Rhythmicity as a welfare indicator – looking into the effect of extrinsic and intrinsic motivation in group housed horses

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Introduction

The synchronization of an organism to its environment gives indications on its wellbeing, where a high level of synchronicity reflects a good state of physiological and psychological welfare, whereas a desynchronization with its environment reflects the disturbance of the animal's state. It has therefore been proposed that the rhythmicity of animals can serve as a welfare indicator in livestock, as they have shown to follow animal specific rhythmic patterns [4] and [6]. This rhythmicity of animals can be measured by motion sensors and calculated by a Fourier Transformation, resulting in the degree of functional coupling (DFC) [6]. The Fourier transformation calculates the rhythmicity of the animal's locomotion over the past 7 days, which results in the DFC as an output. The DFC is presented on a level from 1 to 0, where 0 presents no rhythmicity and a poor state of welfare and 1 presents a good state of welfare with high rhythmicity. The DFC has shown promising results in extensively managed sheep [5] and in housed dairy cows [2], and has been used to asses activity and feeding behaviour in wild horses [1]. In theory, the DFC can be computed from any sensor data that reflects and organisms' locomotion patterns, such as accelerometers, feeding stations or automatic milking systems, thus it would be a feasible opportunity to gain data on the animal's welfare. However, to date it is unclear how well the DFC reflects the animal's wellbeing in strictly managed husbandry systems, where rhythmicity could be affected by extrinsic factors such as feeding regimes. It therefore cannot be distinguished if the rhythmic pattern detected by the sensors is intrinsically or extrinsically motivated. In the current project we aim to evaluate this circumstance in a two- phased trial in domesticated horses.

Methods

Ethical statement: The experiment was approved by the Freiburg Cantonal authority under the license 2023-40-FR. All relevant guidelines for animal handling were respected.

Two controlled trials were carried out in four paddock trail group housing systems (see Figure 2). Each group housing system contained five female warmblood *Equus Caballus*. Each paddock trail offered a shelter with wood shaving littering material, free access to water and a feeding station at the other end of the trail (see Figure 2). Data was collected at 1 Hz by wireless MSR loggers (X, Y and Z axis) attached to the horses' leg for a period of 14 days per treatment (see Figure 1).

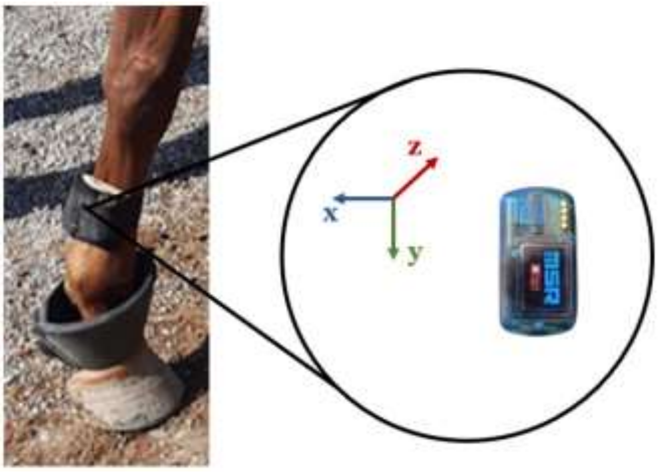

Figure 1. Accelerometer placed on the horse's leg, capturing the orientation of each acceleration axis.

Figure 2. Overview of paddock trail setup during trial 1. The shelters are located on the right, the feeding station are on the left. The four groups are separated by an electronic fence. The grass is fenced off and trails connect functional areas for resting and feeding.

Trial 1: Rhythmicity as a consequence of extrinsic factors:

In the paddock trail system, the feeding regime of the automatic feeding stations was programmed to three different feeding regimes (see Table 1). No additional roughage was offered during the course of this trial. Each treatment was carried out for a period of four weeks (two weeks habituation followed by two weeks of data collection):

A Loose hay three times per day for two hours
B Loose hay six times per day for one hour
C Ad libitum Hay with hay net 24 hours per day

Table 1. Experimental design of scheduled feeding.

	Treatment 1	Treatment 2	Treatment 3
Group 1	B	A	C
Group 2	B	C	A
Group 3	A	B	C
Group 4	C	A	B

We hypothesized that rhythmicity in horses with set feeding regimes is synchronized to the feeding regimes.

Trial 2: Rhythmicity as a consequence of intrinsic factors:

The same equines were kept on the same paddock trail system displayed above, however, the intrinsic motivation for lying behaviour was adjusted by an alteration of the shelter design, as well as a change of their orientation. Automatic feeding was set to provide hay three times per day for a duration of two hours each, additionally hay was offered in hay nets and hay bells at the shelters for an extended feeding period. Additionally, straw was offered ad libitum in the shelters. We tested the effect of shelter layout on intrinsically motivated rhythmicity and lying behaviour by implementing four treatments for a duration of four weeks each (see Figure 3 and Table 2).

Initial layout: Shelters were closed with two exits.	
No wood: The wood of one long side of the shelters was removed.	
No wood + Sand: The wood of one long side of the shelters was removed and sand was supplied to extend the lying area.	
Sand: Shelters were closed with two exits, but sand was supplied to extend the lying area.	

Figure 3. Stable design layout.

Table 2 Experimental design of altered stabled design.

Groups \ Weeks	3-4	7-8	11-12	15-16
1	No wood	Initial layout	Sand	No wood + Sand
2	No wood + sand	Sand	Initial layout	No wood
3	Sand	No wood + sand	No wood	Initial layout
4	Initial layout	No wood	No wood + Sand	Sand

We hypothesized that the rhythmicity of horses will change according to their intrinsic motivation to rest in different shelter layouts.

Data analysis

For both trials, we analyzed the Degree of Functional Coupling (DFC) from the sum of the square root of the x, y and z axis (√(x^2 + y^2 +z^2)) of the accelerometer data using the R package "digiRhythm" (README (r-project.org)) [3].Seven DFC values were computed for each horse and treatment. Additionally, we computed the lying behaviour from the y-axis during this time period using the "triact" [7]. All special occurrences were documented in the animal health protocol. Cameras were installed inside the shelters to observe horse behaviour; however, these videos were not systematically analyzed.

Statistics

The data will be analyzed with a general linear mixed effects model.

Results

At the time of writing this paper, no results are present as data analysis is still ongoing. However, we will present the results of both trials during the conference.

Discussion

This research will provide further evidence on the validity of using rhythmicity as a welfare indicator in managed livestock. However, we would like to also point out shortcomings in the study design. Despite their separation and different treatments, all groups of equines had visual, oral and olfactory contact over the fence. Thus, causing a synchronization between all groups. Further, the horses were group housed in the same groups for over six months prior to onset of the trial. They were well adjusted to their herds. However, after moving them to the paddock trail system, the lying behaviour of all horses reduced notably. Thus, we assume that the welfare of the horses in this trial was comprised. Yet this could in fact give us further evidence, if rhythmicity can serve as a welfare indicator in managed husbandry systems. If the DFC is high in systems with synchronized feeding regimes, despite a poor state of welfare, it cannot be a good welfare indicator in managed systems. However, it low despite the synchronized feeding schedules it could well be a good indicator. The link between lying behaviour and DFC will provide further evidence on the value of rhythmicity as a welfare indicator in managed livestock.

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