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Vocal Communication and the Importance of Mother-Offspring Relations in Cattle

Commentary on Marino and Allen (2017) The Psychology of Cows

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As Marino and Allen (2017) comprehensively highlight, cattle are not just simple herd animals, but instead show evidence for complex cognitive and social behaviors, as well as rich emotional lives. Nevertheless, these aspects of the lives of cattle, which are potentially important for improving their welfare, remain relatively understudied. Vocal communication in cattle also plays a central role in individual recognition and the coordination of social behaviors, and it is particularly relevant for the bond between mothers and their offspring. The importance of mother-offspring recognition, and mother-offspring bonds in early life, are crucial to the development of appropriate behavioral repertoires as calves mature into adult cattle.

Vocal communication, and the contact calls of cattle, have been examined in detail in the context of the source-filter theory that is used to explain call production across a diverse array of animals (Padilla de la Torre, Briefer, Reader, & McElligott, 2015). The source–filter theory states that mammalian vocalizations are generated by vibrations of the vocal folds ("source"). This source sound is subsequently filtered by the vocal tract ("filter"). The source determines the fundamental frequency (also known as pitch). Fundamental frequency can vary between individuals as a result of differences in the way that the larynx is operated, or because of variation in the morphology of callers, such as body size. In the supra-laryngeal vocal tract (i.e., the tube that links the larynx to the mouth and nasal openings), certain frequencies of the source spectrum, which correspond to the vocal tract resonances, are selectively amplified or "filtered." The physical characteristics of the filter, such as length and shape of the cavities of the vocal tract, pharynx, mouth and nasal cavities, determine the frequencies of the formants and the relative energy distribution in the spectrum (Taylor & Reby, 2010).

Two types of cow contact calls with differing acoustic structures and associated with different maternal behavioral contexts have been identified in cattle. Low frequency calls (LFCs) are relatively quiet and produced by cows when they are in close proximity to their calves, in the first three or four weeks postpartum, and they are made with the mouth closed or only partially open. By contrast, louder,

high frequency calls (HFCs) are produced by cows when they are separated from their calves (e.g., not in visual contact) and often precede nursing. Calling in calves is also often associated with separation from their mothers. A detailed analysis of cow LFCs and HFCs, and of calf calls, showed that all three types of calls are individually distinctive. The study also showed that calf calls encode age, but not sex (Padilla de la Torre et al., 2015). Furthermore, using playback experiments, it is clear that mothers and calves recognize each other using HFCs from at least 10 days old. Maternal responses to calf vocalizations are also partially influenced by calf age, because mothers of younger calves tended to respond more strongly to playbacks than those of older calves (Padilla de la Torre, Briefer, Ochocki, McElligott, & Reader, 2016).

Vocalizations in non-human animals including cattle may also signal the physiological and emotional state of the calling animal (Briefer, 2012; Watts & Stookey, 2000). Individuality in mother-offspring contact calls in cattle, in addition to full mother-offspring bidirectional recognition, might suggest that specific acoustic parameters produced in different contexts are indeed likely to convey expressions of emotion in mother-offspring contact calls. Marino and Allen (2017) provide a comprehensive overview of the mother-calf emotional bonds; considering how cattle communicate is an important aspect of these social behaviors.

In cattle, isolation before giving birth is an important preliminary step in the formation of the mother offspring bond, because it protects the dyad from disturbance by other cows and predators, and facilitates early social interactions without interference. Sophisticated recognition strategies are evident in many social mammals, including cattle, where mothers and offspring potentially spend long periods of time out of sight and yet a refined parent-offspring vocal recognition process allows the dyad to find each other. In cattle, the recognition process between mothers and their offspring involves vision, olfaction and audition. However, vision is more useful in open habitats and olfaction cues permit identification at only short range (e.g., in sheep, *Ovis aries*: Sèbe. Duboscq, Aubin, Ligout, & Poindron, 2010). Vocalizations are potentially more reliable over both short and long distances and open and inconspicuous habitats (Torriani, Vannoni, & McElligott, 2006). Therefore, vocal communication appears to be a key factor for mother-offspring recognition in gregarious ungulates.

Two main strategies for avoiding predators in the first few weeks of life have evolved in ungulate newborns: 'hiding' and 'following' (Fisher, Blomberg, & Owens, 2002). Hider offspring spend most of their time hidden and remain silent and concealed in vegetation. Mothers of these species usually forage away from the offspring hiding place and return intermittently to nurse them. By contrast, follower offspring stay with their mothers and thus rely on maternal and group defense. Therefore, follower offspring are potentially able to suckle more often (Fisher et al., 2002; Jensen, 2001). Cattle are commonly classified as a hider species, although in modern farms young calves often do not have the opportunity to hide (Tucker, 2009; Watts & Stookey 2000). However, when cover is provided, hiding behavior has been observed (Langbein & Raasch, 2000). Early bidirectional mother-offspring vocal recognition could reflect the fact that hiding behavior in domestic cattle is relatively weak. Indeed, the period of hiding (or isolation if hiding is not possible) appears to be rather short in species under captive rearing systems (e.g., 4-7 days in domestic goats, *Capra hircus*, Briefer & McElligott. 2011). Three weeks after birth, calves spend most of their time in small groups with other offspring of similar ages (Bouissou, Boissy, Le Neindre, & Veissier, 2001). Therefore, calling cattle "facultative hiders" has been suggested to be more accurate (Padilla de la Torre et al., 2016).

As outlined by Marino and Allen (2017), there are several important studies that provide evidence of how rearing systems affect not just mother-offspring behaviors and emotions, but other behaviors and cognition later in life after calves have matured. For example, behavioral responses to isolation and novel object test carried out in 2.5 year-old cows that early in life were reared either in contact with their mothers or under artificial rearing, showed that those with access to their mothers had better social skills in order to cope with the new situations. Data on heart rates and cortisol levels further supported the suggestion that cows with access to their mothers during early life were better able to cope when confronted with unknown situations or challenges in later life (Wagner et al., 2015). In addition, calves

reared in isolation show poorer performances in reversal learning and novel object recognition compared to socially-housed calves (Gaillard, Meagher, von Keyserlingk, & Weary, 2014).

Social competence has been tested in dairy calves under two different rearing systems — common rearing (separation of cow and calf within 24 hr after birth) and dam or foster reared calves (calves left with cows). Behavioral responses to confrontation tests using calves from both systems showed that threatening behavior from cows resulted in calves that were reared in contact with cows to display submissive behaviors more often than calves reared in the common rearing system. Heart rates of calves reared in contact with cows were also lower during the tests. Therefore, calves reared in contact with cows have more appropriate social behaviors and physiological responses compared with the common rearing system in which there is no cow-calf contact (Buchli, Raselli, Bruckmaier, & Hillmann, 2017).

It is important to consider the large differences in the rearing conditions of dairy and beef cattle breeds when assessing their impacts on cattle psychology and welfare. Marino and Allen (2017) already provide examples showing how cow-calf separation leads to stress for the animals. While most dairy cows have been bred over generations without the chance to raise their calves, beef cows, in general, are allowed to live with their calves for potentially long periods (7-8 months; Tucker, 2009). It might therefore be expected that maternal skills might differ among breeds and according to the conditions in which humans keep them. The environments in which cattle are raised and the methodology used to study them must therefore be carefully considered. It is not wise to assume that only the maternal skills of dairy cattle could be different to beef cattle, because it is also possible that many other behavioral responses will vary (e.g., emotions and cognition processes). For example, as a gregarious species, cattle, when allowed, show complex social organization such as calf nurseries that are protected by an adult guardian (Bouissou et al., 2001). However, conditions on modern farms (and especially dairy farms) do not allow cattle to express these types of behaviors. Thus, more research on farms where cattle are able to express a wider range of naturalistic behaviors and further comparisons with those limited by husbandry systems would be helpful in order to improve rearing systems in cattle. We celebrate the achievement of this highly comprehensive review on cow psychology, which represents an important milestone for future research on cattle behavior and welfare.

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