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The effect of breed, time spent with dam and late pregnancy induction of parturition on behavioural development in dairy calves

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ABSTRACT

Three experiments examined the impact of breed, time spent with dam (TWD), gender, and late pregnancy induction of parturition and caesarean on the behavioural and heart rate responses of dairy calves at 2 and 6 weeks of age to Open field, Novel object and Startle tests and a Learning task. In Experiment 1 with male Jersey, Friesian and Friesian × Angus calves, there were some significant breed effects on responses to the Open field and the Novel object tests; Jersey calves appeared more curious and less fearful than Friesian × Angus calves. In Experiment 2, in which male and female Friesian calves were removed from their dams either between 0 and 12 h or 12 and 24 h after birth, there were no significant effects of gender or TWD. In Experiment 3, which studied the effect of induction of parturition using a long-acting glucocorticoid combined with short-acting progesterone 10 days prior to due calving date, there were no significant effects of late pregnancy induction of parturition. Across all three experiments, age at testing was the main factor influencing the responses of the calves. However, a number of interactions suggest that gender, time spent with dam and late pregnancy induction of parturition modified some of the responses to the tests as the calves developed.

1. Introduction

Exploration, cognition and emotions, particularly fear and curiosity (Toates, 1980), are behavioural constructs integral to the survival and welfare of animals: together they provide animals with adaptive responses and essential survival mechanisms. Exploration acquaints the animals with key features of their surroundings; fear responses, such as innate orienting and startle responses, help the animal orientate itself towards changes in its environment and flee from danger; and learning and memory (cognition) help the animal develop an understanding of its environment for future reference. These integrated responses assist the animal in preferring those aspects of its environment that are beneficial and avoiding those that may be harmful. Therefore, they can be viewed as part of the animal's biological response to environmental change, a response repertoire for survival and maintenance of welfare (Lauber et al., 2006). Deficiencies in exploration, learning and memory are considered by many as key indicators of compromised welfare (Toates, 1980; Veissier, 1993; Lauber et al., 2006), and chronic and/or repeated acute fear is widely regarded as an undesirable state of emotional suffering in animals (Broom and Johnson, 1993).

Understanding if and how the development of behaviours considered essential to survival (e.g. cognition, emotion and exploration) are influenced by demographic and reproductive management practices provides essential knowledge for determining and minimising risks to the welfare of livestock. In addition, this knowledge provides the basis to determine how new and future reproductive manipulations and technologies may impact upon the development and welfare of farm animals. There are numerous reports of demographic factors, such as breed and gender effects on behavioural responses of cattle to novelty and learning (Le Neindre and Sourd, 1984; Tilbrook et al., 1989; Arave et al., 1992; Kosako and Imura, 1999). In addition, reproductive management practices, such as time of separation of calf and dam and late pregnancy induction of parturition, have been reported to influence the development of certain behaviours (MacDiarmid, 1983; Hopster et al., 1995). In particular, the effects of time of separation of dam and calf on behaviours, such as time to stand, allogrooming and vocalisation, as well as longer term behaviours, such as socialisation and fear of humans, have been highlighted as welfare issues (Webster, 1984; Lidfores, 1996; Weary and Chua, 2000; Vaarst et al., 2001; Flower and Weary, 2001, 2003). Furthermore, while the impact of late pregnancy induction of parturition on the subsequent welfare of the calf has received little attention in the literature, the general

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consensus appears to be that calves induced with a short-acting glucocorticoid within 2 weeks of term show little or no difference in viability and vigour compared with calves delivered naturally at full-term (MacDiarmid, 1983). However, viability in calves born after the use of a single or a double injection of long-acting glucocorticoid given pre-term is reduced; calves are reported to be lethargic and slow to stand and suck properly (MacDiarmid, 1983). Therefore, it seems reasonable to suppose that, if birth is induced by a long-acting glucocorticoid and that initial instinctive behaviours, such as time to stand and suckle, are impaired, then behavioural development may also be impaired.

In this paper we describe three experiments examining the effect of breed, time spent with dam and late pregnancy induction of parturition on behavioural development in dairy calves, from 2 to 6 weeks of age, using an Open field test, a Novel object test, a Startle Test and a Discrimination Learning Task. Determining whether behaviours considered essential to survival are altered as a result of reproductive management and demographic factors is essential in gaining an understanding of the impact of reproductive manipulation on the welfare of dairy calves.

2. Materials and methods

Animal ethics approval for this study was sort and obtained through the Department of Primary Industries Victoria, Primary Industries Research Division Animal Ethics Committee in accordance with Part 3 of the Prevention of Cruelty to Animals Act Victoria, 1986. All animals undergoing surgical procedures were provided with post surgical analgesics and careful monitoring for pain and/or discomfort. Any calf displaying continuing signs of distress during any of the procedures and or tests was removed from the study. Any calf or cow showing signs of infection was treated by a veterinarian. No animal was euthanized as a result of any of the procedures carried out during the study.

Calves in this study were purchased from multiple herds and farms. Where possible, however, calves within a given experiment were purchased from the same herd and the number of sires was limited. In addition, all calves were transported by a single transport company, and calves were handled and managed in as standard a manner as possible from their arrival at the calf rearing facility for at least 9 days prior to the commencement of testing.

2.1. Subjects

2.1.1. Experiment 1: effects of breed on behavioural development

Fourteen male Friesian calves, 14 male Friesian–Angus cross calves and 14 male Jersey calves from three commercial sources in South Western Victoria were transported 140 km, at 5 days of age, to the research facility and housed in groups of 3–4 within their breed groups.

2.1.2. Experiment 2: effects of time spent with dam and gender on behavioural development

Forty-seven Friesian calves, 23 female and 24 male, produced by artificial insemination were obtained from a commercial source in South Western Victoria. Twenty three (12 male and 11 female) of the calves had been removed from their dam within 12 h of birth (mean time on dam = 6.06 h; S.D. = 3.44 h) and 24 (12 male and 12 female) had been allowed to remain with their dam for at least 12 h and up to 24 h after birth (mean time on dam = 17.44 h; S.D. = 3.33 h). Calves were transported 140 km, at 5 days of age, to the research facility.

2.1.3. Experiment 3: effects of late pregnancy induction of parturition and gender on behavioural development

Thirty Friesian calves (15 female and 15 male) were produced by artificial insemination at the research facility used for the three experiments. The calves consisted of two groups, 15 calves (7 male and 8 female) delivered naturally (Group 1) and 15 calves (8 male and 7 female) induced 10–15 days prior to expected parturition with 10 mL Dexafort [Dexafort Aqueous Suspension of Dexamenthasone as mixed esthers; Intervet Australia Pty Ltd.] (long-acting glucocorticoid) and 5 mL Lutalyse [Lutalyse Solution; Pfizer Animal Health] (prostaglandin) injected intramuscularly (Group 2). This method of induction of parturition was used to mimic the method currently used by researchers at Monash University, Australia, and Genetics Australia (a commercial company), for the caesarean delivery of *in vitro* produced and cloned dairy calves. All induced calved in the present experiment were delivered within 36 h of the injections.

2.2. Housing and husbandry

The specialised research facility was located north-west of Melbourne, Victoria (Australian Metric Grid 55 – 5839.2N 200.3E). Calves were housed in groups of 3–4 in 2.8 m × 2.8 m pens made from steel mesh gates. Calves in adjoining pens had visual and limited tactile contact with one another. One wall of each pen was divided into four 0.7 m wide × 1 m long feeding chutes that had solid walls. The floor of the pens was covered in rice hulls.

The calves were given *ad libitum* access to hay/pellets and water and 4 L of milk was provided to each calf once daily. The calves were individually fed milk in the feeding stalls between 0800 and 0900 h daily (from the day of arrival until the end of the study) from 3-teat feeders and these feeders were the same as those used in a learning task (see below). Individual feeders were suspended at the front of each stall and three teats, positioned 10 cm apart and 80 cm from the ground were easily accessible to the calf. Two of the teats on each feeder had their ends blocked with water-safe silicon and had been used to feed non-experimental calves for several months prior to their use in this study to minimise any effects of residual odour from the silicon. The position of the open teat was randomly selected each day to ensure that all the calves had drunk from all teat positions; each day the open teat was located in the same position on all feeders. Access to the feeders was restricted to feeding times, when feeders were placed into each stall and milk was added to the feeder within 30 s. If more than one calf entered a stall, the animal attendant would enter the pen and move one of the calves to an empty chute.

2.3. General procedure

Each calf in each experiment completed an Open field test, a Novel object test and a Startle test in sequence, one test per day on 3 successive days, and a Learning task that began on day 3 and continued for a further 14 days. All tests were conducted at both 2 and 6 weeks of age. Heart rate was monitored during each of the tests using a Polar Heart Rate Monitor Polar® (Accurex Plus, Performance Matters, Adelaide, South Australia). The heart rate monitors recorded average number of beats per minute every five seconds. These recordings were used to profile the heart rate (in beats per minute). A brief methodology for each of the tests is provided. Detailed descriptions and diagrams of the apparatus are reported in Lauber et al. (2006). The test arena was 4.4 m × 3.0 m in size, located within 2.0 m of the nearest calf pen, with a concrete floor and 3 solid brick walls (Fig. 1). The fourth wall separated the starting area from the testing arena and was 1.3 m high and made from solid plywood. The starting area consisted of an experimenter's box and a start box. The start box, with 1.3 m high solid plywood walls, was located in