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Automated measurement of acceleration can detect effects of age, dehorning and weaning on locomotor play of calves

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ABSTRACT

Play may be a behavioural indicator of positive emotions in young animals, but in calves spontaneous play is time consuming to record. We examined whether measures of acceleration of calves in a large enclosure could detect effects on play running of age, dehorning and weaning off milk. Holstein calves were placed in an arena for 15 min and their running, jumping/kicking and walking were recorded from video. Accelerometers were attached to one hind leg and the summed acceleration was recorded. In Exp. 1, 24 calves were placed in the arena the days before and after being dehorned on d4 of age with caustic paste and sedation or as control calves. Prior to and after dehorning, there was a strong positive correlation between the duration of running and the total acceleration ($r_s > 0.77$; $P < 0.001$). After dehorning, the dehorned calves had a lower duration of running (median = 19.7 s vs. 29.2 s; $P = 0.049$) and a smaller total acceleration ($P = 0.031$) than control calves and the duration of running was positively correlated with total acceleration ($r_s = 0.78$; $P < 0.001$). In Exp. 2, 12 calves were placed in the arena during the week before weaning began and the week after being weaned fully off milk, with weaning completed around 10 weeks of age. Before weaning, the duration of running was positively correlated with total acceleration ($r_s > 0.84$; $P < 0.001$). After weaning, there was a decrease in both the duration of running (median = 14.2 s vs. 47.9 s; $P < 0.01$) and the total acceleration ($P < 0.01$), and the change in running duration following weaning was correlated with the change in total acceleration ($r_s = 0.83$; $P < 0.001$). Data combined from the two experiments showed that older calves did more running and had a higher summed acceleration than younger calves ($P < 0.001$) but tended to walk less ($P = 0.09$). The summed acceleration was strongly correlated with the duration of running ($r_s = 0.88$; $P < 0.001$) and moderately correlated with the frequency of jumping/kicking ($r_s = 0.44$; $P = 0.008$). Age, dehorning and weaning all affected the amount of running the calves did in the arena, and measures of acceleration could be used to automatically estimate the duration of play running suggesting this was a time-efficient way of detecting the calves' locomotor play.

1. Introduction

There is increasing interest in using measures of good or "positive" welfare in an overall assessment of the welfare of farm animals (Boissy et al., 2007; Yeates and Main, 2008), and play behaviour has been proposed as a positive welfare indicator for young animals (Boissy et al., 2007; Held and Špinka, 2011; Špinka et al., 2001). Young calves show a variety of play behaviours, of which locomotor play, consisting

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mainly of running, bucking and jumping, forms a major part (Jensen et al., 1998; Jensen and Kyhn, 2000). Locomotor play of dairy calves is reduced by a number of threats to welfare such as an insufficient intake of energy, weaning off milk and dehorning without adequate pain control (Krachun et al., 2010; Tucker et al., 2008). However, calves spend only a few minutes each day in play (Jensen et al., 1998; Krachun et al., 2010; Tucker et al., 2008), and so spontaneous play occurring in the home pen is time consuming to record by observation. Young calves placed for a brief period of time in a large enclosure (sometimes called an "open-field") show similar locomotor play (Dellmeier et al., 1985; de Passillé et al., 1995; Jensen et al., 1998) and the amount of play shown by a calf correlates with the amount of spontaneous play shown in its home pen (Mintline et al., 2010).

The difficulties in recording many behaviour patterns through observation have led to the development of methods for automatic recording (European Food Safety Authority, 2012; Rushen et al., 2011). Relatively inexpensive accelerometers are now readily available and have been used to automatically measure a variety of behaviours (Rushen et al., 2011). Measures of total acceleration, taken by attaching an accelerometer to the leg of a calf, can distinguish between periods where the calf is walking, trotting and running (de Passillé et al., 2010) and so may be able to automatically measure duration of locomotor play.

In two experiments, we examined if measures of acceleration taken from calves placed for a period of time in a large open enclosure were correlated with the duration of locomotor play the calves showed, and whether these measures were affected by the calf's age, dehorning and weaning off milk.

2. Methods

All experiments took place at the University of British Columbia's Dairy Education and Research Centre in Agassiz, British Columbia, Canada, and were reviewed and approved by the local Institutional Animal Care Committee following the guidelines of the Canadian Council for Animal Care.

2.1. General methods and housing

Calves were fitted with a tri-axial accelerometer (HOBO Pendant G Acceleration Data Logger, Onset Computer Corporation, Pocasset, MA, USA), described in de Passillé et al. (2010), attached with Vet Wrap (Co-Flex, Andover Coated Products Inc., Salisbury, MA, USA) to the lateral side of one hind leg. The convention in scientific publications on the use of accelerometers to record aspects of animal behaviour is to measure acceleration in terms of the acceleration due to gravity, *g*, where 1*g* = 9.8 m/s/s. The accelerometer could measure a maximum of 3.2*g* in each dimension with an accuracy of ±0.075*g* at 25 °C and an accuracy of ±0.105*g* from −20 °C to 70 °C. The accelerometer was set to measure the acceleration at 33 readings/s. This was based on calculations which showed that this was the maximum sampling rate that we could use which would allow the memory of the accelerometer to store data for the duration of the trials.

Immediately after being fitted with the accelerometer, the calves were individually guided along a corridor leading to an arena, which measured 29.13 m × 4.77 m, with concrete floors covered with sawdust and high walls that prevented visual contact with other calves. Calves were in auditory and olfactory contact with other calves during the tests. Depending on the position of the calf's pen, the distance walked along the corridor varied from 10 m to 30 m. The calves were gently led to the arena from their home pens without a halter always by the same person. After 15 min, the calves were taken back to their pens. A wooden gate was constructed at one end of this arena and observers were positioned behind this gate. A digital camcorder (Sony DCRSR100 HDD Handycam Camcorder, Sony Corp., Park Ridge, NJ, USA) on a tripod was used to record the locomotion of the calves at 30 frames/s when they were in the arena. In subsequent tests, the calves were always tested in the same order.

The videos were watched by three observers in Experiment 1 and two in Experiment 2 with each calf always watched by the same observer. The videos were scored for the duration of running, the duration of walking and the frequency of jumping/kicking. The behaviours were defined as follows: Running included all instances of trotting (two-beat leg movements synchronized diagonally), cantering (three-beat gait in between a trot and a gallop) and galloping (four-beat gait with a phase where all legs are off the ground). Walking included all instances of walking. Jumping/kicking: included all instances of jumping (both forelegs were lifted off the ground and the body moves upward), bucking (head is lowered, below the shoulders; both rear legs lifted off the ground) and kicking (one hind leg is lifted off the ground and extended quickly at the back). We scored the duration of bouts of running and walking that lasted more than 3 s but only the frequency of running and walking events that lasted less than 3 s and estimated the duration of each instance as 1.5 s. We scored only the frequency of jumping/kicking.

2.2. Experiment 1

In this experiment, we examined locomotor play following disbudding (removal of the horn buds) in very young calves. Ten male and 14 female Holstein calves (mean ± SD birth weight = 42.6 ± 5.1 kg) were removed from their mothers soon after birth and placed in individual pens (1.22 m × 2.44 m), bedded with wood shavings. For purposes of other experiments, they were fed whole milk at a rate of either 6 L/d or 8 L/d in two meals. On d4 of age (in the afternoon), a semi-randomly chosen half of the calves (equal numbers of males and females and equal numbers receiving 6 L/d and 8 L/d of milk) were disbudded in their home pens with caustic paste and sedated with 0.2 mg/kg BW of xylazine, which is the routine procedure for this farm (Vickers et al., 2005). The sedative was injected between 14:00 h and 15:00 h, 15 min before the caustic paste was applied. The other half of the calves were controls and were dehorned using the same procedure on d6, after the experiment was completed.

The calves were tested in the arena, using the procedure described above, on d3, d4 of age (before disbudding)