

Vocalizations as a Behavioural Indicator of Pain in *Bos taurus*

Vocalization in cattle has been shown to be a reflection of their state of welfare as vocalizations can encode information about the physiological and emotional state of the animal (Green et al., 2018). Vocalizations in cattle are often associated with social interaction, sexual interaction, lying and rumination, feeding, or stress and pain (Meen et al., 2015). However, vocalization in cattle is most often associated with stressful or aversive events (Meen et al., 2015). Higher vocalization rates occur with increased cortisol levels, indicating that vocalization is a behaviour directly initiated by the release of stress hormones (Bristow & Holmes, 2007). In addition to higher cortisol levels, vocalizations are also associated with an increase in heart rate and a change in urination and defecation rates, further proving that cattle with increased vocalizations are experiencing stress and pain (Watts & Stookey, 2000).

It is important to determine the event and/or behaviour associated with individual vocalizations in order to be able to determine their significance (Grandin, 2001). Grandin (1998) observed that 98.2% of vocalizations during slaughter plant procedures were a result of aversive events, and therefore determined that vocalizations can be used to indicate pain or stress. Vocalizations occurred most often after repeated electric prodding, slipping on the stunning box floor, missed captive bolt stuns, or excessive pressure exerted by restraining devices (Grandin, 1998). Slaughter plants with a total vocalization rate of 5% or more had easily identifiable equipment or handling problems and therefore plants should maintain a vocalization rate of 3% or less (Grandin, 1998). Watts & Stookey (1999) demonstrated that exposure to prior aversive events had no impact on future vocalizations rates, therefore vocalization analysis can be used to evaluate the current state of welfare due to any immediate stressors involved. Hence, analysis of vocalization is one of the most reliable and least invasive methods used to assess stress and pain in cattle (Watts & Stookey, 1999).

After it had been proven that vocalizations can be a response to pain and stress in cattle, researchers looked to determine if pain elicits a specific vocalization that can be categorized (Watts & Stookey, 2000). Watts & Stookey (1999) compared the vocalizations of cattle during hot-iron branding and sham branding and found that vocalizations from the hot-iron branded cattle had a greater frequency range, maximum frequency, and intensity. Watts & Stookey (2000) indicated that the vocalizations of calves isolated from their mothers had a higher amplitude compared to other calls, further indicating that vocalizations due to stress and pain can be categorized. Manteuffel et al. (2004) also supports the notion that specific vocalizations are a result of the state of welfare by stating that during states of low stress vocalizations have lower maximum frequencies, whereas in high stress situations vocalizations have significantly higher frequencies and intensities. Further analysis of cattle vocalizations has revealed that high-pitched tonal sounds signal fear, whereas harsh low-pitched vocalizations are correlated with aggression (Manteuffel et al., 2004). These studies reveal that vocalizations have specific meaning that can indicate the current welfare state of cattle (Watts & Stookey, 1999).

In order to successfully improve cattle welfare, there needs to be an improvement of the behaviour and attitudes on handlers in dairy farm and slaughter plants (Grandin, 1998). Simon et al. (2016a) showed that a majority of stockperson handlers disagree that animals experience physical pain as humans do, resulting in poor practices including the excessive use of electric prods. Grandin (1998) showed that humane methods of handling significantly reduce vocalizations without decreasing efficiency of the plants, however, it is up to management and handlers to incorporate this behaviour into their practices. Further research in this area is needed in order to educate the livestock and farming community on pain behaviour in cattle and the importance of reducing cattle vocalization (Simon et al. 2016b). Future research regarding the categorization of cattle vocalizations would be beneficial as they could be associated with specific welfare concerns that can be applied to multiple environments such as, practical farming, transport, and slaughter (Manteuffel et al., 2004). This would result in a dramatic increase in cattle welfare wherever these practices are applied (Manteuffel et al., 2004).

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