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Lying, standing, and eating behaviour

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Introduction

Standing and lying behaviours are well-defined. Lying is often described as when the flank or sternum of the animal is in contact with the ground, and end of lying when all four legs are perpendicular to the body (see [1]). The transition from lying to standing and vice versa requires only a few seconds, and therefore differences in the description of lying do not greatly affect the calculation of time spent lying or standing. By contrast, if the transition between lying and standing is the subject under study, then the description of the behaviour is crucial, especially when one wants to compare results from different studies. For instance, if one investigates the comfort of cubicles, the total duration of lying may reflect the comfort of the cubicle when the animal is lying, while a low frequency of lying bouts may reflect difficulties in lying down/getting up due to poor design of separations [2]. Likewise, standing and walking can be defined in different ways. For instance, counting every second as walking when a leg is moving is not necessarily the same as counting the time when the animal's body is moving forward or backwards.

Eating behaviour can be defined as the whole process by which the animal ingests feeds, able to satisfy organic needs, and rejects non-alimentary or toxic compounds [3]. In practice, measuring eating behaviour often consists of assessing the number and duration of eating bouts over a specified time interval. In cattle, eating behaviour can be difficult to describe because they often take small breaks during a meal where they lift their head from the feeder whilst still chewing – or not, and they often move from one location to another to explore and select food. Therefore, a precise description of the variable 'eating' is necessary. One must be specific as to what metric is to be measured over what time interval, as the specific research question will be dependent on this. Sometimes, duration per day is appropriate to address a particular research question, while the frequency of bouts (i.e. sequences when the behaviour is uninterrupted) and average duration of bouts will be more appropriate for a different question. Again these latter metrics can be measured on a whole day or over specified time intervals.

Because there can be large variations in behaviour within and between animals, it is suggested that data should be collected for a few days to get representative estimates of daily lying duration [4], [5], [6] or eating behaviour [6]. If eating behaviour is to be combined with feed intake in digestion studies, at least 5–6 d of measurements are necessary to align all measurements (intake, digestibility, etc.). However, different research objectives often require different levels of accuracy and precision.

New equipment for automatic recording of lying/standing/eating behaviour has been developed for both research and commercial use. This increases the available opportunities for collecting data. However, it is not always possible to use sensors for data collection. Direct observations or analysis of video recordings can be a suitable alternative. Continuous focal animal sampling will provide the most accurate and precise data. However, this method is very time-consuming. Therefore, instantaneous scan sampling, where the behaviour of each animal in a group is recorded over a specific time interval, can be more efficient. The choice of sampling method is very important for the accuracy and precision. This is detailed in the book introduction to 'Measuring behaviour' [7].

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Prerequisites

The Animal Trait Ontology for Livestock (ATOL) numbers linked with lying, standing and eating behavior are: **ATOL_0000363, ATOL_0000837** and **ATOL_0000835** (https://www.atol-ontology.com/en/erter-2/).

A – Measures based on visual observation or video recordings

1. The animals must be marked so that each animal can be identified. For video or visual observation, this can be done by painting numbers or specific symbols or combinations of them on the animal's back and flanks such that they are clearly visible at distance and/or on the video footage. Care must be taken to ensure the identification system remains intact throughout the duration of the study, or reapplied where necessary. This can also be achieved by using collars of different colours or the use of discoloration.
2. Video equipment should be placed and tested to cover the entire area in question, and the number of frames per second adjusted to the behaviour under observation. We recommend 25 fps to achieve video footage which is comfortable to look at whilst being analysed. Nevertheless, 12 fps can be sufficient to detect lying, standing and walking time as well as duration of lying down/standing up movements. If less frames per second are to be used, it is essential to check that the observer will be able to adequately visualise the targeted behaviour from the video footage.
3. It is necessary to establish a clear description (ethogram) of each behaviour.
4. Intra- and inter- observer concordance should be estimated, and the observer(s) trained if needed.
5. The observer should be able to identify both the behaviour and the animal from a position where the presence of the observer does not affect the behaviour of the animals. If the animals are able to see the observer, then they should be acclimatised to the observer's presence, and the observer should adopt smooth movements and speak quietly.
6. If instantaneous scan sampling is used, the interval between scans should reflect the accuracy and precision needed to answer the research question. For frequency of lying bouts, previous research suggests ≤3 min [8], and for accurate estimates of duration ≤30 min [8] or ≤15 min [6]. For high accuracy and precision estimates of eating duration intervals of 15 min, less than 5 min and 4 min between scan sampling has been suggested [6], [8], [9]. For estimates of frequency, [8] suggest that continuous observations is required. However, both lying and eating behaviour can vary within and between animals due to a variety of factors such as feed type etc., and the shorter the duration of bouts, the shorter the time interval between scans is needed. The authors of [10] have developed a software programme that can help in the choice of length of the interval between scans, based on pilot studies.

B – Automated recording of lying, standing and eating

Most available systems to measure standing and lying behaviour are based on accelerometer technology and placed either on the leg (strap), neck (collar) or the ear (tag) of the animal. Eating behaviour can also be measured using accelerometer technology placed on a neck collar or using a noseband pressure sensor to detect jaw movements of the animal. Another option to measure eating behaviour is to combine RFID technology with feed bins placed on a weighting scale. These systems are generally restricted to housed environments. Alternatively, some systems are entirely based on the position of the animal (Real time Locating Systems, RTLS), and use for example the term 'resting' for when the cow is present in a cubicle, and 'feeding' when the cow is next to a trough.

There is an increasing number of commercially available loggers for automatic recording of eating, lying and standing behaviour. For instance, AfiAct Pedometer Plus, CowAlert, Iceqube, and HOBO Data logger use accelerometers to detect the activity of the animal [11]; Rumiwatch uses a noseband pressure sensor to detect eating [12]; BioControl and Record Feed Intake, HOKO Farm Group Insentec Roughage Intake Control, GrowSafe, and MooSystem Intake Control Feeding Systems utilise feed bins on weighing scales [13]; and CowView is an RTLS device [14]. All these systems have been validated by scientists. New loggers from new companies are continually coming onto the market. It is recommended either to use a validated sensor or to perform a validation study before using a new sensor for research purposes [15].

A leg-mounted logger often estimates standing and lying behaviour more accurately and more precisely compared to when placed on the neck collar or an ear tag. For eating behaviour, systems based on accelerometer technology need to be placed on the neck or the ear. Systems using accelerometer technology are often less accurate than systems that record jaw movements, but there is a significant cost difference between the technologies. All systems need to be carefully validated against direct visual observations, especially when animals can eat without completely dropping their heads down. Recording jaw movements also allows the measurement of rumination behaviour, but needs an appropriate algorithm to separate rumination from eating jaw movements. Automatic feed bins can give accurate estimation of eating duration and number of meals together with the quantification of feed intake, but are less suited to the analysis of more specific feeding behaviours, e.g. to distinguish activities such as taking food and ingestive chewing.

The data granulation level for the sensors also differs. Some sensors provide information per second (Icetags, IceRobotics, Scotland), whereas other systems provide information at for instance 15 min intervals (AfitagII, AfiMilk, [16]). It is important to take the technology and the sampling frequency into consideration. Careful examination of the output from the sensors is needed to choose the optimal solution for each experiment.

1. Sensors should be correctly positioned on the animal during the whole sampling period.
2. Cow ID and sensor ID should be carefully related to each other and checked both when attaching the sensor and when removing it. Record any sensor replacements, made during the course of the study.
3. Time synchronisation between sensors and other equipment should be checked regularly and, if needed, adjusted. The best is to synchronise all equipment to the Coordinated Universal Time (UTC).
4. When possible, performing a daily check of data coming from sensors is recommended.
5. It is necessary to check the data to detect outliers and remove them.

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