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LEARNING AND LOCOMOTOR BEHAVIOUR STUDY OF DAIRY CALVES KEPT IN GROUP HOUSING

J. BROUČEK*, M. UHRINČAŤ, A. HANUS

Animal Production Research Centre Nitra, Slovakia

ABSTRACT

The purpose of this study was to investigate the effects of gender, and sire on learning and locomotor behaviour of calves. The study included 40 dairy calves (23 males and 17 females) which descended from 3 sires. The maze learning ability tests were performed at the age of 15 weeks, open field tests were conducted at 16th and 25th weeks. At the maze tests, males were less movable than females ($P<0.05$) and their total time of standing in maze was also higher compared to heifers ($P<0.05$). Heifers took shorter time to run across the maze than bulls in both days ($P<0.05$). Significant differences were found in sire lineages assessment of maze behaviours, especially on time standing in the first part of maze ($P<0.001$), time of maze traversing on the second day ($P<0.01$). During open field tests at 16th and 25th weeks of age heifers were more mobile. Sire lineage effect was manifested in the number of grid crossing and movement time during the first test ($P<0.05$) at the age of 16 weeks. At the age of 25 weeks significant differences were displayed in number of grid crossing for the first test ($P<0.05$) and in movement time on the 2nd day ($P<0.05$). The results of used behavioural tests indicated that speed of traversing the maze and locomotor behaviour are affected by the gender and sire lineage of calves.

Key words: calf; maize; open field test; behaviour; gender; sire

INTRODUCTION

Biological functions in animals change with age. The best demonstration of this is shown in relationship to behavioural pattern and efficiency of internal metabolism. Ontogenetic processes strongly determine the behaviour and reaction of adult animals. Welfare of the animal can be explained through absence of five groups of deprivate factors: thirst, hunger and malnutrition; discomfort; pain, injury and disease; abnormal behaviour; fear and distress (Webster, 1993). Measurements relevant to the assessment of welfare include those of behavioural, physiological and immunological values, injuries, disease incidence, growth and reproduction (Broom, 1991; Uhrinčať *et al.*, 2007). Animal care aims to fulfil animal needs. In essence, the physiological needs are well understood and they are being fulfilled reasonably well. The behavioural needs are not well understood at all, and thus we do not know yet whether or not they are being met (Arave and Albright, 1981; Curtis, 1987).

Hohenboken (1987) suggested that the knowledge of genetic variation in behaviour can be used to improve animal welfare. Artificial selection in an experimental environment may prove to be a powerful tool for investigating the relationships between selection for production traits, including litter size and welfare-related behavioural characteristics such as fear and anxiety.

It is usually assumed that being in a group reduces fear in animals. Hence isolation should prevent exploration and active adaptive strategies. The grouped heifers appeared much less ready to move and to explore than did the isolated ones (Hart, 1985 b; Hall, 2002). Veissier and Le Neindre (1992) concluded that being in a group impaired the occurrence of active adaptive strategies of calves.

Previous findings of Arave *et al.* (1985) and

***Correspondence:** E-mail: broucek@cvzv.sk
Jan Brouček, Animal Production Research Centre Nitra,
Hlohovecká 2, 95141 Lužianky, Slovak Republic
Tel. +421 37 6546 280 Fax: +421 37 6546 483

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Dellmeier *et al*. (1990) showed that the circadian activities of dairy calves are temporarily disorganized after weaning. Motivation for locomotor and investigatory behaviours decreased in response to weaning. Veissier *et al*. (1989) conducted an experiment about effect of different time at weaning on behavioural reactivity and on abilities to learn. It was reported that soon after weaning as opposed to later on, spontaneous fear reactions are more overt and less physiological in nature and that learning was improved.

Farm animals of today learn to manipulate mechanical devices such as self-waterers and self-feeders. The development of future, more sophisticated labour-saving devices depends upon the abilities of future farm animals (Kratzer, 1971).

Genetic differences created by human selection may have pro¬nounced effects on the ability of different stocks within a species to learn specific things (Craig, 1981; Toates, 2000; Brouček *et al*., 2008). Maze learning ability of dairy calves was influenced by sex and sire in the experiment of Arave *et al.* (1992). Activity differed between calves from different sires, sexes, during certain trials, and when the location of the food source was changed. There was difference between sire groups in time required to pass through the maze. Other results indicated that observation enhances the ability of heifers to learn the correct pathway through a maze (Stewart *et al.,* 1992). The open-field test, which measures animal activity or distance covered by individuals subjected to a novel arena, is used frequently in behavioural studies (Kottferová *et al*., 2008; Lauber *et al*., 2009; Debrecéni *et al*., 2009).

MATERIALS AND METHODS

Forty Holstein calves (23 males and 17 females) were used. The calves originated from 3 sires (Sire 1, n=12; Sire 2, n=16; Sire 3, n=12). The experiment and all tests were done in the exact condition on the experimental farm of the institute. Calves were separated from their mothers at 1 or 2 days of age, kept in individual hutches. After 8 weeks they were weaned from the artificial milk and moved into the experimental barn. Twenty calves were kept in a pen of 9 x 4.5 m size (2 m^2 per animal).

The maze learning ability tests were performed in the indoor space at the age of 16 weeks. The 6-unit maze was constructed in the pen of 16.4 x 4.5 m from 1.5 m high steel fencing covered with a black plastic sheet. Five barriers were installed inside which marked the beginning and the end of the route and also particular parts of the maze. The calves were tested individually during 2 consecutive days, four times each day. Time was recorded from calf entry until exit. Total time of standing in the maze was also observed.

An open field test was conducted at two ages (16 and 25 weeks) in an inside arena marked off into 9 squares. The calves were given four 5-minute tests during 2 consecutive days. The behaviour was analyzed directly from a monitor screen and checked up from video tape afterwards. The numbers of grid crossing and total time of movement were recorded.

The data were analyzed using a General Linear Model ANOVA by the statistical package STATISTIX, Version 9.0. The normality of data distribution was evaluated by the Wilk-Shapiro/Rankin Plot procedure. All data conformed to a normal distribution. Significant differences between groups were tested by Comparisons of Mean Ranks. Values are expressed as means ± SE.

RESULTS AND DISCUSSION

Differences in the length of standing in the first part of maze for gender factor were significant during both days. Males were less movable than females (76.26±18.41 s vs. 66.49±20.67 s; 177.41±29.00 s vs. 68.21±32.58 s; P<0.05). Similar situation was in the total time of standing in maze evaluation on second day (260.44±46.19 s, 97.80±51.88 s; P<0.05). Heifers took shorter time to run across the maze than bulls on both days, significant difference was recorded on the 2nd day (197.25±67.54 s vs. 422.76±60.13 s, P<0.05) (Table 1).

Calves originated from Sire 2 were the most movable in the first part of maze, especially on the 2nd day (240.25±38.37 s, 26.12±23.56 s, 120.25±44.05; P<0.001). Total time of standing in the maze was the highest in calves after Sire 3 (204.44±58.15 s, on the 1st day) or Sire 1 (264.42±61.10, on the 2nd day) (Table 2). The fastest were in the maze traversing calves descended from Sire 2 (191.68±72.00 s). Calves originated from Sire 3 (359.59±79.20 s, on the 1st day) or Sire 1 (502.67±79.54 s, on the 2nd day) crossed the maze at the slowest speed (Table 2).

We found differences in locomotor behaviour between genders. During both observations at 16th and 25th weeks of age were more mobile heifers. Grid crossing number differed between genders significantly at 1st minute of the 1st test (7.24±0.86, 10.17±1.00; P<0.05) at the age of 15 weeks only (Table 3).

The highest number of grid crossing was recorded on the first test and first day in calves according to Sire 2 (23.83±3.09, 29.49±2.67, 17.73±3.09, P<0.05; 36.83±5.49, 51.63±4.76, 36.21±5.49) at the age of 15 weeks. The lowest movement time was found in calves after Sire 3 (55.08±5.68, 53.75±4.92, 36.50±5.68, P<0.05; 84.08±9.84 s, 95.79±8.53 s, 71.44±9.84 s) (Table 4). At the age of 25 weeks were the less movable calves originated after Sire 1. Significant differences were displayed in number of grid crossing for the first test (23.83±3.09, 36.44±2.68, 32.27±3.09, P<0.05) and in movement time on the 2nd day

(58.50±5.26 s, 64.29±4.55, 78.36±5.26, P<0.05) (Table 5).

During our ethological observations, we could show that behaviour of calves differed according to gender. Males were less movable than females in the open field tests, and bulls also took longer time to run across the maze than heifers.

Environmental and experimental factors may have effects on young organisms. Many physiological as well as behavioural capabilities of the weaned calves are changed through early experience. When an animal's sensory systems first start to function, the first stimuli it receives obviously have a greater impact than experiences of a comparable type later in life (Hart, 1985 a; Soch, 2005). Exploration of their surroundings is the key features for calves. Fear responses, such as orienting and startle responses, help the animal orient itself towards changes in its environment and flee from danger. Learning and memory help the animal develop an understanding of its environment for future reference (Boissy, 1995; Lauber *et al*., 2009). The lack of significant gender differences in our study is consistent with Kosako and Imura (1999), who reported that the responses of calves were not influenced by gender.

Significant differences were found in sire lineages, especially on solving the configuration of maze from start to goal, also in the moving activities during open field tests. Our ethological tests which we applied are generally used in the evaluation of the learning ability and memory of animals (Arave et al., 1992). Increased concern about the welfare of animals in farm production systems has led to an increased interest in the relative importance of the genetic and environmental components of animal behaviour, their effects on the adaptability of the animal to the farm environment and thereby its welfare and productivity.

Table 1: Maze behaviour according to gender

Time of staying in first part of maze	Gender		P
	male	female	
	$\bar{x} \pm SE$	$\bar{x} \pm SE$	
1st day	76.26±18.41	66.49±20.67	0.7316*
2nd day	177.41±29.00	68.21±32.58	0.0191*
Total time of staying in maze			
1st day	145.39±43.75	131.09±49.12	NS
2nd day	260.44±46.19	97.80±51.88	0.0277*
Total time of maze crossing			
1st day	272.08±59.59	242.04±66.94	NS
2nd day	422.76±60.13	197.25±67.54	0.0196*

*P<0.05; SE = standard error of mean; NS = non significant
Male, N = 23; female, N = 17

Table 2: Maze behaviour according to sire lineage

Time of staying first part of maze	Sire			P	Significance
	1	2	3		
	$\bar{x} \pm SE$	$\bar{x} \pm SE$	$\bar{x} \pm SE$		
1st day	71.25±24.35	41.25±22.24	101.65±24.46	NS	
2nd day	240.25±38.37	26.12±23.56	120.25±44.05	0.0002***	1:2***
Total time of staying in maze					
1st day	92.17±57.88	118.11±52.86	204.44±58.15	NS	
2nd day	264.42±61.10	79.22±55.80	193.72±61.39	NS	
Total time of maze crossing					
1st day	219.92±78.83	191.68±72.00	359.59±79.20	NS	
2nd day	502.67±79.54	141.56±72.65	285.79±79.91	0.0073**	1:2**

**P<0.01; ***P<0.001; SE = standard error of mean; NS = non significant
Sire 1, N = 12; Sire 2, N = 16; Sire 3, N = 12

Table 3: Locomotor behaviour during open-field tests according to gender at the age of 16 weeks

Grid crossing	Gender		P
	male	female	
	$\bar{x} \pm SE$	$\bar{x} \pm SE$	
1st min, 1st test	7.24±0.86	10.17±1.00	0.0407*
1st test	20.57±2.23	26.79±2.59	NS
1st day	35.79±3.97	47.32±4.61	NS
2nd day	32.59±2.28	35.81±2.66	NS
Movement time			
1st test	44.44±4.10	52.44±4.77	NS
1st day	73.94±7.11	93.61±8.27	NS
2nd day	65.48±3.90	74.41±4.54	NS

*P<0.05; SE = standard error of mean; NS = non significant
Male, N = 23; female, N = 17

Table 4: Locomotor behaviour during open-field tests according to sire lineage at the age of 16 weeks

Grid crossing	Sire			P	Significance
16 week	1	2	3		
	$\bar{x} \pm SE$	$\bar{x} \pm SE$	$\bar{x} \pm SE$		
1st test	23.83±3.09	29.49±2.67	17.73±3.09	0.0314*	2:3*
1st day	36.83±5.49	51.63±4.76	36.21±5.49	NS	
2nd day	36.25±3.16	33.80±2.74	32.56±3.16	NS	
Movement time					
1st test	55.08±5.68	53.75±4.92	36.50±5.68	0.0472*	
1st day	84.08±9.84	95.79±8.53	71.44±9.84	NS	
2nd day	72.25±5.41	65.17±4.68	72.42±5.41	NS	

*P<0.05; SE = standard error of mean; NS = non significant
Sire 1, N = 12; Sire 2, N = 16; Sire 3, N = 12

Table 5: Locomotor behaviour during open-field tests according to sire lineage at the age of 25 weeks

Grid crossing	Sire			P	Significance
25 week	1	2	3		
	$\bar{x} \pm SE$	$\bar{x} \pm SE$	$\bar{x} \pm SE$		
1st test	23.83±3.09	36.44±2.68	32.27±3.09	0.0163*	
1st day	42.00±5.49	56.79±4.75	52.86±5.49	NS	
2nd day	35.92±3.19	36.74±2.77	38.88±3.19	NS	
Movement time					
1st test	41.17±4.63	55.39±4.01	54.93±4.63	NS	
1st day	75.33±8.37	92.21±7.24	89.60±8.37	NS	
2nd day	58.50±5.26	64.29±4.55	78.36±5.26	0.0336*	1:3*

*P<0.05; SE = standard error of mean; NS = non significant
Sire 1, N = 12; Sire 2, N = 16; Sire 3, N = 12

Fearfulness, reactivity and emotionality have been given much attention and a number of studies have focused on the development of standard tests to evaluate variability in behavioural responses of sheep to novelty, social isolation, surprise or the presence of a human (Boissy, 1995; Wolf *et al.*, 2008).

The results of used behavioural tests indicated that speed of traversing the maze and locomotor behaviour are affected by the gender and sire lineage of calves. There is much scope for further investigation into the impacts of genetic manipulation on the development of fear, exploratory and learning behaviour, which are important for welfare of dairy calves.

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