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Effects of sounds of different quality on the behaviour and heart beat parameters of goats

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ABSTRACT

In alpine regions, bells are used to relocate free-ranging grazers like cows and goats. Considering that goats have a well-developed hearing capacity, sounds (e.g. a chime of a bell) may act as stressors depending on their characteristics. The aim of this study was to test whether a non-uniform sound (chime of a bell) varying in amplitude and frequency and a uniform sound (sinusoidal tone) with continuously increasing amplitude and constant frequency lead to stress responses in terms of behaviour and heartbeat. Twenty-nine goats were tested individually in a test arena in two sessions, each lasting five consecutive days with one trial per day. A day before the first trial, reference values were collected without playback. During the following five trials, playbacks were conducted. Differences in behaviour and heartbeat parameters between test and reference values were analysed by using generalised linear mixed-effects models. During the first trial, the relative feeding duration was decreased and the relative alertness duration was increased during both stimuli, but more when goats were exposed to the non-uniform than the uniform sound. For both stimuli, the relative feeding duration increased (trial × stimulus: $P = 0.05$) and the relative alertness duration decreased (trial × stimulus: $P = 0.004$) from the first to the fifth trial but returned to the levels of the reference values sooner when goats were exposed to the uniform than the non-uniform sound. Cardiac activity was not affected by the stimuli. Altogether, the chime of a bell led to higher behavioural arousal than the uniform sinusoidal tone, indicating a potential of the chime to being more aversive to goats than a uniform sound. With repeated exposure to the stimuli, goats habituated to both stimuli, but habituation was faster to the sinusoidal sound than to the chime of a bell. Free-ranging goats in alpine regions usually are equipped with bells 24 h a day during the summer season. Thus, the question arises whether the long-term exposure to the chime of a bell might have negative effects on animal welfare.

1. Introduction

In several animal species, bells are used either to relocate free-ranging animals (e.g. cows, goats, sheep, yak) or for ornamental or religious purpose (e.g. in elephants, cows, horses, falcons). Considering that goats have a well-developed hearing capacity (Tracey and Fleming, 2007) and an auditory perception comparable to that of humans (Heffner and Heffner, 1990), sounds may act as stressors, depending on their amplitude and/or frequency (McAdie et al., 1993; Talling et al., 1996, 1998; Sevi et al., 2001; Quaranta et al., 2002; Moore, 2012). Goats can hear sounds between 78 Hz and 37 kHz, with the best sensitivity at 2 kHz, and are capable to detect sounds at −11 dB, i.e.

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sounds the human ear cannot detect (Heffner and Heffner, 1990).

Sounds of high amplitudes, i.e. 'noise', have been found to act as stressors in several species (chickens: McAdie et al., 1993; pigs: Talling et al., 1996, 1998; cattle: Waynert et al., 1999; sheep: Sevi et al., 2001; rats: Masini et al., 2008; koalas: Larsen et al., 2014). As the hearing capacity differs between species (Heffner and Heffner, 1983; Heffner and Heffner, 1992), this might explain to some extent why some studies found sound to elicit stress responses in animals and other studies did not. Heffner and Heffner (1990) and Ames and Arehart (1972) showed that goats and sheep have a similar but not exactly matched frequency sensitivity compared with humans and pigs. By testing the animals in an operant conditioning paradigm, Heffner and Heffner (1990) found goats to be by 20 dB more sensitive than pigs and more sensitive than most other animals tested. Talling et al. (1996) found that pigs had a higher heart rate and ambulation score when exposed to high compared with low amplitudes. Further, lambs that were exposed to sounds with amplitudes increasing from 45 dB to 95 dB showed increased plasma cortisol concentrations (Sevi et al., 2001), and pregnant ewes exposed to the same increase in sound amplitudes reduced their feeding time, increased the time spent inactive, and had increased plasma cortisol concentrations (Quaranta et al., 2002). Larsen et al. (2014) showed that an increase from 'little background noise without visitors' to 'loud visitor noise' resulted in an increased time spent being vigilant in koalas. McAdie et al. (1993) found chicken to show greater averseness to the sound of other chicken in a commercial poultry shed at 100 dB compared with a piece of music at 90 dB and 95 dB. Characteristics other than amplitude were shown to affect the effects of sound in different animal species additionally. In pigs, intermittent sounds with varying amplitudes appeared to be more aversive than a constant sound as pigs avoided the former more than the latter (Talling et al., 1998). In general, a sound with fluctuating frequencies and/or amplitudes led to a stronger reaction in humans than a sound with constant frequency and/or amplitude (Molino, 1979). All in all, a non-uniform sound that is intermittent, irregular, unpredictable may elicit a stronger stress response than a uniform, tonal and constant sound because it is hardly possible to habituate to intermittent, unpredictable acoustic stimuli (Todt, 1988; Moore, 2012).

Additionally to the characteristics of the sound, duration of exposure affects the reaction to the sound. If an initial aversion to an acoustic stimulus is motivated mainly by neophobia, a reduction in arousal (i.e. habituation) would be expected after repeated exposure (Treisman, 1984). It has been shown that the stronger the response to a sound, the longer it takes the animals to habituate (Koehler et al., 1990; Voipio, 1997; Biedenweg et al., 2011).

Although much is known about the hearing capacity of goats in general and the impact of noise on other animal species, systematic investigations of the reactions of goats to acoustic stimuli that may affect welfare are not available. Our study thus aimed at investigating whether a uniform sound (i.e. sinusoidal tone) with continuously increasing amplitude and a non-uniform sound (i.e. chime of a bell) with varying frequencies and amplitudes differ in their effects on behaviour, heart rate and heart rate variability of goats. In addition, we tested for habituation effects by exposing goats to these stimuli repeatedly. We expected the behavioural and physiological responses to increase with increasing amplitude, and the non-uniform sound leading to increased arousal compared to a uniform sound, indicated by a stronger stress response and slower habituation.

2. Materials and methods

The experiment was approved by the ethical commission for animal experiments of the Thurgau Cantonal Veterinary Office, Switzerland (Approval No. 03/11).

2.1. Animals and housing

Experimental subjects were 29 horned non-lactating female goats of various Swiss milking breeds (Saanen, Toggenburger, Chamois Coloured, St. Gallen Booted, Grisons Striped, Peacock, Valais Blackneck and Nera Verzasca) or their crossbreeds. The goats were housed in eight identically equipped pens at the Agroscope Research Station (Tänikon, Switzerland). The total area of each pen was 15.3 m^2 (approx. 3 m × 5 m), consisting of a deep-bedded straw area of 11.7 m^2 (approx. 3 m × 4 m) and an elevated (0.5 m) feeding place (3.6 m^2) divided by a wooden wall into two compartments of equal size (1.2 m × 1.5 m). The deep-bedded area was structured further by two wooden elements that provided climbing opportunities and protected lying areas. Hay and water were provided ad libitum.

2.2. Test arena and waiting area

The experiment was carried out in a test arena (10.5 m^2, Fig. 1), which was acoustically separated from the goats' home pens. The walls were constructed of wood and the floor was littered with long straw. A ladder for the experimenter to sit on was located opposite to the door (Fig. 1). The room was lit with fluorescent light and was naturally ventilated, with an average temperature of 7.6 °C ± 4.4 °C throughout the experimental period. To record the behaviour of the animals, a video camera (SELVAG® OC-5 IR-Outdoor-Colour-Camera, Selvag c/o ELV, Leer, Germany) was mounted in one corner of the test arena (Fig. 1). The acoustic stimuli were transmitted into the test arena via two loudspeakers (Edifier® S2000 v, Edifier International, Hong Kong, China), which were attached to the ceiling (Fig. 1). A microphone (Sennheiser® ME 62, adapter K6, Sennheiser electronic GmbH & CO KG, Wedemark, Germany) fixed to the ceiling in the middle of the test arena at a height of 2.5 m recorded the sound emitted by the speakers. The computers and all additional equipment needed to record the behavioural responses of the goats were located in an adjacent room. About 50 m away from the test arena, and thereby acoustically separated, an outdoor pen (18 m^2) served as a waiting area for the goats shortly before they were used in the experiment.