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Can the location of cattle be managed using broadcast audio cues?

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ABSTRACT

Fences are crucial for successful grazing management of livestock. However, conventional fencing is expensive and lacks spatial flexibility. To date, this flexibility has been provided by electric fences, but these are not always efficient to erect and move and are not suitable for all locations. The development of virtual fencing could improve flexibility, but implementations often incorporate electric shock as a means to deter animals from crossing a defined line. Alternative deterrent methods may be required due to legal requirements in some countries. Therefore, the aim of the study was to test "irritating" sounds from the sonic range (8 kHz and a mix of 8–10 kHz) in order to establish if they could discourage beef cows from spending time in a specific area. A third treatment using "acute alarming" sounds as a comparison was also tested.

In our study, we created a virtual fence by placing loudspeakers at 10 m intervals across a small paddock. There were six groups of test cows: three groups were tested in a first observation session and three groups in a second session each day. Testing took place over three consecutive weeks, with two control days and two test days per week. In each week each group was tested with one of the three sounds in one of three paddocks.

The results indicated that irritating sounds are as effective as acute alarming sounds at discouraging animals, but not sufficiently effective for commercial application when played from loudspeakers mounted on posts. However, a highly significant effect of the use of sounds was identified, showing that sounds can be used as adverse stimuli. Moreover, reduction in use of zones closest to the loudspeakers and increased use of zones furthest away from the loudspeakers during the sound tests strongly indicates that the use of sound can influence cattle location.

In synthesis, the study has shown that the use of irritating sounds as aversive stimuli is a valid and potential option for the development of virtual fencing. Although, it does not have exactly the same effect as a conventional fence in terms of stock-proofing, this technology can open up new possibilities in grazing management, especially when low grazing pressure is favourable. However, for commercial applications, further research is needed to investigate the use of animal-borne devices to broadcast sounds so that the dB level for the sound is kept at a consistent level.

1. Introduction

The historical development of fencing systems was a revolution in the management of livestock, as it allowed stockmen to control the location of the animals. Especially in extensive livestock systems, the capacity and

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capability to build and maintain fences is crucial to the successful management of stock and their grazing. However, for systems that include moorland or mountainous areas, it is not always feasible to build fences in very steep, rocky or broken terrains. In some situations, temporary or flexible fences are sufficient because they are only needed for short periods of time, but fencing is very expensive and costs are rising. For example, in Scotland, costs have risen by 47% from 2007 to 2009 (SAC Farm Management Handbook, Beaton et al., 2007; McBain and Curry, 2009).

In addition, it is often considered that a more flexible approach to grazing management would lead to improved utilisation of pastures, for example, by better exploiting seasonal growth. In some management applications, such as nature conservation in moorland areas, reduced grazing pressure is all that is required to encourage the growth of rare plant species. However, a more flexible approach is currently difficult to put into practice. To date, this flexibility has been provided by electric fences, but these are not always efficient to erect and move and are not suitable for all locations and species. Therefore, technical devices such as "virtual fence" concepts are currently under investigation to enable livestock managers to optimise grazing management. Virtual fences were defined by Umstatter (2011) as a structure serving as a barrier or boundary, but not requiring any physical barriers or boundaries. Many patents have been filed for different types of virtual fencing since 1973. Further, Umstatter (2011) identified three main categories of virtual fencing:

(1) those that contain animals in a defined area using animal-borne devices,
(2) those that contain animals without mounting a device onto the animal,
(3) those that consist of moving fence lines (keeping animals apart or gathering livestock).

The most well known virtual fence devise is probably the Directional Virtual Fence (DVF^{TM}) patented by Anderson and Hale (2001). The device is usually based on a GPS collar with integrated triggering system. GPS coordinates are used to define the virtual 'fence line' or boundary that the animal must not cross. The animal wears a collar which is GPS-enabled to allow the position of the animal on the ground to be mapped relative to the virtual fence boundary. If the animal approaches the fence it may be given a warning tone, but if it continues towards the fence an electric stimulus is delivered. In Anderson and Hale's patent, there is also a magnetometer included to identify the angle from which the animal is approaching the virtual fence line, hence the name directional virtual fence. The warning cues and the electric stimuli are then triggered only on the side of the animal which is near the virtual fence. Once an animal crossed the fence line too far, the stimuli stop and a text message is send to the farm manager or stockman with the location of the animal.

The majority of virtual fence patents use electric shock as the main aversive stimulus to deter animals from crossing a certain boundary. This is a problem in some European areas, such as Wales and Switzerland, where electric shock collars for dogs are banned (e.g. Animal Welfare Regulations, 2010, Wales) and this principle is likely to be upheld for other species. This issue prompted the current study, which aimed to explore whether it was possible to deter cattle from entering designated areas, or at least reduce the time spent by cattle in certain areas, by using broadcast sounds as aversive stimuli. More importantly, there are two different methods to either keep animals out or contain them within, controlled by auditory stimuli only. (1) They can either be repelled from a fence line (acute alarming sounds) or they can be made uncomfortable when they have entered an exclusion zone or left an enclosure (irritating sounds). The two approaches have different underlying principles, with the acute alarming sounds repelling the animal almost instantly, while with irritating sounds, the animal may leave after a period of time. Consequently, there will be differences in detailed animal responses on spatial and temporal scales. However, for this specific trial, we have chosen to look at the ultimate aim, that is, whether the amount of time spent in a specific area can be reduced by playing sounds to the animals.

A previous experiment showed that the use of acute alarming sounds (such as a short piercing sound, or the sound of a predator) could be used to reduce the crossing of a virtual fence line by animals (Umstatter et al., 2009), and certain sounds showed some success. However, the problem with using acute alarming stimuli to deter cattle from entering an exclusion area is that animals can habituate to them, as no negative outcome is ever associated with the sound. The hypothesis tested in the present experiment was that irritating sounds may be effective in discouraging cattle from spending time in the exclusion area. Irritating sounds do not elicit an immediate response (such as that shown to acute alarming sounds), but cattle may withdraw from the broadcast area after a period of time because continued exposure to the sound is aversive. Irritating sounds have been used as deterrents in other species (e.g. Vilata et al., 2010). One invention, made by Stapleton (2007), which is based on the same principle, is a device to disperse teenage children if they congregate around shop-fronts to the detriment of the business. The sound is irritating to teenagers and they move away from the broadcast area. The device is marketed under the name "Mosquito ultrasound device". It works on the basis of a frequency of ultrasound which most humans under 25 can hear, but with increasing age there is a general loss of hearing ability in this range so that people over 25 are less likely to be able to hear the sound. The noise is supposed to become increasingly irritating with continued exposure. This concept could be used in a virtual fence, with irritating sounds replacing electric shock. The key to success is certainly to choose the correct sound for the species concerned. The audible range of frequencies, for example, is more restricted in humans than in cattle (Phillips, 1993).

The aim of this study was to test irritating sounds from the high-sonic range in order to find out if they could be used to discourage cows from entering a specific area. Therefore, the study design consisted of two treatments using irritating sounds and one using an acute alarming sound as a comparison, to assess the efficacy of time spent in an area using these broadcast audio cues in beef cattle. In our study, we used a virtual fencing approach from