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The effect of conspecific removal on behavioral and physiological responses of dairy cattle

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ABSTRACT

Adverse social and welfare implications of mixing dairy cows or separating calves from their mothers have been documented previously. Here we investigated the behavioral and physiological responses of individuals remaining after conspecifics were removed. We conducted a series of 4 experiments incorporating a range of types of different dairy cattle groupings [experiment 1 (E1), 126 outdoor lactating dairy cows; experiment 2 (E2), 120 housed lactating dairy cows; experiment 3 (E3), 18 housed dairy calves; and experiment 4 (E4), 22 housed dairy bulls] from which a subset of individuals were permanently removed (E1, n = 7; E2, n = 5; E3, n = 9; E4, n = 18). Associations between individuals were established using near-neighbor scores (based upon identities and distances between animals recorded before removal) in E1, E2, and E3. Behavioral recordings were taken for 3 to 5 d, before and after removal on a sample of cattle in all 4 experiments (E1, n = 20; E2, n = 20; E3, n = 9; E4, n = 4). In 2 experiments with relatively large groups of dairy cows, E1 and E2, the responses of cows that did and did not associate with the removed cows were compared. An increase in time that both nonassociates and associates spent eating was observed after conspecific removal in E1. In E2, this increase was restricted to cows that had not associated with the removed cows. A reduction in ruminating in remaining cattle was observed in E3 and eating in E4. Immunoglobulin A concentrations increased after separation in both E3 and E4 cattle, but did not differ significantly between associates and nonassociates in E2. Blood and milk cortisol concentrations were not affected by conspecific removal. These findings suggest that some animals had affected feeding behavior and IgA concentrations after removal of conspecifics.
Key words: association, dairy cattle, separation, immunoglobulin A, conspecific

INTRODUCTION

Increasingly, animal emotions form the basis of animal welfare definitions (Dawkins, 1990; Fraser and Duncan, 1998; Mendl and Paul, 2004; Broom, 2010), with public concern for the welfare of farm animals often arising from the recognition that animals are able to experience emotions (Špinka, 2012; Boissy and Erhard, 2014). Farm animals are gregarious and their social environment plays a fundamental role in the individual's welfare status (Keeling and Gonyou, 2001; Rault, 2012), with many benefits being derived from the presence of a conspecific (Rault, 2012). Dairy cattle form long lasting social bonds (Reinhardt and Reinhardt, 1981; Færevik et al., 2006) and show strong affiliation to conspecifics (Holm et al., 2002). In modern production systems, the regrouping of cattle [regrouping is defined here as a 2-step process: (1) Separation from the old group and (2) introduction to a new group] occurs frequently to create homogenous groups organized by common characteristics, such as age, milk yield, body condition, reproduction, and health status (Bøe and Færevik, 2003; Raussi et al., 2005). This regrouping process, in particular step 2, has been documented to result in social stress evidenced by behavioral changes that include increased aggression (Raussi et al., 2005), vocalizations (Boissy and Le Neindre, 1997; Færevik et al., 2006; De Paula Vieira et al., 2010), and changes in locomotory behavior (Hasegawa et al., 1997; von Keyserlingk et al., 2008) and has negative effects on production traits, such as reduced feed intake (von Keyserlingk et al., 2008; De Paula Vieira et al., 2010; Schirmann et al., 2011; Duve et al., 2012), milk yield

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(Hasegawa et al., 1997; von Keyserlingk et al., 2008), and weight gain (De Paula Vieira et al., 2010). These negative effects have been documented across a range of cattle scenarios including lactating cows, heifers, and bulls (Mench et al., 1990; Hasegawa et al., 1997; Mounier et al., 2006). However, studies investigating the effect of repeated regrouping show contradictory findings, with some suggesting cattle do habituate to regrouping over time (Mench et al., 1990) and others providing no evidence of this (Raussi et al., 2005). Conceivably the stability of relationships between the cattle and the number of animals affected by the regrouping may determine the ability of cattle to habituate to the practice.

The majority of studies investigating the regrouping of cattle have focused on the effect on the individual(s) being regrouped (e.g., Mench et al., 1990; Raussi et al., 2005; Mounier et al., 2006; von Keyserlingk et al., 2008). In these studies the effects of separation are often hard to distinguish from the effects of the novel environment (Rault, 2012). Although the effect of new individuals introduced to a previously established group has been described, the effect on the individual(s) remaining in the original group has not. In one study by Schirmann et al. (2011), the difference in response to regrouping between cows that were moved to a new pen and those that stayed in their home pen was investigated; however, due to the experimental design, the effects of removal of individual cows on those remaining in the home pen could not be separated from the effects of the newly introduced cows.

Measurement of stress traditionally involves behavioral observation and physiological evaluation of, for example, hypothalamic-pituitary-adrenal (**HPA**) activation (e.g., cortisol) or immunological response (e.g., IgA). Immunoglobulin A represents a main element of the humoral immune response, which provides protection against pathogens at mucosal surfaces (Snoeck et al., 2006). In its secretory form (**S-IgA**), it serves to prevent infective agents such as bacteria and viruses from breaching the mucosal barrier, whereas within serum it functions as an inflammatory antibody acting on immune effector cells (Snoeck et al., 2006). Relatively little information is available on the relationship between IgA and stress responses in farm animals, with the exception that in pigs S-IgA reportedly increases as a result of chronic stress caused by social isolation during the first 12 d and declines thereafter (Royo et al., 2005). A similar response has been observed in dogs in the first 6 d following separation from a conspecific (Walker et al., 2014) and as a result of stress experienced upon entry into a kennel environment (Skandakumar et al., 1995). In response to acute stress, S-IgA levels in rats and dogs have been documented to decrease (Guhad and Hau, 1996; Kikkawa et al., 2003), and in humans a large body of evidence concludes that negative emotional valence, resulting from short-term stress, results in decreased S-IgA (reviewed by Segerstrom and Miller, 2004). Although the influence of emotional states on IgA secretion in cattle has not been examined, bovine IgA has been quantified in milk (Newby and Bourne, 1977; Honkanen-Buzalski and Sandholm, 1981), and serum, lacteal, saliva, nasal, and vaginal secretions (Duncan et al., 1972). Research has demonstrated that IgA in bovine milk is predominately serum derived (Newby and Bourne, 1977), suggesting that milk could act as an appropriate, noninvasive, accessible alternative to serum in the measurement of short- and long-term stress. Likewise, cortisol concentrations in milk from cows in established lactation have been demonstrated to directly relate to cortisol concentrations in blood (Shutt and Fell, 1985), suggesting that milk is a suitable substitute for serum when measuring cortisol concentrations in dairy cattle.

The objective of this study was to investigate the effect of step 1 of regrouping: The effect that the removal of individuals from the group has on remaining group members, using behavior observations and 2 physiological measures: cortisol and IgA.

MATERIALS AND METHODS

These experiments were approved by the University of Queensland Animal Ethic Committee (approval numbers CAWE139/10 and CAWE068/11).

Experiment 1

Animals. In experiment 1 (**E1**), observations were made of a herd of 126 lactating Holstein-Friesian and mixed breed dairy cows at the University of Queensland (Gatton, Queensland, Australia). The study was carried out during mid-winter (mean temperature = 16°C ± 4.4°C) when the herd was maintained in a 1.93-ha outdoor feedlot area (Figure 1), with a stocking density of 65.3 cow per ha. Of the total 126 cows, 55% (69/126) were Holstein-Friesian; 27% (34/126) Holstein-Friesian crossbreed; one (0.8%) each of Jersey, Brown Swiss, Brown Swiss cross Jersey, Ayrshire cross, and the remaining 15% (19/126) were of unknown crossbreed.

The group structure was dynamic with cows temporarily removed from the herd as a result of cessation of lactation, illness, or estrus cycle, as well as for use during agriculture and veterinary teaching demonstrations and practicals. The cows were milked twice daily in a herringbone parlor between 0600 to 0800 h and 1500 to 1800 h. Feed was delivered twice daily at 0800 and 1300 h to a covered feeding trough in a paddock. The cows