no differences in lamb survival to weaning were found between twin- and triplet born-ewes.

CONCLUSION

Ewe nutrition during mid to late pregnancy produced very minor differences in the arena test and had no effect on the MBS of the ewe progeny. However twin-born ewes had a greater average MBS than triplet-born ewes. Therefore the effects of feeding levels during pregnancy seem to be less important than birth rank on the intergenerational effects on ewe behaviour.

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