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Daily patterns of synchrony in lying and feeding of cows: Quasi-natural state and (anti-) synchrony factors

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ABSTRACT

Synchrony is thought to provide fitness advantages to group-living animals, but little is known how animals maintain synchrony. We investigated intensity of synchrony factors (milking, feed-provision) in cattle herds. Intensity decreased from dairy cows milked in a parlour to cows milked by a robot to suckler cows raising calves. On 30 farms, 10 of each type, we recorded synchrony in lying and feeding. Peaks in lying synchronously were visible in the early morning, around noon, and late at night. These peaks decreased from the suckler cows to the cows milked in a parlour and to the cows milked by a robot. Complementary peaks were found for synchronous feeding. The asynchronous milking times with the milking robot decreased synchrony. Unexpectedly, the suckler cows with the weakest synchrony factors also showed a high level of synchrony. These results indicate that internal motivations for synchrony may be present in addition to external synchrony factors.

1. Introduction

By definition, individuals of a social species have a certain motivation to be close to other members of their social group as this closeness provides corresponding adaptive value (Duranton and Gaunet, 2016). At least to some extent, this motivation inadvertently leads to synchrony in behaviour among the individuals of a group. However, maintaining such synchrony may involve compromises for the individuals. With regard to feeding behaviour, for example, (energetic) needs of individuals may differ according to body size and thus have an influence on the level of synchrony (Aivaz and Ruckstuhl, 2011; Meldrum and Ruckstuhl, 2009). Moreover, external stimuli that synchronise behaviour at specific times of the day, so-called zeitgeber factors, may help to maintain synchrony over long periods. An important zeitgeber is the light of day (Golombek and Rosenstein, 2010; Schulz and Steimer, 2009), but feeding times (Challet and Mendoza, 2010; Webb et al., 2009) and rest-activity cycles (Schibler et al., 2003) can act as additional zeitgeber.

To address the importance of varying intensities of synchrony factors that may function as zeitgeber, we used a 'natural' experiment occurring through different approaches of managing cows. We considered three types of farms: farms with suckler cows, farms with dairy cows milked by a milker in a milking parlour, and farms with dairy cows milked by a milking robot. Suckler cow herds are used for nature-oriented extensive beef production in Switzerland, and calves stay with their mothers and suckle milk from them (quasi-natural state). In dairy production, calves are usually separated from their mothers directly after birth. If allowed, dairy calves suckle less than the total milk produced by their mothers (Johnsen et al., 2016). Suckler calves are likely to consume even less milk because the corresponding breeds are not selected for high milk yield. Physiologically, dairy cows are more closely at the energy limit of productivity than suckler cows. Accordingly, higher-yielding cows feed more than lower-yielding cows (Løvendahl and Munksgaard, 2016; Norring et al., 2012). Also, dairy cows are more motivated and thus cover longer distances to access feed the longer they have been food deprived (Schütz et al., 2006). It can therefore be assumed that provisioning of a fresh feed ration is a comparatively weaker incentive for suckler cows, especially when they have access to grass on pasture. Also, fresh feed is usually of lower quality for suckler than for dairy cows in respect to its energy content. The provision of additional feed in the barn is therefore likely to be a stronger synchrony factors for dairy than for suckler cows because feed for dairy cows is more energy rich and dairy cows are closer to their physiological limits.

In central Europe, dairy cows milked by a milker in a milking parlour have traditionally been milked twice a day, and this tra-

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dition is still widespread. In the parlour, all cows of a herd are milked within about 1 to 2 h in consecutive batches, several cows at a time. These milking times, one in the morning, one in the evening, potentially act as a synchrony factors forcing the cows to perform similar behaviour twice a day at the same time. Nowadays, farmers make use of milking robots that automate the milking process but can usually milk only one or two cows at the same time. Therefore, milking by a milking robot possibly acts as an anti-synchrony factor because individual milking times desynchronise behaviour between individual cows.

The proportion of animals behaving in the same way at a specific moment of observation indicates synchrony. In previous studies, a specific proportion of animals engaged in the same behaviour often provided the criterion for 'true' synchrony if surpassed. Yet, the proportion chosen in these studies was somewhat arbitrary. In addition, a certain amount of synchrony can be expected by pure chance alone even if animals act completely independently (for examples and a discussion of various approaches to measure synchrony see Zwicker et al., 2015). In addition to the proportion of animals of a group that engage in the same behaviour, the pattern of how simultaneously animals switch between behaviours in the course of a day may indicate how synchronously group members behave. In this study, we considered synchrony of lying and feeding as reflected by the proportion of cows in a herd that lie or feed simultaneously. This approach does not allow identifying above-chance synchrony but allows comparing synchrony relatively between farms of different types (i.e. with milking parlours, milking robots, or suckler cows) and between different times of day within farms.

We expected that the combination of strong synchrony factors (milking and feeding) in dairy cows milked in milking parlours would lead to the highest level of synchrony in respect to feeding and lying. In contrast, individual milking times of dairy cows when milked by a robot were expected to reduce synchrony. Synchrony in herds of suckler cows should reflect the situation as close to a natural state as possible because it is least influenced by external stimuli with regard to milking and feeding. In that, synchrony in herds of suckler cows would reflect the level of synchrony sought by cows if they were allowed to choose freely (a quasi-natural state).

2. Material and methods

2.1. Farms and animals

All observations took place on 30 farms with pens that allowed free movement of the cows and had been used since at least 6 months. As the number of farms was most limited for the farms with a milking robot, these 10 farms were directly recruited based on addresses provided by the Swiss branches of milking robot manufacturers (DeLaval Schweiz AG, Sursee; GEA Switzerland, Ittigen b. Bern; Lely Center Dairy Solution GmbH, Hägendorf; Lemmer Fullwood AG, Gunzwil). On each recruited farm, the farmer provided addresses of farms with a milking parlour and farms with suckler cows in the vicinity. Based on these addresses, one farm with a milking parlour and one farm with suckler cows were recruited for each farm with a milking robot (farm triplets). Thus, 10 farms of each type were included in the study. All farms were situated in area of approximately 375 km^2 in central Switzerland.

On suckler cow farms, calves could choose at all times to be with their mothers. For milk production, calves were separated from their mothers shortly after birth, which was the case on the farms with a milking parlour or a milking robot. Milking parlours either provided several units for single cows or provided space for several cows being milked while in body contact, for example, when standing side by side. Farms with a milking robot had a maximum of two milking units enabling a maximum of two cows being milked simultaneously. On 6 farms with a milking robot cows could choose freely how to move. On the other 4 farms, cows had to either go through the milking unit when passing from the lying cubicles to the feed alley, or they were led through the milking unit on their way from the feed alley to the lying cubicles. Some farms gave their cows access to pasture. Here, the cows either had free access to a close-by pasture from the barn or they were put onto pasture for a specific period during which they had no access to the barn. Whereas suckler cows received only further roughage (silage or hay) when fed in the barn, the dairy cows' feed (robot and parlour milking) included some components with higher energy content such as corn silage, grain concentrates, potatoes or beet chips. Therefore, suckler cows may have covered a large proportion of their energy intake on pasture while dairy cows could not do so to the same extent. The farms reflected a realistic cross-section of practical Swiss farms and were quite variable (Table 1). Any pattern identified as typical for the type of farm therefore can be considered strong because it was detectable in spite of this farm-to-farm variability. Given the large number of visited farms, the external validity of any pattern that is found also needs to be considered as high (see also Richter et al., 2010).

We notified the Cantonal Veterinary Offices responsible for the conduction of animal experiments but were exempted from applying for a formal permit because we did in no way interfere with the standard practices on the farms.

2.2. Experimental design and observations

The observations were conducted between 15 September and 10 November 2015. On each of 10 observation days, the farms of a triplet, that is one farm each with a milking robot, a milking parlour, and suckler cows, were visited in parallel to control for potential seasonal and weather influences. Each observation day lasted 24 h during which farms were visited every hour except for 0200 and 0400 resulting in 22 hourly observations per farm. Within each hour, the three farms were visited in sequence (i.e. the observations were delayed by a maximum of 20 min from one farm to the next). The sequence was kept constant for a given triplet. For evaluation, every observation was assigned to the last full hour before the observation took place.

During each farm visit, the numbers of lying and feeding adult cows were counted, and it was noted whether the cows had access to pasture. For evaluation, we did not differentiate whether cows had access to the barn during their access to pasture because we focused on the fact that they had fresh grass available during the time of pasture accessibility. Cows were considered to be feeding in the barn if their head was above the feed and they could be observed chewing. Ruminating can be observed only rarely in this situation and was therefore not confounded with feeding. On pasture, cows perform typical short sequences of steps while tearing off grass with their tongues, and this behaviour was considered as feeding. During the dark hours, observations were made by using an infrared camera (FLIR T620, FLIR Systems GmbH, Frankfurt am Main, Germany) in order to avoid lighting at times when the animals were not used to light in the barn. The observer (RF) took care that she entered the area of the animals as little as possible and that she moved calmly without jerky movements at all times. There were no obvious reactions of the animals in response to the observer; specifically, animals were not seen to interrupt feeding for a prolonged time or to stand up in response to the observer.

In order not to disturb the cows in their current behaviour, they were not identified individually in each observation (which would have been possible based on their earmarks). Marking the animals with signs more visible than the earmarks would have been prohibitive in respect to work effort. Therefore, we could not directly