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Practical application of Observer XT software for behaviour and welfare research in small and large ruminants

Nadya Bozakova[1*], Mehmed Halil[1] and Svetlana Georgieva[2]

[1] *Trakia University, Department of General Animal Breeding, Animal Hygiene, Ethology and Animal Protection Section, Faculty of Veterinary Medicine, 6000 Stara Zagora, Bulgaria*
[2] *Trakia University, Department of Fundamental Sciences in Animal Husbandry, Faculty of Agriculture, 6000 Stara Zagora, Bulgaria*
[*]*Corresponding author:* nadiab@abv.bg

Abstract

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Contemporary scientific animal research often relies on the synchronization and combination of various vital signs to obtain a complete picture of an animal's welfare.

Observer XT software not only provides detailed and refined data on animal behaviour, but also allows the visualization of physiological data. It also facilitates the export and synchronization of ethological data with other physiological indicators.

The aim of the present study is to review the practical use of Observer XT software for synchronizing and integrating ethological observations in large and small ruminants with different physiological parameters in relation to their welfare.

To achieve this goal, we reviewed over 250 official documents and scientific publications through online databases, such as PubMed, Research Gate, and Elsevier. They are related to using Observer XT software to integrate data from video recordings of various behavioural reactions of large and small ruminants with their physiological, hormonal, biochemical, and other indicators concerning their poor and positive welfare.

As a result, we summarized and systematized the scientific data from the practical use of Observer XT software to synchronize and integrate indicators from ethological observations in sheep and cattle with other multimodal data. This permitted us to establish relationships and regularities between the various vital indicators and, as a result, to obtain a more complete picture of animal welfare, as well as to significantly improve the quality of scientific research.

Based on the obtained data, Observer XT software proved to be an optimal method for integrating and synchronizing ethological data in research with different physiological parameters in large and small ruminants in relation to their poor and positive welfare.

Keywords: Observer XT; large and small ruminants behaviour; integrating of ethological and physiological parameters

Introduction

The study and quantification of animal behaviour are important for biological research and for the assessment of animal welfare. Quantitative measurement of animal behaviour is an important approach in various fields of biology and particularly for characterizing animal welfare (Egnor & Branson, 2016; Datta et al., 2019; Altimus et al., 2020; Pereira et al., 2020). Whether the object of study is to reveal behavioural structure, or observe underlying neural or genetic mechanisms, researchers are interested in useful, quantifiable, and stable characteristics of behaviour that allow us to describe how behaviour changes under different conditions and the influence of various factors (Noldus, 1991; Zimmerman et al., 2009; Egnor & Branson, 2016).

Animal behaviour is a sequence of movements that are performed to satisfy various needs. It can be defined in terms of the goals that motivate it: navigating to a burrow (Wehner, 2003; Hu et al., 2023), escaping a predator (Roeder, 1962), courting a mate (Bradbury & Vehrencamp, 2011) or defeating a rival (Kravitz, 2000; Naguib & Kipper, 2006).

The exact definition of behaviour depends on the pre-set objectives of the study. For the purposes of this review, we define behaviour as any movement that an animal makes.

Certain behaviours can be used to gain insight into the animal's emotional state and well-being. It is important to be able to recognize the specific and unusual behaviours that are accurate indicators of poor animal welfare, as well as the specific behaviours that characterize positive animal welfare (Berkson, 1968). The use of recording methods to quantify positive and negative welfare-related behaviours can be a powerful tool for the welfare assessment of farm animals (Noldus, 1991; Zimmerman et al., 2009; McCormick, 2012; Friard et al., 2016).

The characterization and assessment of animal welfare is a multifaceted and complex task.

A classic definition of animal welfare is provided by Donald Broom, who phrases it as follows: "The welfare of an animal is its condition to cope with its environment" (Broom, (1996). Injury, abnormal behaviour and stress-provoked physiological changes may signal that the animal is not coping with the environment – poor welfare (Broom, 1986), while growth and reproduction are indicators that the animal is coping – positive welfare.

The advantage of this definition is that it takes a complex approach to characterizing animal welfare. Welfare can vary between satisfactory and unfavourable, but when exhaustion occurs as a result of prolonged pathology, the state of wellbeing is compromised (Broom, 2006).

Animal welfare contains behavioural, physiological, hormonal, biochemical, biological, zoohygienic, economic, ethical, emotional and philosophical nuances. Therefore, for its accurate assessment, various, complex studies and intricate interdependent methods and regularities are used.

In recent decades, methods for assessing animal welfare have evolved significantly in terms of both behavioural and physiological indicators.

Traditional methods of animal behaviour studying require long periods of visual observation and specifically trained personnel (Arrington, 1943; Altmann, 1974; Føske, 1975). Video recording of animals was initially done manually (Kendon, 1975; Buelthoff et al., 1980; Moran et al., 1981; Dolen et al., 2013; Egnor & Branson, 2016). With the modernization of animal husbandry technologies, new ways of studying animal behaviour are being applied today, which include the use of special software tools for analysing different behaviour forms and the position of animals over time (Dell et al., 2014). Some of them are: Animal Observer, WelfareTrak, ZooMonitor, Observer XT, EthoVision XT, BORIS, Tracks Software, Animal Care Software, LabGym (Farrimond et al., 2009; Friard & Gamba, 2016;). In this regard, Noldus Observer XT software is a professional and easy-to-use software for behaviour logging, data analysis and presentation. It can support the entire workflow on animal behaviour research: from experiment setup, ethogram design and data collection, to analysis and presentation of these data. In this way, the software provides detailed and precise data on the behaviour of different animals (Horner & Storey, 1989; Noldus, 1991; Zimmerman et al., 2009).

Observer XT offers the possibility to visualize physiological data, to export and synchronize the video recordings with other physiological parameters, such as heart rate, respiratory rate, rumen movements from various experiments with large and small ruminants. It also allows us to formulate a more complete idea about the studied phenomena.

Initially, Observer was developed as a device for recording behavioural data, managing, analysing, and presenting these data obtained during observing animals (Noldus, 1991; Noldus et al. 2001; Zimmerman et al., 2009; Pullin et al., 2017).

Later, due to its flexibility, Noldus software was adapted for almost any study involving the collection, processing, analysis and presentation of various data on the overall state of the studied problem.

In current scientific research on animal behaviour and wellbeing, an emphasis is placed on the synchronization and combination of various vital indicators of the studied animals to assess their condition.

According to Zimmerman et al. (2009), the advantage of combining various vital signs is that a more accurate, comprehensive picture can be obtained. However, when combining the different features acquired by different programs, synchronization and integration problems may often occur.

All this has motivated us to summarize and systematize the diverse application of the Noldus Observer XT software to observe the behaviour of mostly pasture-raised large and small ruminants, whose wellbeing is more challenging to assess.

The purpose of the present study is to review the practical use of Observer XT software for synchronizing and integrating ethological observations in large and small ruminants with various physiological, hormonal, biochemical, haematological, pharmacological and other indicators, in relation to their welfare.

Materials and Methods

To achieve the goal of this overview, a theoretical analysis was made of over 250 official documents, reports from international research organizations and scientific publications. A detailed search was performed of numerous scientific articles related to the traditional methods of studying animal behaviour and new modern special software tools for analysing different behaviour forms and the position of animals over time, such as Animal Observer, WelfareTrak, ZooMonitor, Observer XT, EthoVision XT, BORIS, Tracks Software, Animal Care Software, LabGym.

Basic detailed information was found through the scientific databases PubMed (1966–June 2021), EMBASE (1973–May 2021), Research Gate, Elsevier by keyword filtering related to the use of Observer XT integration software of data from the behaviour of small and large ruminants with their physiological, hormonal, biochemical, haematological, pharmacological and other indicators characterizing their wellbeing.

Different ethological studies analysed with Observer XT software were summarized and systematized in cattle, calves, sheep, and lambs and synchronized with their heterogeneous indicators to monitor their welfare.

Discussion

Observer XT for the study of behaviour in large and small ruminants

The capabilities of the Observer XT for recording, analysing the behaviour of large and small ruminants and presenting the results appropriately are numerous. There are many and varied studies on various behaviours – social, maternal, research, etc. in large ruminants performed by means of this application – Boivin et al. (2009), Hemsworth et al. (2009), Johnsen et al. (2016), Todd et al. (2018), Waiblinger et al. (2020).

Research has been done with Observer XT on various behaviours in sheep and lambs as well – feeding, lying down, standing, drinking, locomotor and oral manipulations in lambs (Pullin et al., 2017), early vocal recognition of the mother by the young (Sèbe et al., 2010), social sociability in lambs (Ligout et al., 2011), etc. (Figure 1).

The software encodes and quantifies the behaviour and automatically records the time, as well as the sound of the recording. It reports significant data of the animal's behaviour or from the video and reflects the temporal characteristics of each recorded event. In addition, Observer XT calculates statistics on the average number of animals engaged in a par-

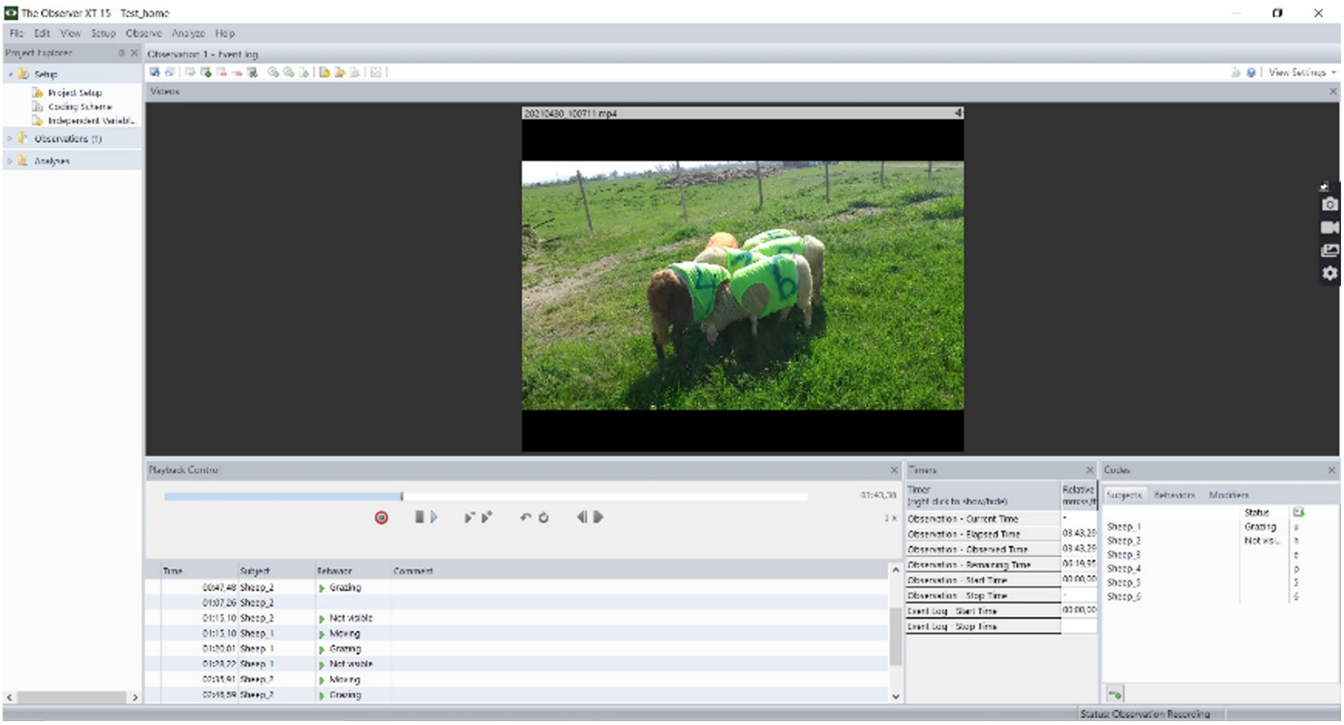

Fig. 1. Screenshot of the user interface of sheep behaviour observation project in the Observer XT

ticular behaviour, as well as reporting the average duration of behavioural responses. This software enables easy data export and presentation. It successfully analyses groups of observations simultaneously (Noldus, 1991; Noldus et al. 2001, Zimmerman et al. 2009; Pullin et al., 2017) (Figure 2).

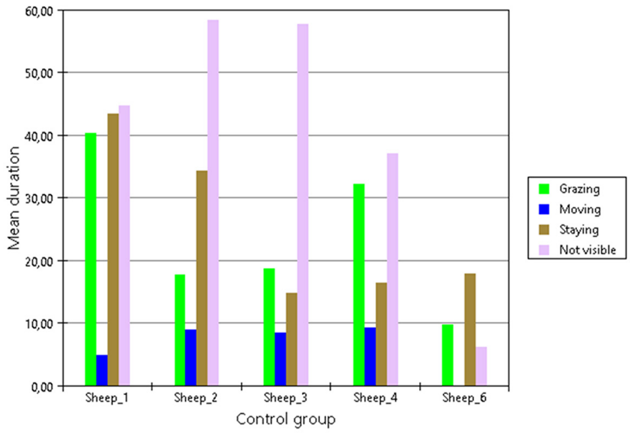

Fig. 2. Mean duration of different behavioural activities

Observer XT has the ability to synchronously play individual video and audio files (MP3, WAV and WMA). It previews the audio of the imported videos. It is compatible with a variety of digital video files (QuickTime (MOV), MP4, MPEG-1/2, MPEG 4 DivX, DV-AVI and AVI) as well as videos made by Apple iPod, Sony PSP and others (Noldus, 1991; Noldus et al., 2001; Zimmerman et al. 2009; Pullin et al., 2017).

The software features Explo for data exploration and visualization: tables and graphs for events over time, video highlights, and more.

Intelligent software can process the data statistically using various methods – descriptive statistics, reliability analysis, sequential lag analysis, etc. (Noldus, 1991; Noldus et al., 2001; Zimmerman et al. 2009; Pullin et al., 2017).

Observer XT for synchronizing behaviour with physiological, hormonal, biochemical and haematological indicators in poor and positive animal welfare

Through Observer XT software, both pre-recorded video files can be imported and offline observations can be made.

A major advantage of this software is the ability to make live observations and create video via a FireWire camera and simultaneously acquire physiological data from the animals using an external data acquisition (DAQ) device (analogous with a digital system). External physiological data are imported into the software after monitoring. This can be done automatically by sending a synchronization signal during observation from the Observer computer to the DAQ device through the Observer computer's COM or USB port. The sync signal is received by the DAQ device and contains a continuous stream of time and date information. This time and date information is used when importing the physiological data file into Observer XT, to synchronize the observed and physiological data (Noldus et al., 2001; Zimmerman et al., 2009; Pullin et al., 2017).

In this way, synchronization of the observed behaviour and the physiological data obtained from the animals can be achieved both when the welfare of the animals deteriorates during stress and disease, and when it improves – during treatment and technological enrichment of the environment.

Observer XT for characterizing poor welfare in large and small ruminants

In studying behaviour and welfare of cows and calves, more studies combine stress-behavioural responses, such as standing and stereotypical walking, head turning, foot stomping, tail wagging, mooing, with measurement of physiological indicators of stress – increased heart rate rhythm, increase in body temperature, slowing of rumen movements, etc. Similar data on synchronizing the behaviour of large ruminants and their physiological indicators under stress are presented by Lensink et al. (2001), Schmied (2008), Chapinal et al. (2009); Zimmerman et al.(2009), Ligout et al. (2011), Lambooij et al. (2012), Gellatly et al. (2021) in cows and calves.

Similar stress-behaviour, such as pointing back ears, increased heart rate and elevated plasma cortisol concentrations in sheep and lambs are presented by: Roussel et al. (2004); Greiveldinger et al. (2009) and others.

Another important advantage of Observer XT is the ability to add data from the hormonal status and biochemistry of the research animals to the processed behavioural indicators. In this way, dependencies between the behavioural data of the animals and the concentrations of a number of stress-related hormones – faecal cortisol metabolite dioxoandrostane, plasma adrenaline, norepinephrine, cortisol, etc. – can be easily calculated.

Thus, the condition and welfare of ruminants is characterized even more fully. Comprehensive studies on stress behaviour, physiological parameters, hormones and biochemistry in cows and calves have been presented by: Hopster et al. (2002), Van et al. (2002), Mülleder et al. (2003), Bourguet et al. (2010), Wagner et al. (2015), Føske et al. (2015); Todd et al. (2018), and others.

Similar studies on stress behaviour and hormones – faecal metabolite of cortisol – dioxoandrostane, plasma adrenaline, norepinephrine, cortisol in sheep and lambs have been reported by: Greiveldinger et al. (2009); Paul et al. (2009); Destrez et al. (2012) and others.

Observer XT for characterization of positive welfare in large and small ruminants

Other authors use the capabilities of Observer XT to characterize the positive welfare of large and small ruminants by synchronizing behavioural data with physiological, hormonal, biochemical, haematological, etc. indicators. They also rely on the complex capabilities of this software to get a full characterization of the study.

Based on social behaviour, emotional reactivity, physiology and performance indicators in heifers, Raussi (2005) found that group rearing of future cows contributed to their more varied social experiences and better welfare. The author confirms that cattle of different ages have different social needs that must be met to ensure their welfare.

Sometimes even small improvements in animal husbandry and transportation can improve their welfare.

For example, according to Lambooij et al. (2012) increasing the distance from the withers of transported cows to the tray of the vehicle to 20 cm had a positive effect on the condition of the cows – reducing head banging, heart rate and rectal temperature.

Broucek et al. (2017) reported that after moving Holstein cows from tied to free-box housing, lying time and survival time increased as well as daily milk yield per cow.

A number of authors have used the capabilities of the Observer XT to characterize positive welfare in small ruminants using pharmacological agents.

For example, Destrez et al. (2012) investigated the effects of diazepam (0.10 mg/kg) (a benzodiazepine), known for its anxiolytic properties, on 5-month-old female lambs subjected to isolation and startle stress. The authors use a complex approach to characterize the wellbeing of the lambs – by studying behaviour, plasma cortisol concentration, heart rate, etc. The researchers found that the treated lambs showed a more positive judgment of an ambiguous event than the controls. Thus, reducing fear may elicit a more positive response in animals.

Similar data on medicinal positive effects on castrated or tail docked lambs, have been noticed by Marini et al. (2017). The authors use energy flunixin, included in the feed, by which pain is reduced after surgical manipulation. Animal behaviour, haematological parameters, cortisol and plasma haptoglobin concentrations were monitored to characterize lamb welfare. Lambs treated with flunixin in feed exhibited less pain avoidance behaviour ($P < 0.05$) than control animals 12 h after treatment. At the same time, they had a lower cortisol concentration compared to the control lambs. Dietary flunixin treatment also contributed to a reduction in neutrophil/lymphocyte ratios in treated lambs. The authors confirmed that in-feed flunixin improved behaviour and reduced inflammation in lambs after castration and tail docking.

Conclusion

Observer XT software is an optimal method for integrating and synchronizing ethological data with various physiological, hormonal, biochemical and hematological parameters in large and small ruminants in relation to their poor and positive welfare.

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