Ingestive mastication in horses parallels rumination but not ingestive mastication in cattle and camels

M.T. Dittmann, U. Runge, M. Kreuzer, M. Clauss

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Introduction

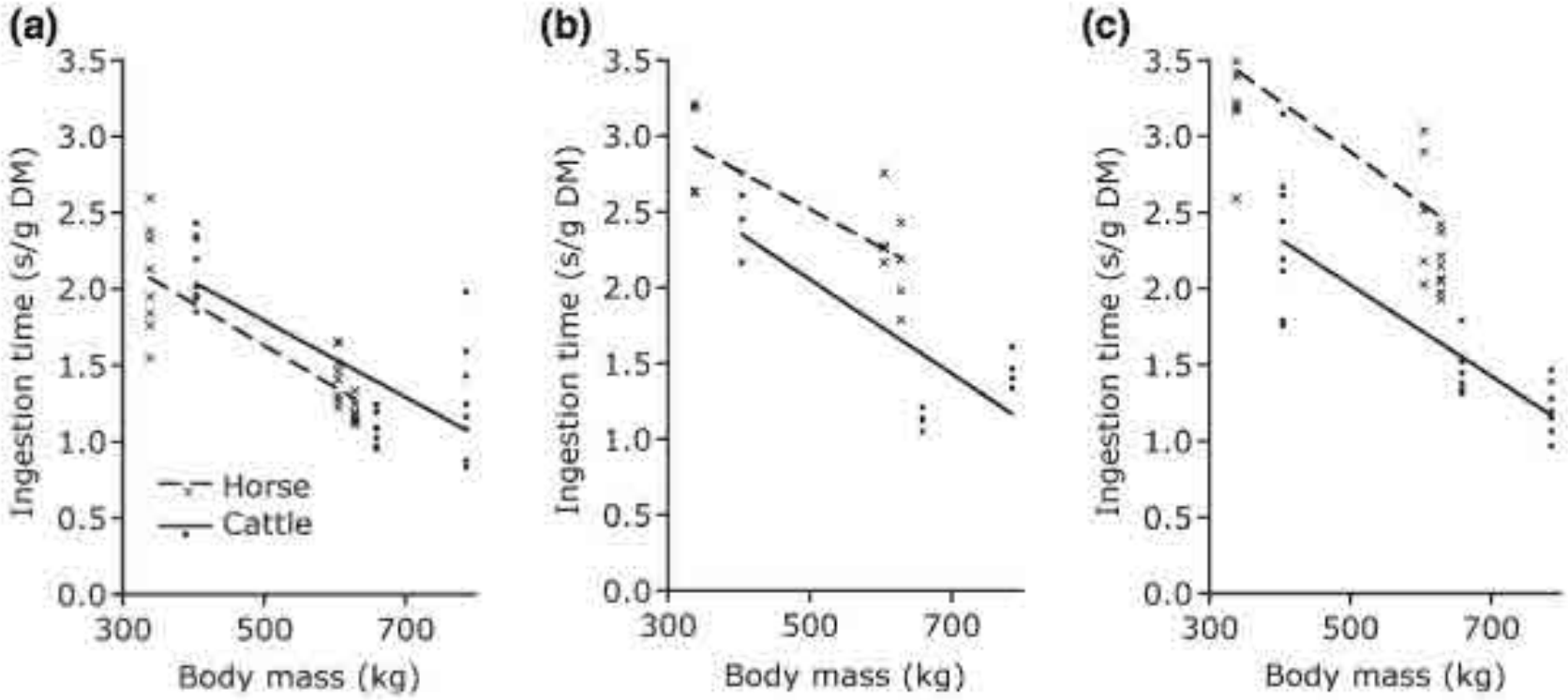
⇒ Horses have – on high-fibre forage – a higher chewing intensity (chews per gram) and a longer ingestion time (sec per gram)

⇒ What about the rhythm of chewing ('regularity')? measured in Rumiwatch system by an algorithm that separates 'eating' from 'rumination' for cattle

Comparative ingestive mastication in domestic horses and cattle: a pilot investigation

C. M. Janis[1], E. C. Constable[1,2], K. A. Houpt[3], W. J. Streich[4] and M. Clauss[5]

Journal of Animal Physiology and Animal Nutrition 94 (2010) e402–e409



increasing fibre level

Comparative ingestive mastication in domestic horses and cattle: a pilot investigation

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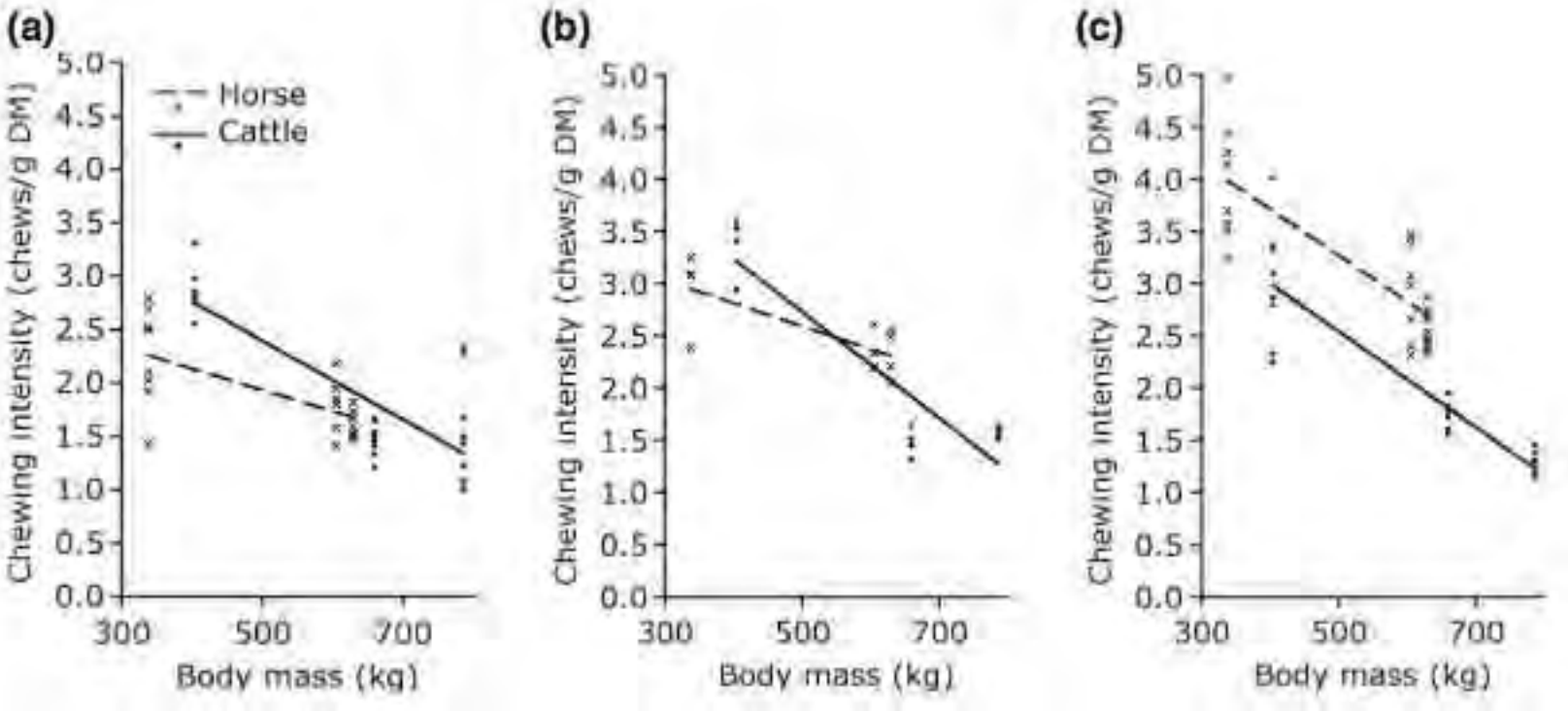

increasing fibre level

Introduction

The effect of methane on properties of digestive physiology in dairy cows

M.T. Dittmann, K.J. Hammond, P. Kirton, D.J. Humphries, L.A. Crompton, S. Ortmann, T. Misselbrook, K.-H. Südekum, A. Schwarm, M. Kreuzer, C.K. Reynolds, M. Clauss

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Introduction

Introduction

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Validation of a pressure sensor-based system for measuring eating, rumination and drinking behaviour of dairy cattle

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ABSTRACT

The main objective of our study was to validate, for dairy cows, a new pressure-based system (RumiWatch noseband sensor, Itin + Hoch GmbH, Liestal, Switzerland; RWS) that measures eating, rumination and drinking time. In experiment 1, eating, rumination and drinking time (RWS, min/h) measurements were compared with continuous behaviour recording (CR) of six dairy cows in tie-stalls (a total of 72 h). In addition, eating time measured by RWS was compared with the visiting time at automated feeders of a widely used type (Roughage Intake Control, RIC, Insentec BV, Marknesse, The Netherlands) to gain experience of the utility of RWS in a loose-housing system (experiment 2). A total of 403 h of RWS and RIC data from 18 cows was used for these two comparisons in experiment 2. In experiment 1, RWS and CR had a very dependable relationship (random coefficient regression model) for eating and rumination: eating, $y = 0.98$ (0.89–1.07)$x + 3.25$ (1.35) (the slope with the 95% confidence interval and the intercept with standard error of the mean) and rumination, $y = 0.88$ (0.73–1.02)$x + 1.77$ (1.00). The R^2 values were 0.94 and 0.93, respectively, i.e. random error was small. The 95% confidence intervals of the slopes included value 1, and the intercepts did not differ from 0; i.e. there was no significant systematic error. However, experiment 2 confirmed a tendency observed in experiment 1 that RWS overestimated eating, since RWS eating time (5.1 ± 2.7 h/24 h) exceeded significantly visiting time (RIC) (3.2 ± 1.1 h/24 h; paired t-test, $n = 18$) in the setup where, in principle, eating was possible only in the RIC feeders. In experiment 1, the relationship between drinking time (RWS) and CR was poor: $R^2 = 0.20$, and $y = 0.49$ (0.12–0.85)$x + 0.64$ (0.13). However, this may reflect more the challenges in measuring drinking in general than merely with RWS. In conclusion (i) the RWS results were relatively free from random errors for rumination and eating, but not for drinking, (ii) there was systematic error for eating and drinking, but not for rumination, and (iii) due to the relatively limited size of our data, further validation of RWS is recommended and RWS needs further development at least for eating and drinking measurements.

1. Introduction

Eating, rumination and drinking are essential components of the nutritional behaviour of dairy cows (Phillips, 2002). In scientific studies, the feeding behaviour of loose-housed cattle has been measured traditionally by direct observation methods. Automated equipment for measuring feeding behaviour and feed intake of cattle is, however, used more and more widely, because of the very labour-intensive requirements for conducting visual observations of behaviour (Beauchemin et al., 1989; Elischer et al., 2013). These types of automated equipment could also be of great benefit in large commercial dairy herds because ingestive behaviour can also be regarded as an important parameter for predicting health issues (as reviewed by Weary et al., 2009).

Devices used for measuring the feeding behaviour of dairy cows can be classified into two categories: stationary systems and systems based on sensors attached to animals. Stationary feeding systems use transponder tags that identify the individual animals and measure either the duration of visits at a feed alley (DeVries et al., 2003) or the visit duration and feed intake at feed troughs

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1 These authors contributed equally to this work.

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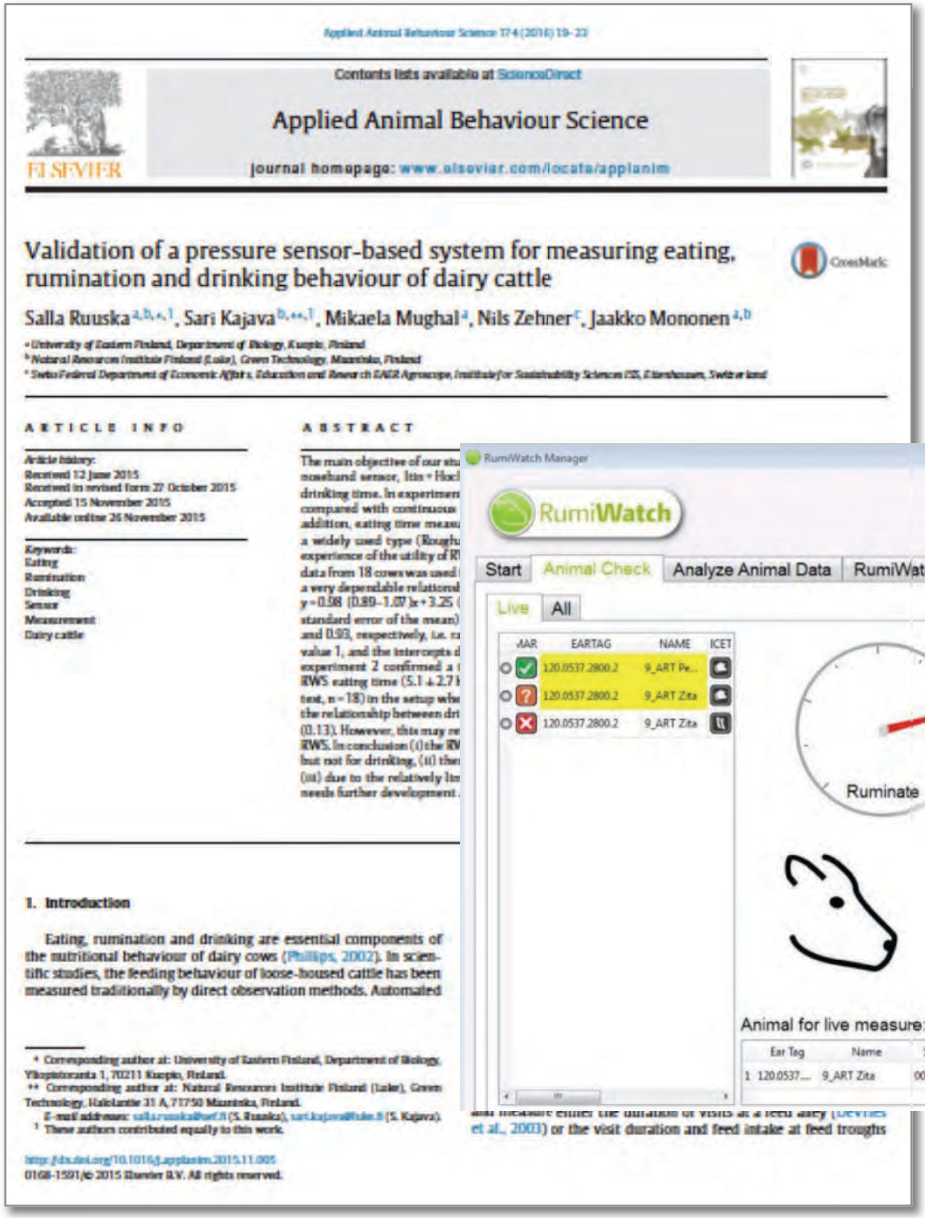
0168-1591/

Introduction



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[a] University of Eastern Finland, Department of Biology, Kuopio, Finland
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ABSTRACT

The main objective of our study was to validate a new noseband sensor, Itin + Hoch GmbH, Germany, for measuring eating and drinking time. In experiment 1, data from 18 cows was used to compare with continuous visual observations. In addition, eating time measured with the RWS was compared with a widely used type (Roughage Intake Control System, Insentec B.V., Marknesse, The Netherlands). In experiment 2, data from 18 cows was used to validate the RWS. In experiment 1, a very dependable relationship between the RWS eating time (5.1 ± 2.7 h/d) and visual observations was found ($y = 0.98\ (0.89–1.07)\ x + 3.25$ (standard error of the mean) and 0.93, respectively, i.e. the slope was close to 1, and the intercepts did not differ significantly from 0. In experiment 2 confirmed a high correlation between the RWS eating time (5.1 ± 2.7 h/d) and visual observations ($r = 0.98$, $n = 18$) in the setup where the relationship between drinking time and the RWS. In conclusion: (i) the RWS is a reliable tool for measuring eating time, but not for drinking, (ii) the RWS is a reliable tool for measuring eating time, but not for drinking, (iii) due to the relatively low sensitivity of the RWS, it needs further development.

1. Introduction

Eating, rumination and drinking are essential components of the nutritional behaviour of dairy cows (Phillips, 2002). In scientific studies, the feeding behaviour of loose-housed cattle has been measured traditionally by direct observation methods. Automated

et al., 2003) or the visit duration and feed intake at feed troughs

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E-mail addresses: salla.ruuska@uef.fi (S. Ruuska), sari.kajava@luke.fi (S. Kajava).
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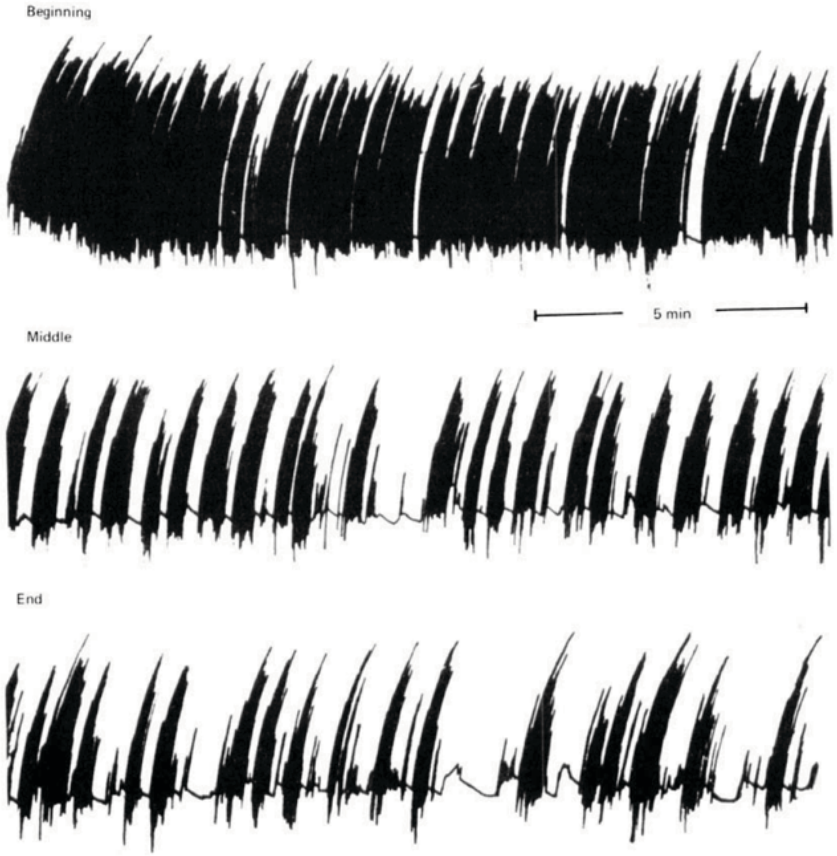
Silage intake, rumination and pseudo-rumination activity in sheep studied by radiography and jaw movement recordings

BY A. G. DESWYSEN* AND H. J. EHRLEIN

Br. J. Nutr. (*1981*), **46**, 327



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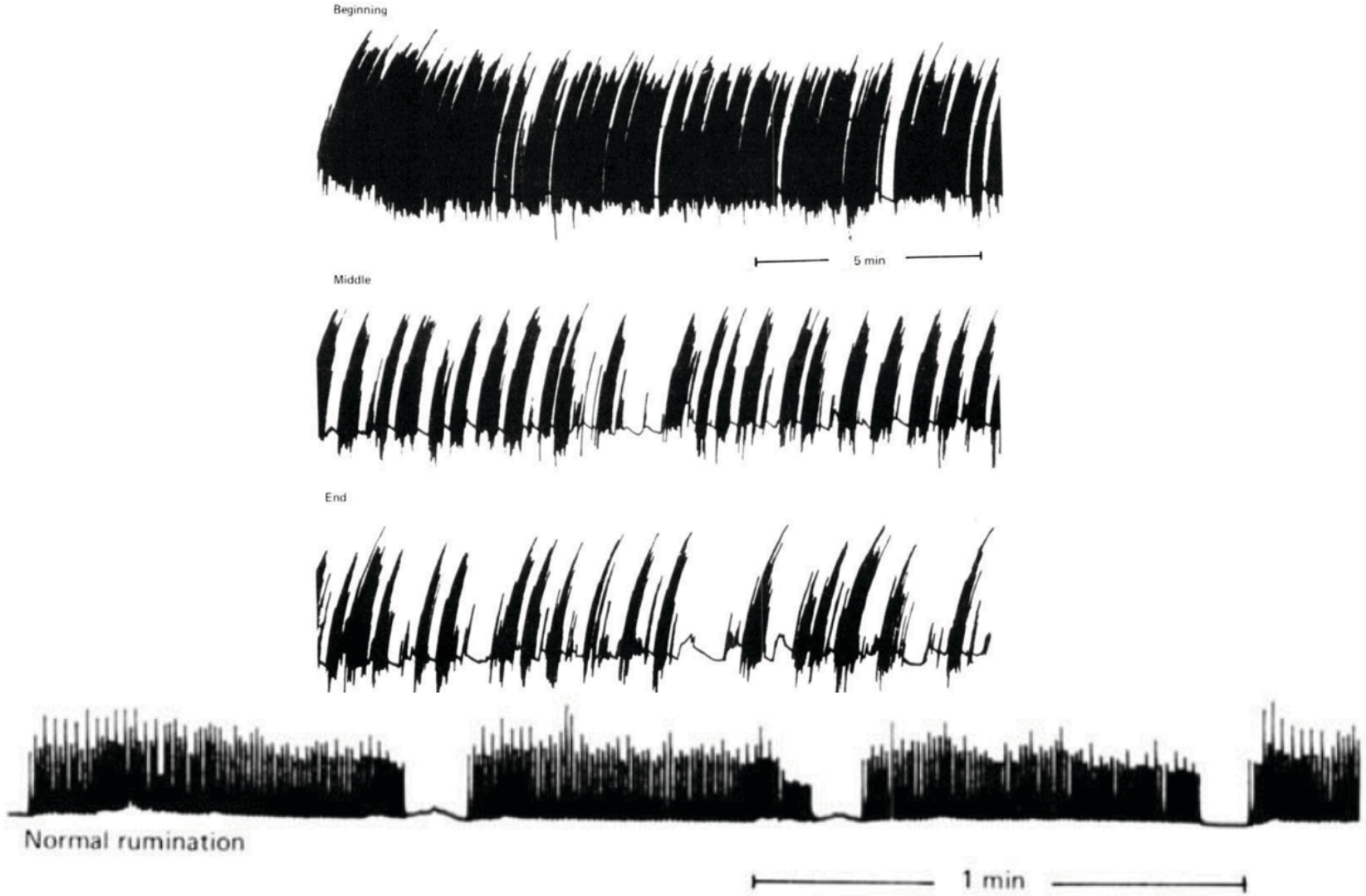

Introduction

Introduction

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Validation of a sensor-based automatic measurement system for monitoring chewing activity in horses

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ABSTRACT

The aim of this study was to determine the feasibility of using a jaw movement measuring system developed for cattle, the "RumiWatchSystem", on horses. The system records the chewing activity and consists of a noseband pressure sensor, integrated into a halter, and a software package. In order to investigate the accuracy of the system, 10 horses (5 mares, 5 stallions) were equipped with the device. Additionally, they were observed visually as a reference method, while feeding three different feeds (hay, haylage and concentrate). To ensure similar conditions, the horses were stabled individually and fed twice daily with roughage and twice or three times with concentrate. The results of the visual observation were compared to the automatic measurement as an evaluation of the accuracy of the automatic measurement system.

The overall agreement of the observed and automatically measured data within all feedstuffs was 93%. The agreement of feeding roughage was even higher with 95%. However, for concentrate the visual observations and automatic measurements agreed only in 91.4%. The decreased agreement compared to the roughage is due to the high sensitivity of the automated system. Horses tend to display a high amount of lip movements towards the end of the concentrate intake. This is different compared to cattle behaviour and their feeding regime. However, the system was not specifically adapted to horses so far and can be optimized in order to improve accuracy. Consequently, the system has a high potential to become a reliable tool for research and practical use.

1. Introduction

The chewing activity of horses can be a suitable parameter for health and welfare assessment as the prevalent housing and feeding conditions often leave horses unsatisfied. Evolutionary, horses adapted over a long period of time to their ecological niche (Janis, 1976). They used to live as grazers in steps with poor vegetation. Therefore, they are adjusted to a low energy and high fibre diet. The feed intake behaviour is defined by a long intake time of 12–16 h (Zeitler-Feicht, 2008; McGreevy, 2004) and travelling long distances of up to 28 km a day (Hampson et al., 2010). Because of the natural food resource, the gastric system is well adapted to small feeding bouts and a consistent filling of the stomach. With the help of microbial fermentation in the large caecum, it is possible to split high fibre feed (Frape, 2010). In modern housing systems, compared to the natural behaviour, horses are often fed roughage restrictive (twice daily) with an additional feeding of grains. This leads to a high amount of starch over a small period of time and can cause illness of the gastrointestinal system like gastric ulcerations (Hymøller et al., 2002). Even in pleasure horses the prevalence of gastric ulcer is 40–60% (Niedzwiedz et al., 2013). Additionally, horses are mostly individually stabled and there is often little or no possibility of social contact to other horses. In Northern Germany, 10% of stabled horses do not even have the possibility to observe their environment (Petersen et al., 2005). This deviation of natural behaviour may lead to abnormalities or stereotypies (Cooper and Albentosa 2005) and even to serious health problems. To evaluate and monitor the feed intake behaviour of a horse, it would be very valuable to measure the chewing activity automatically. The "RumiWatchSystem" could provide us with an assessment tool for different feeding regimes and husbandry systems.

There are still a number of unanswered questions, e.g. why such a high number of stomach ulcers occur in horses. Analyzing the chewing behaviour linked to different feeding regimes would provide us with valuable information and might lead us to the solution how to reduce stomach ulcers. Another possibility to use

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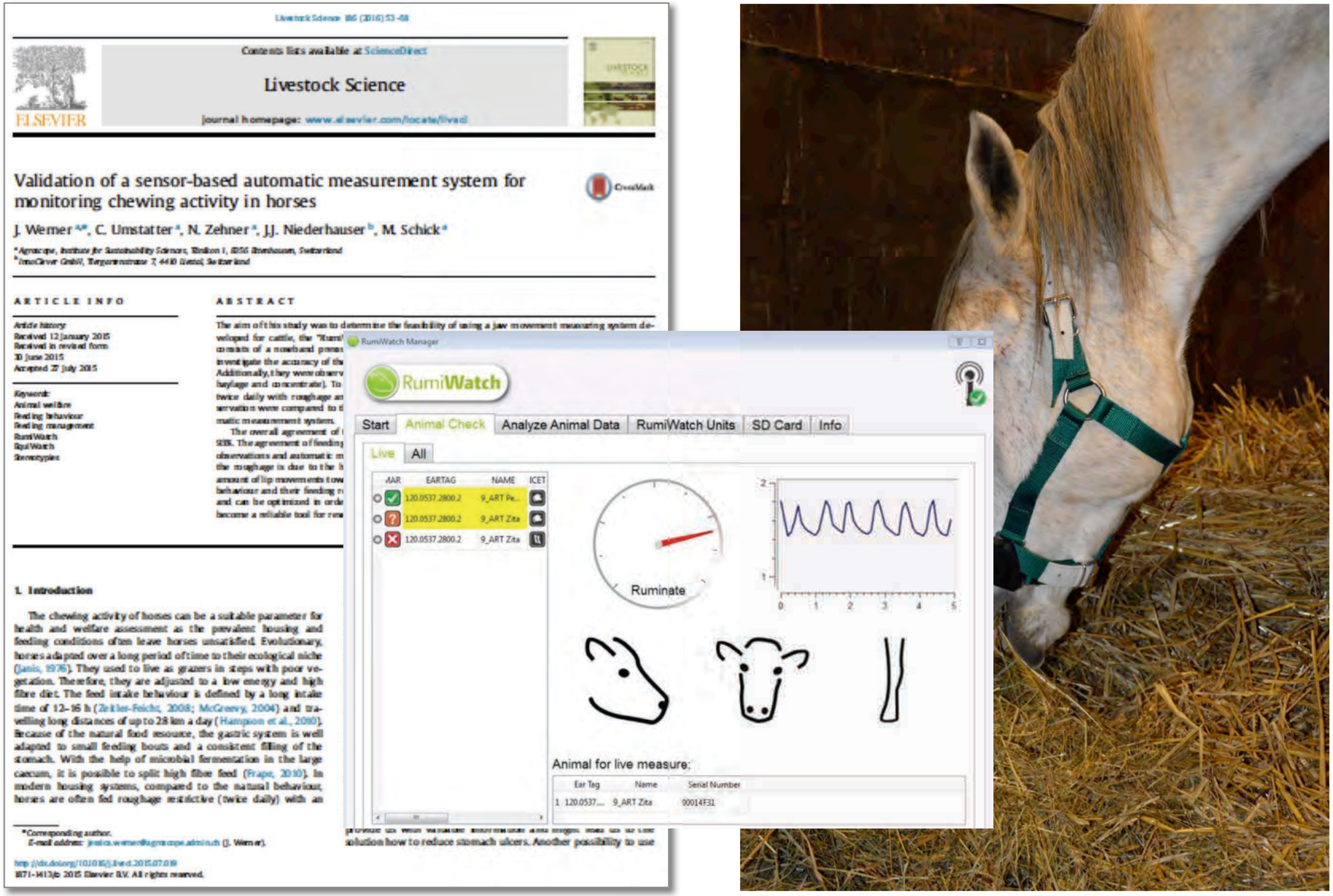
1871-1413/

Introduction



Hypothesis

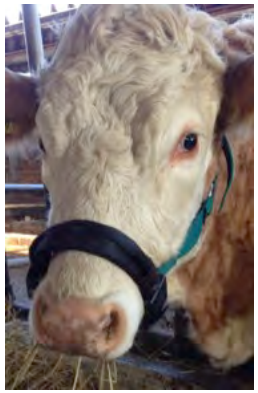
Hypothesis

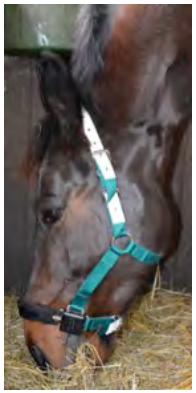
Methods

6 Simmental heifers (*Bos taurus*, 459 ± 110 kg)
6 Bactrian camels (*Camelus bactrianus*, 645 ± 60 kg)
6 Warmblood horses (*Equus caballus*, 563 ± 44 kg)

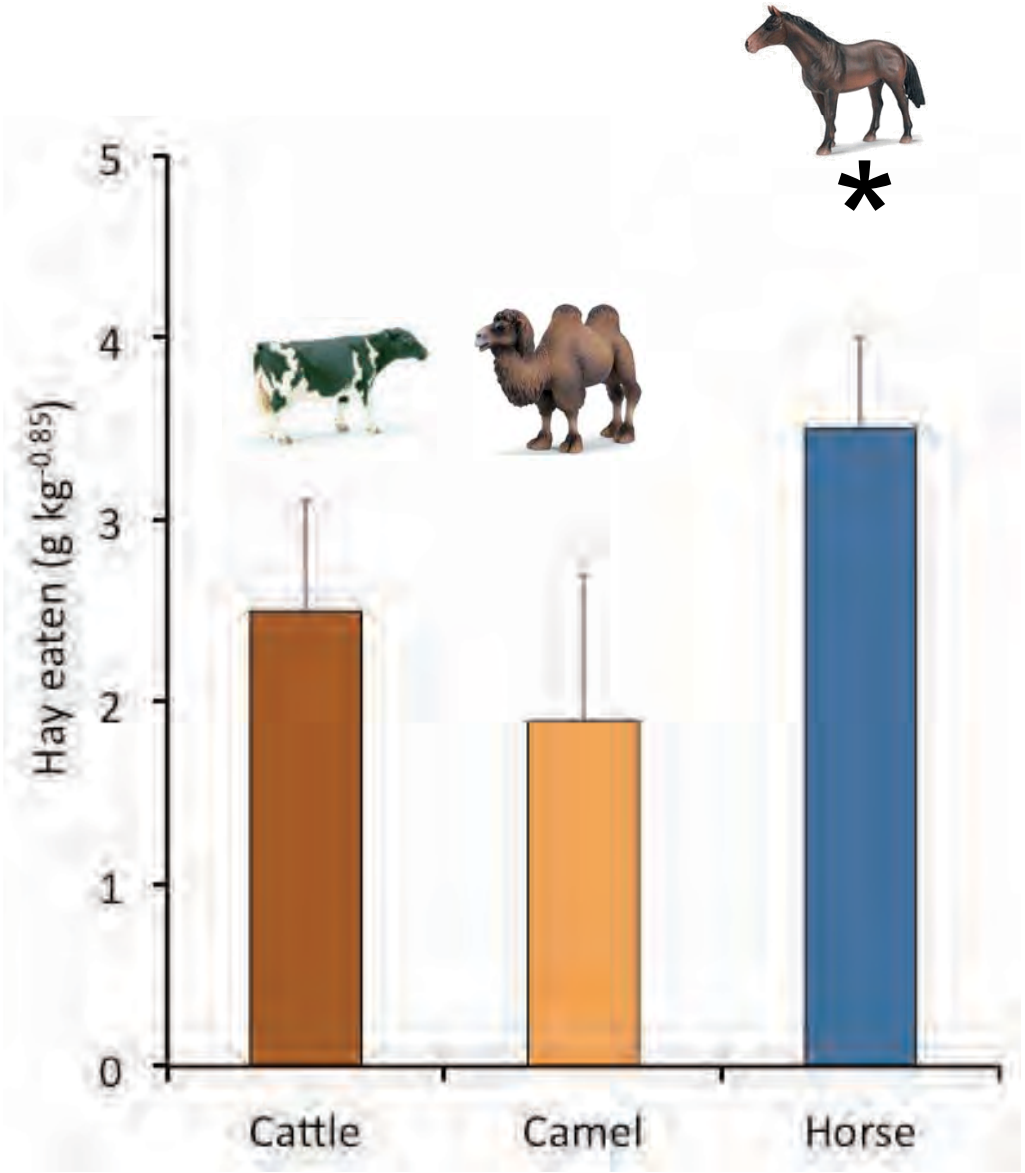
Rumiwatch chew-monitoring halters

Unchopped hay (CP 74, NDF 607, ADF 324 g/kg DM)
for 15 minutes (plus 2 h max. for rumination)
intake measured





Results: Intake



Methods

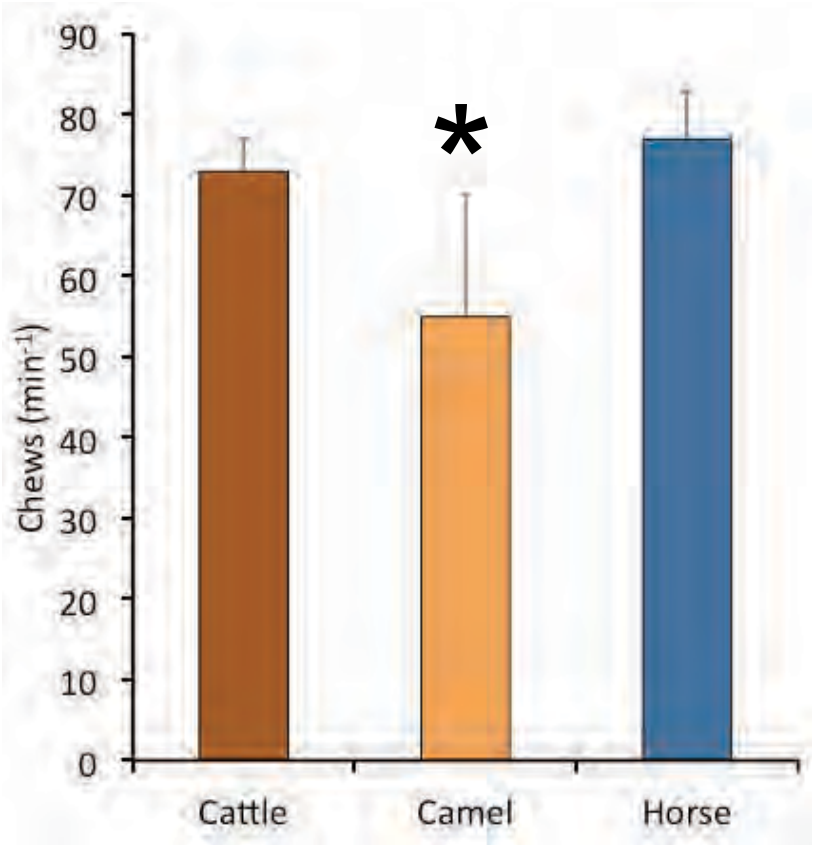
Rumiwatch measurements:

1. Number of chews

Results: Chews

Rumiwatch measurements:

1. Number of chews



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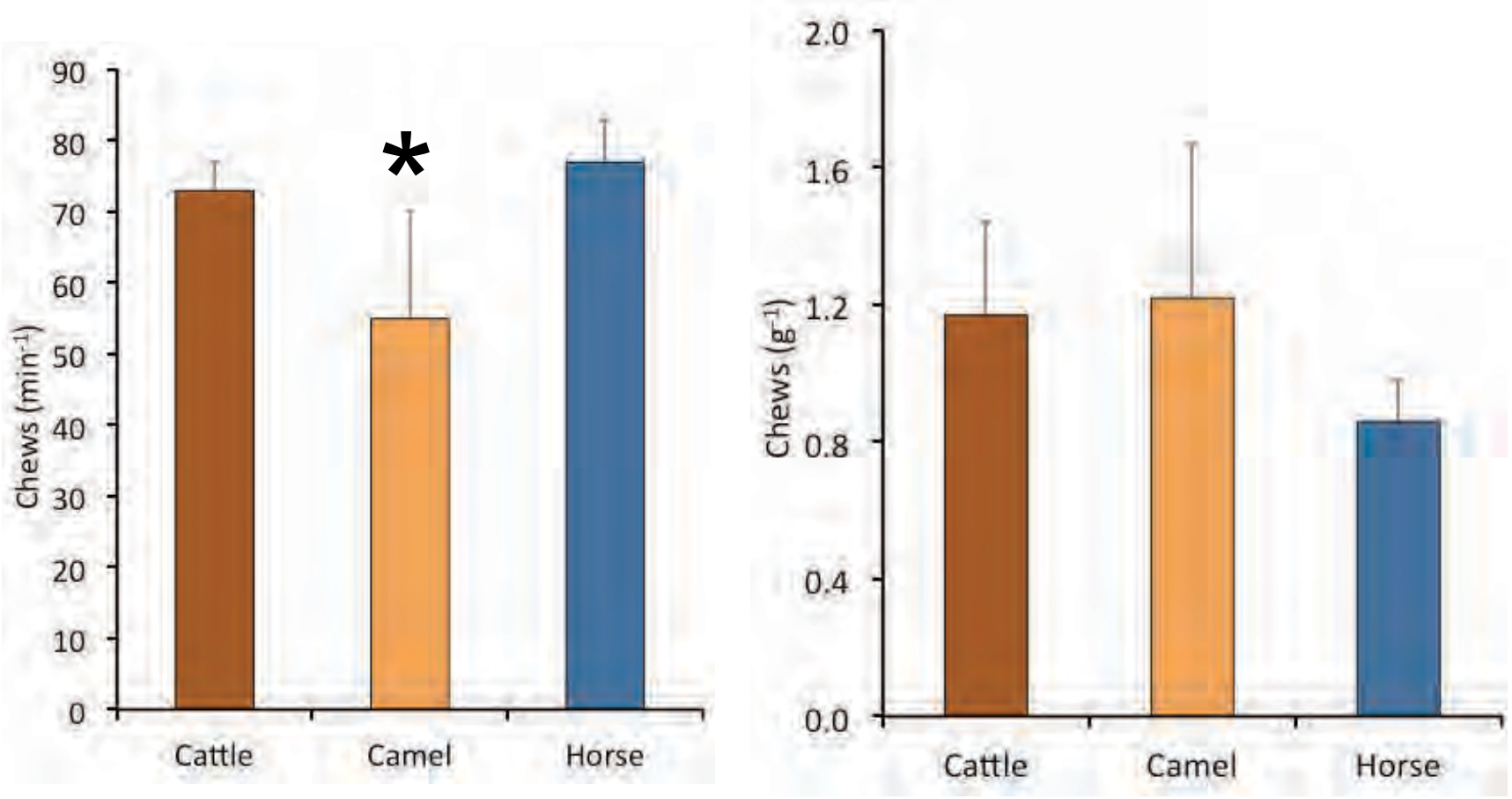

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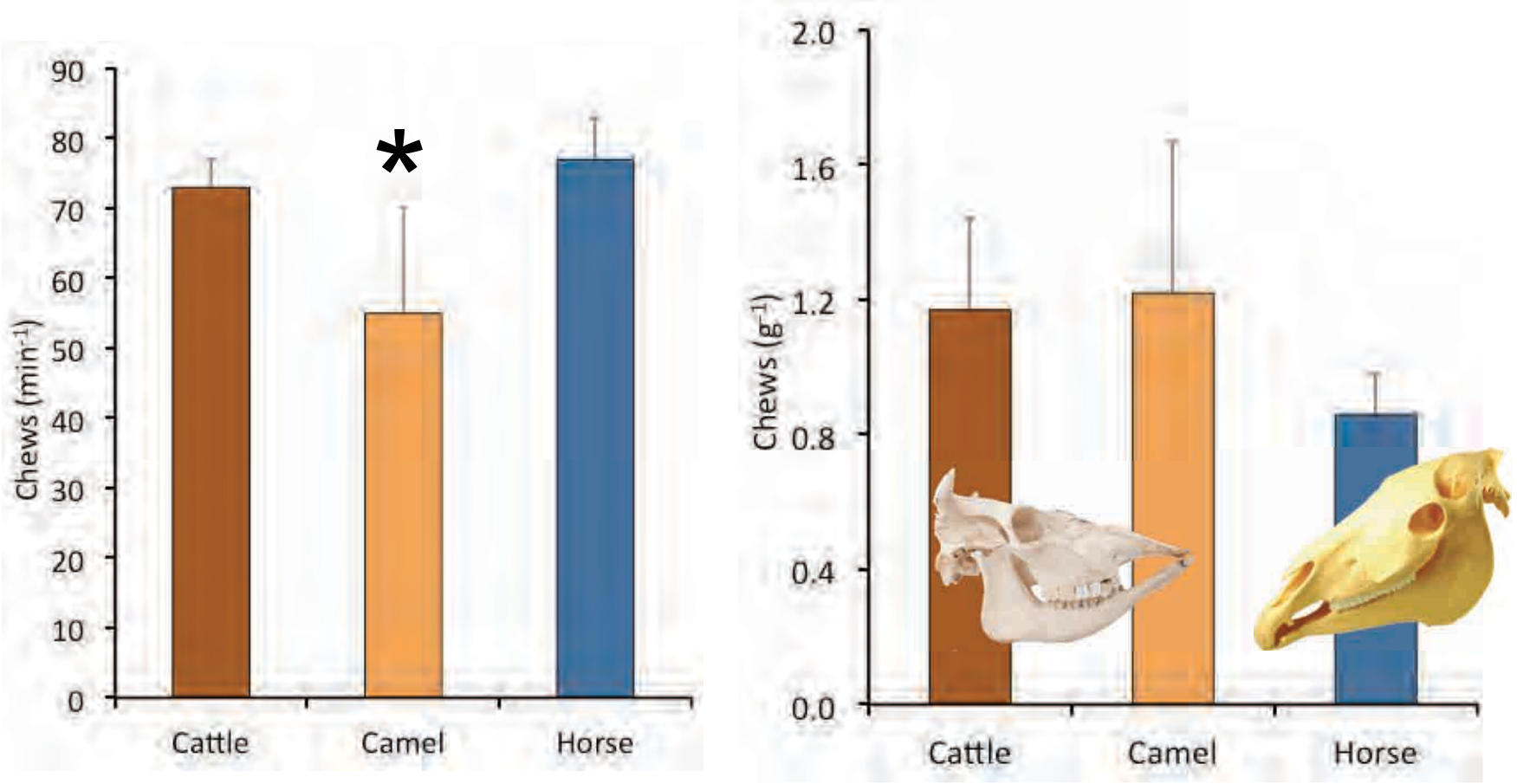


Methods

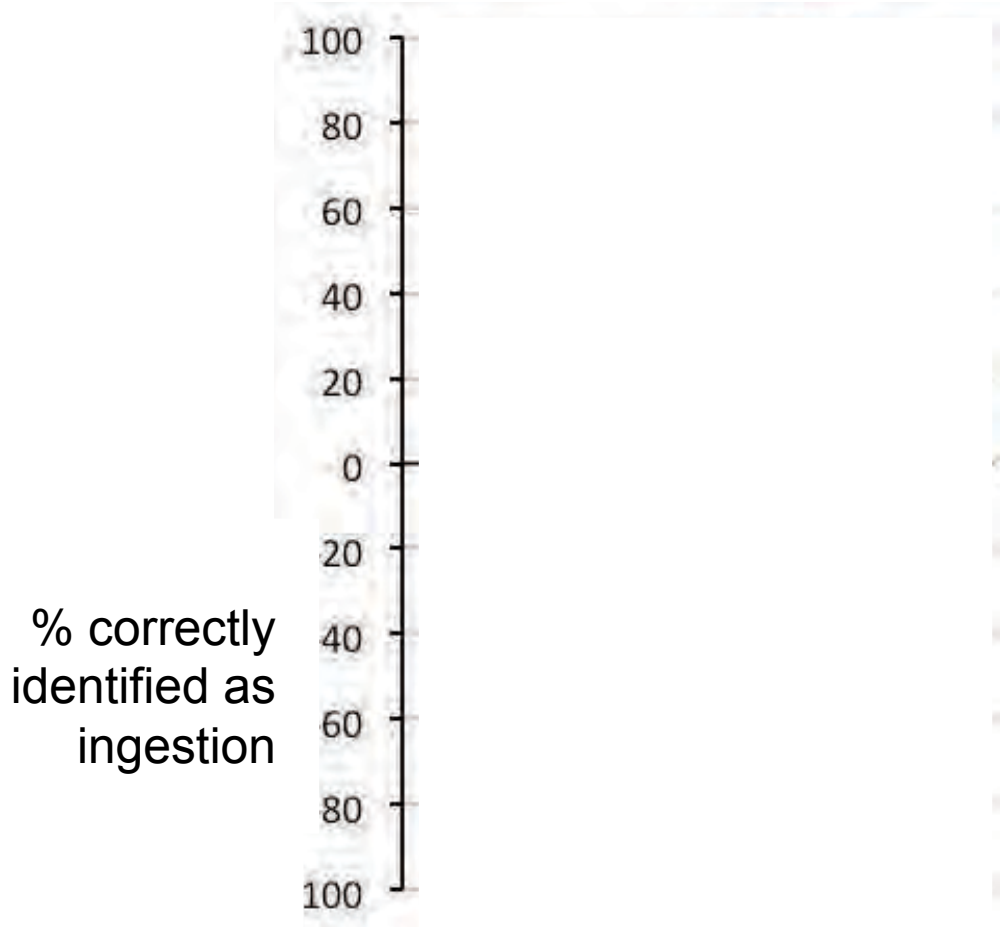
Rumiwatch measurements:

2. Ingestion / Rumination

Results: Chewing classification

Rumiwatch measurements:

2. Ingestion / Rumination



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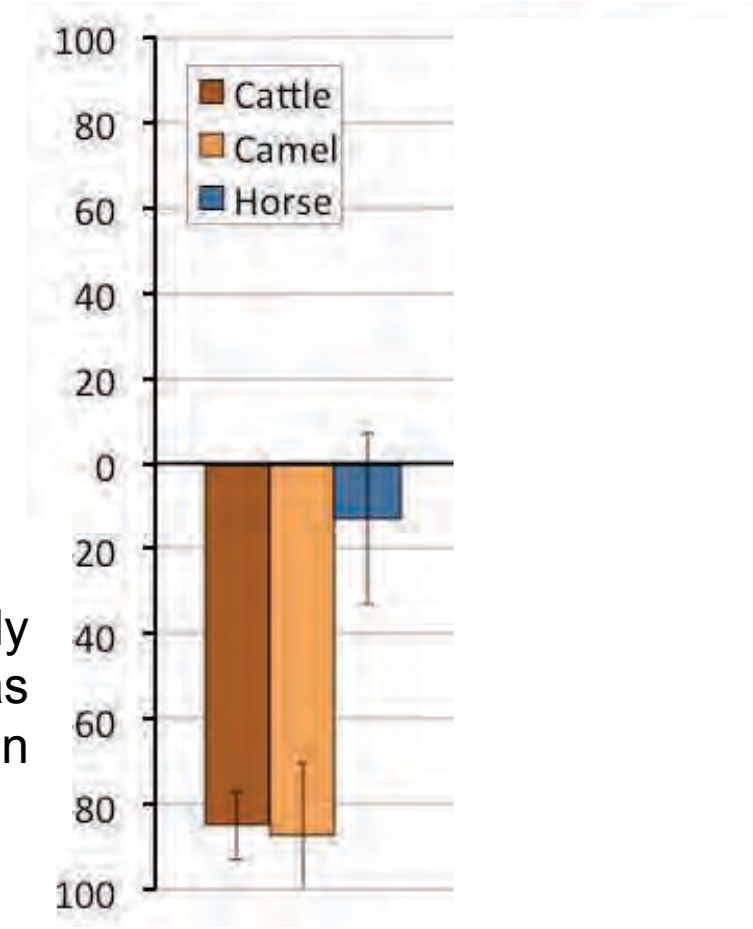

Results: Chewing classification

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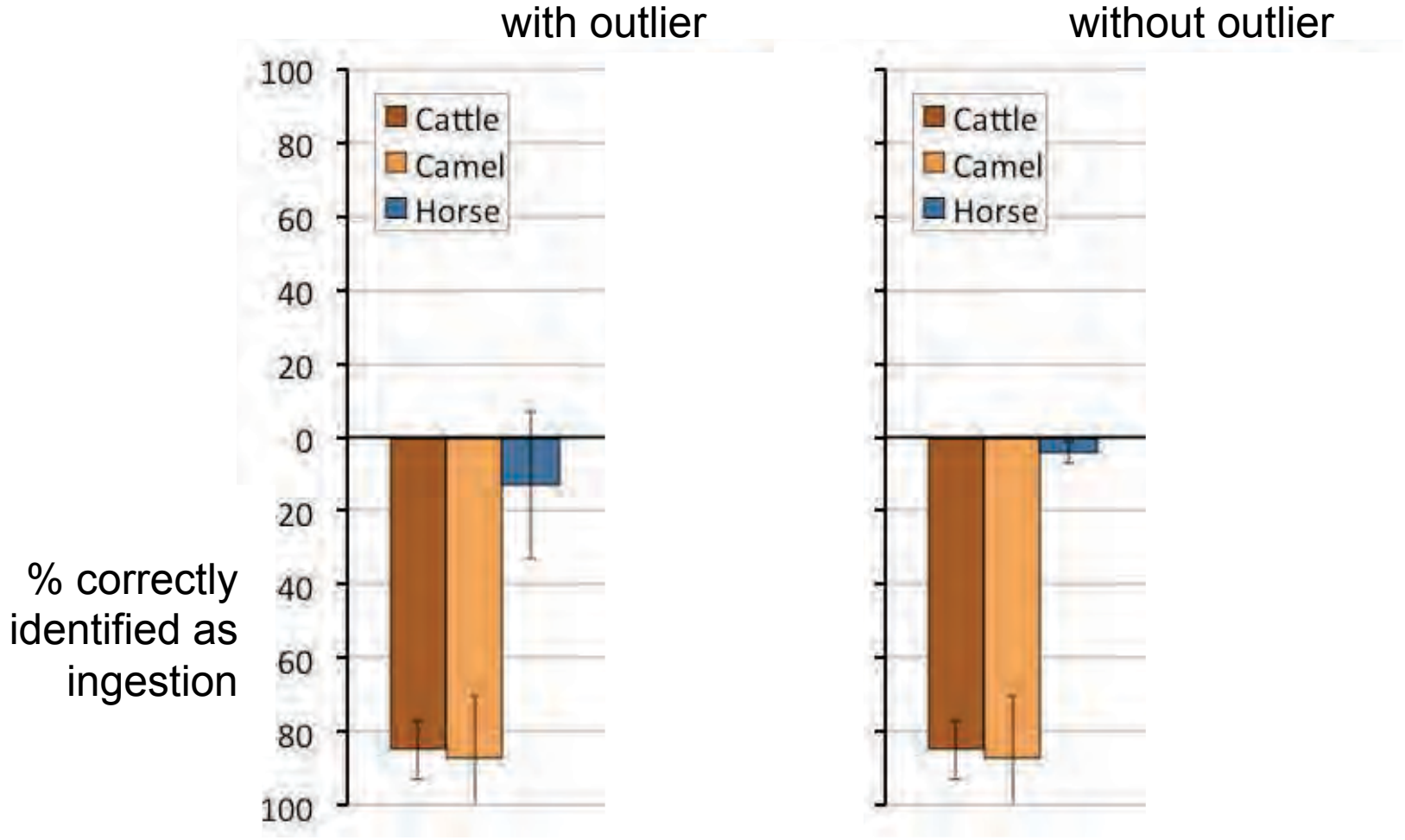
2. Ingestion / Rumination



Results: Chewing classification

Rumiwatch measurements:

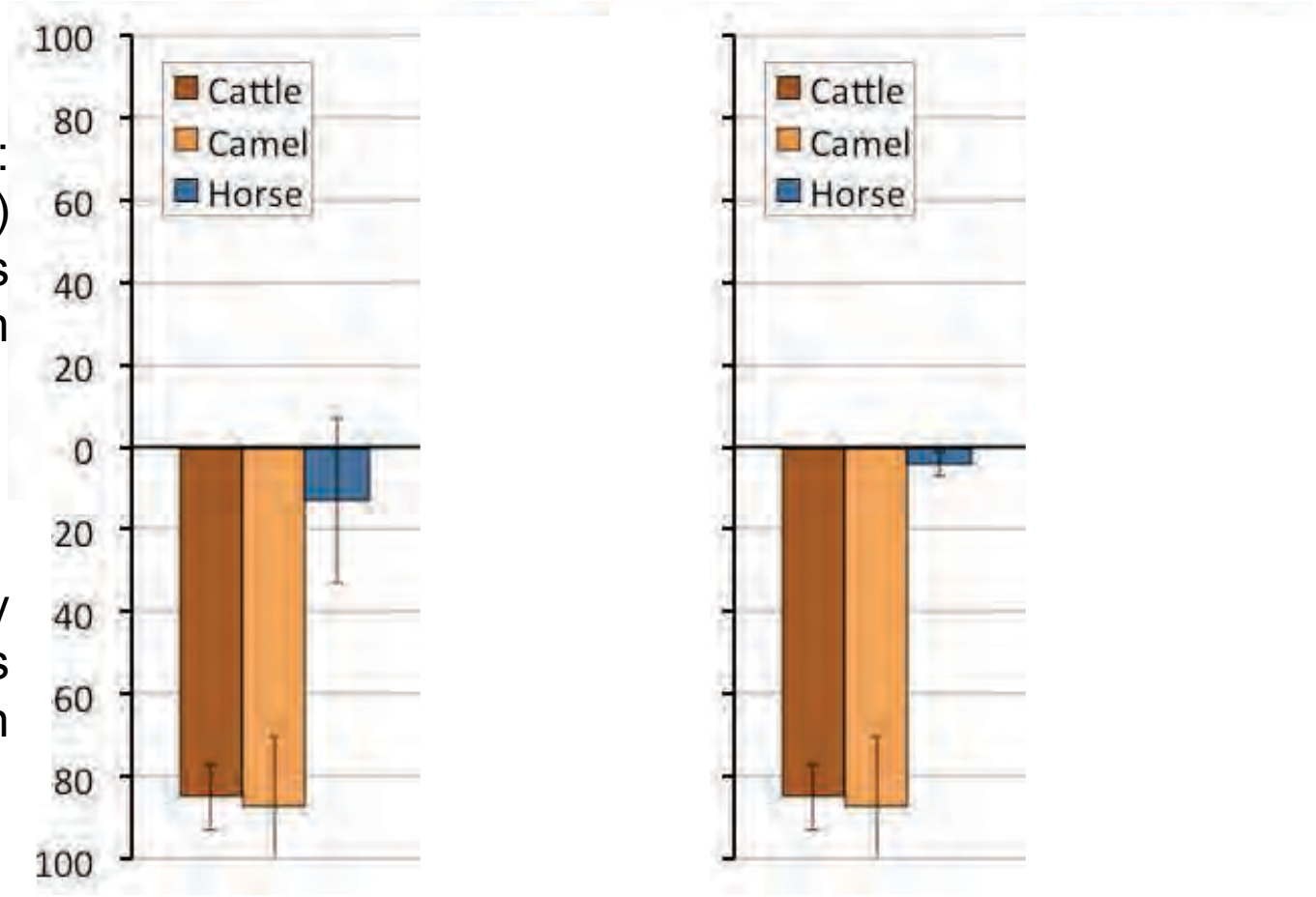
2. Ingestion / Rumination

with outlier

without outlier

% (in ruminants: correctly) identified as rumination

% correctly identified as ingestion



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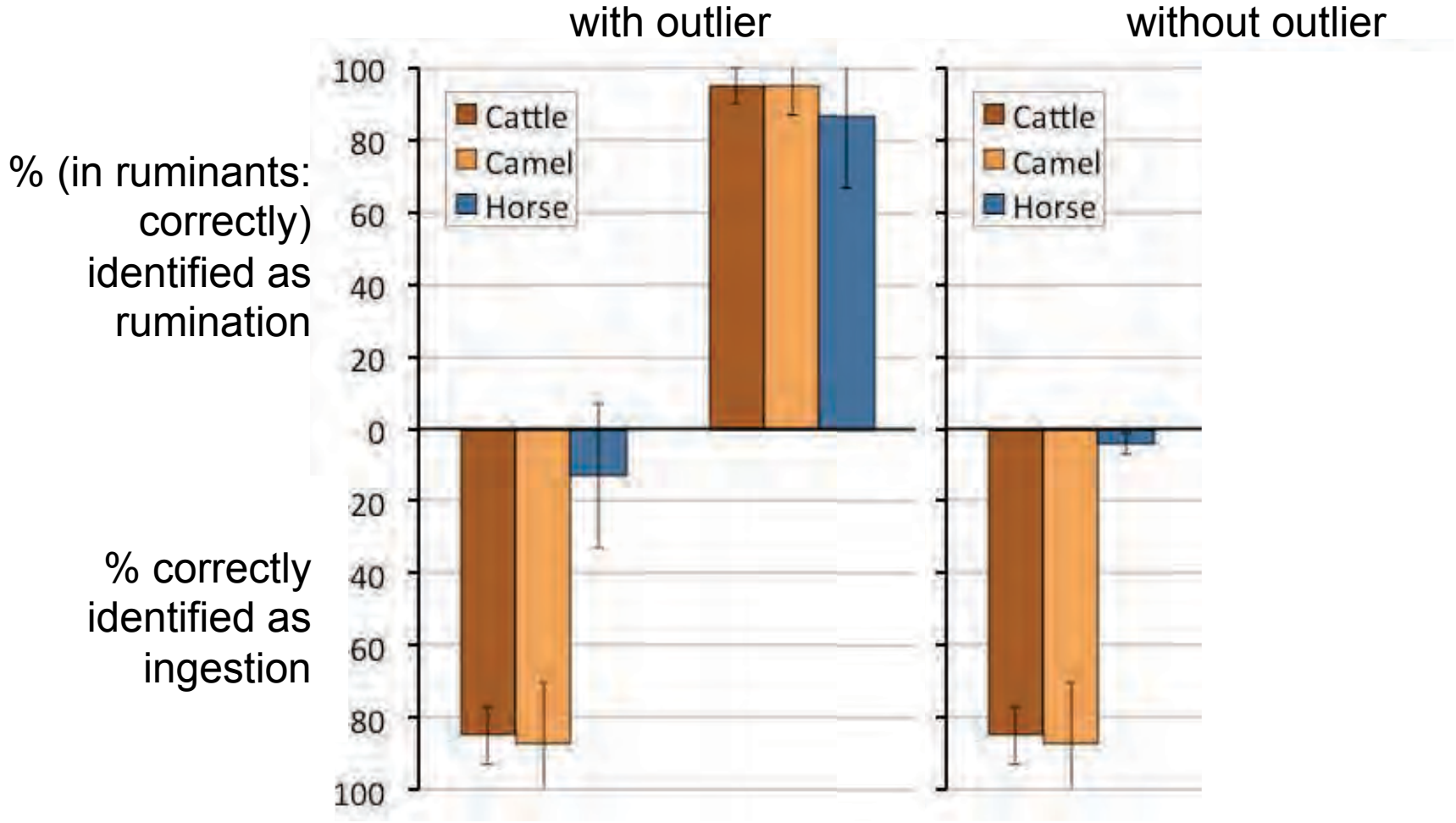

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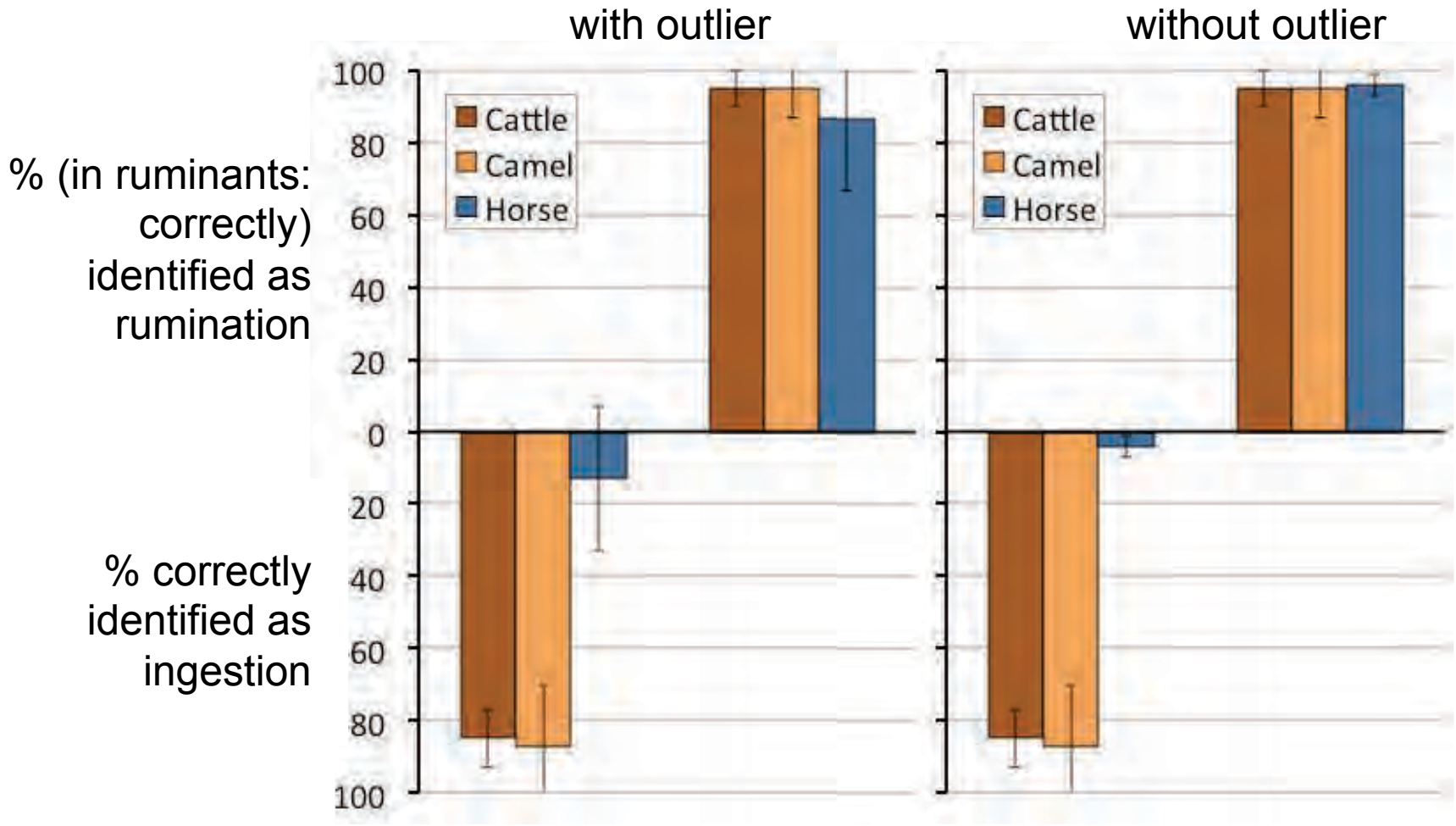

Methods

Rumiwatch measurements (additional software):

3. Visualisation of raw data

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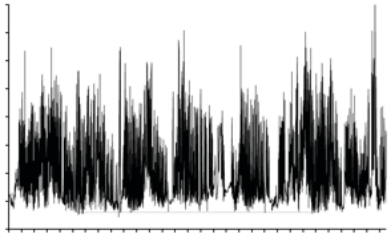

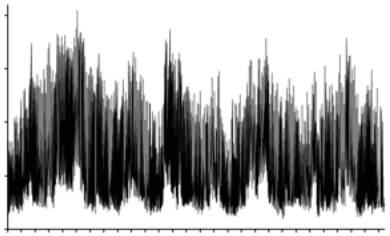

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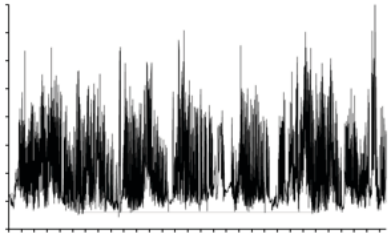

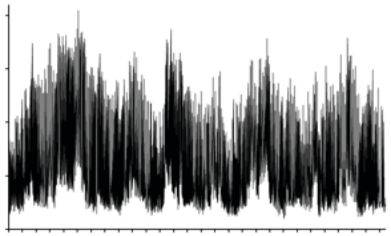
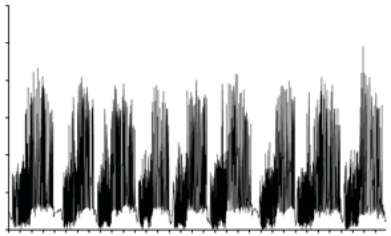

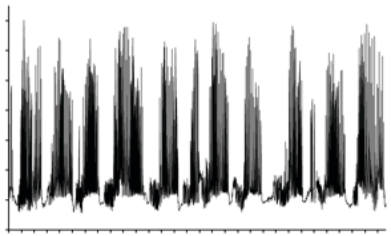

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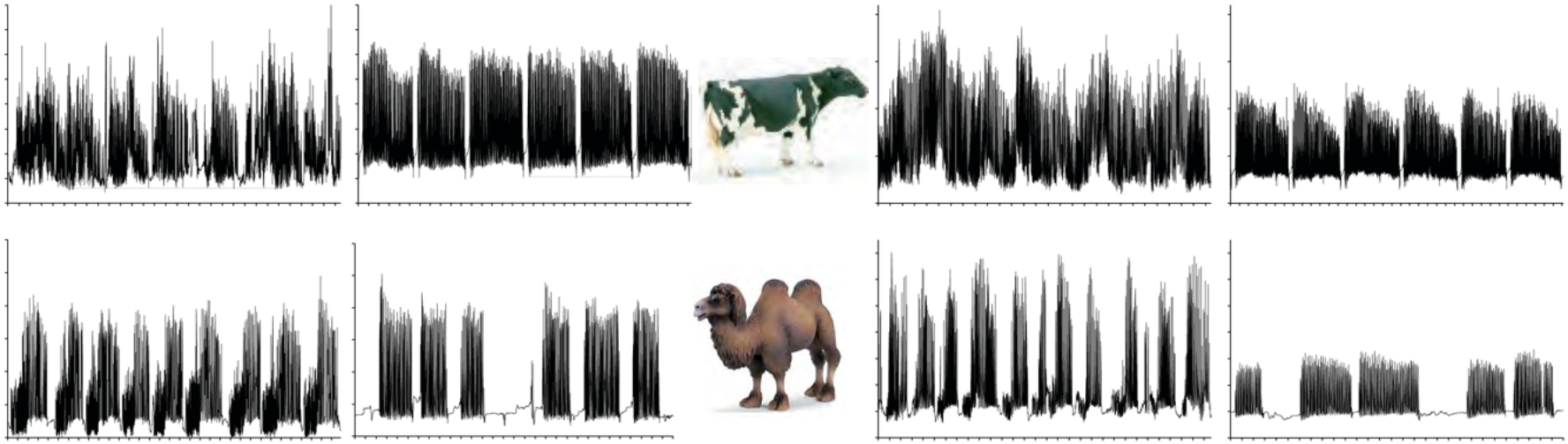

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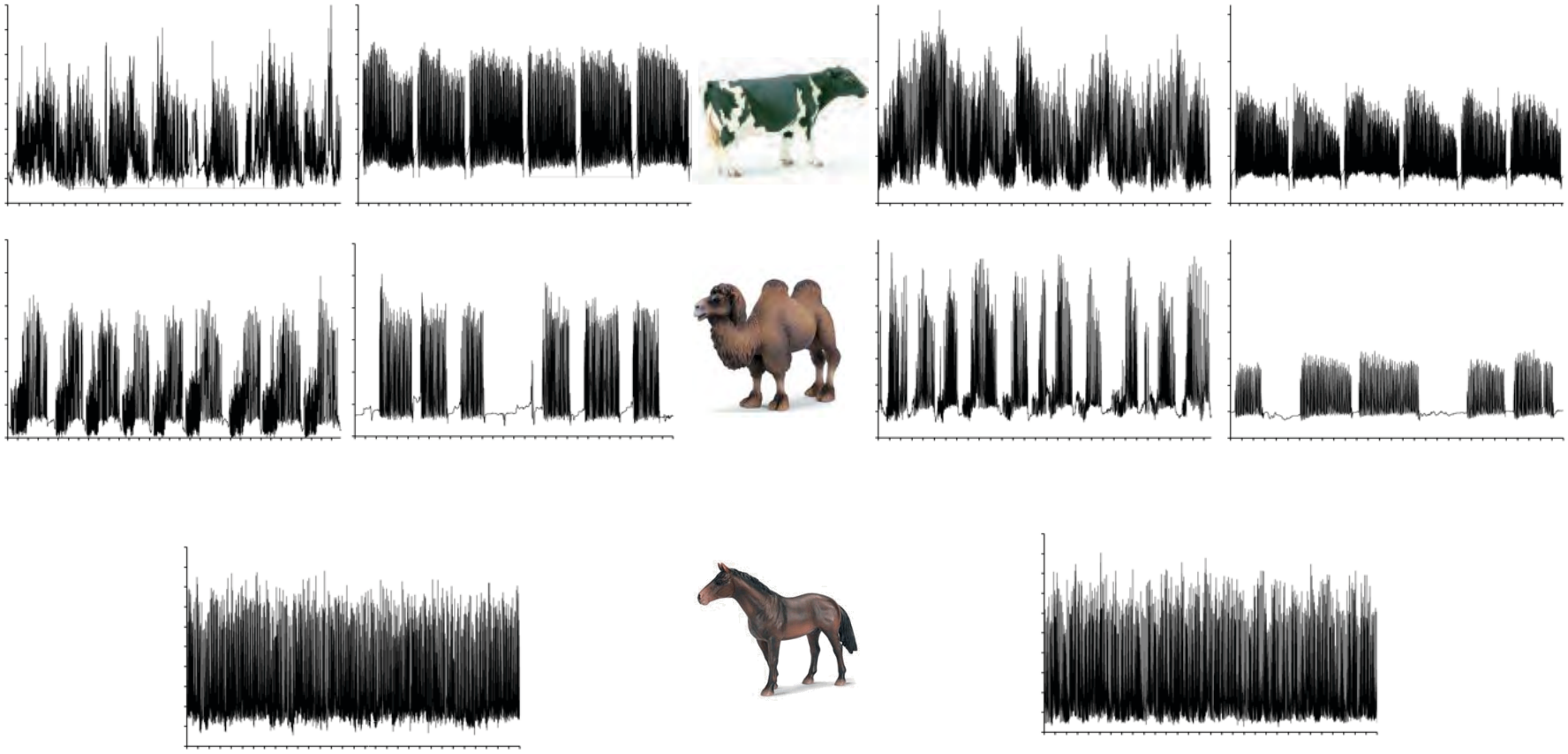
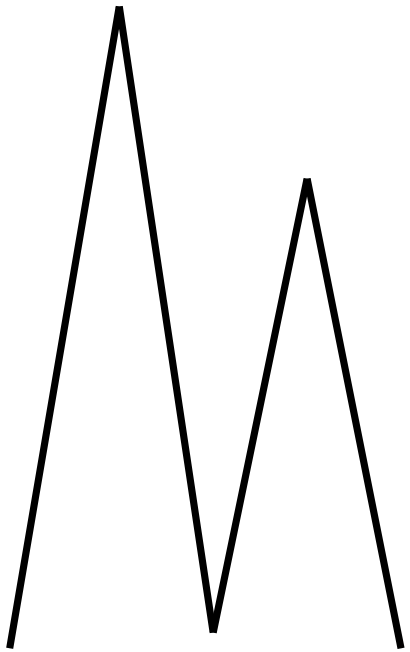


Methods

Rumiwatch measurements (additional software):

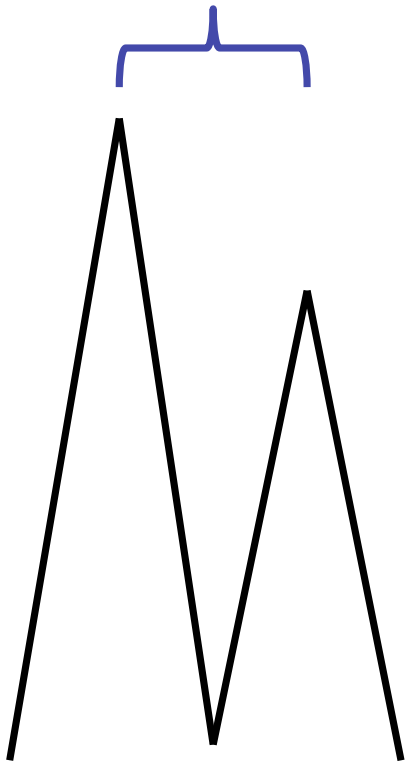
4. for 10 subsequent chewing bouts: calculation of standard deviation of



Methods

Rumiwatch measurements (additional software):

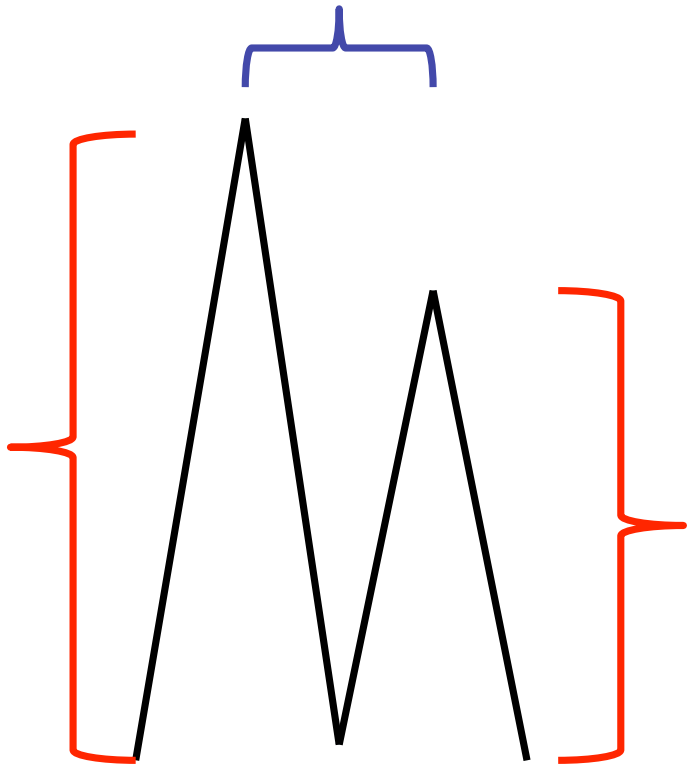
4. for 10 subsequent chewing bouts: calculation of standard deviation of Peak interval (s)



Methods

Rumiwatch measurements (additional software):

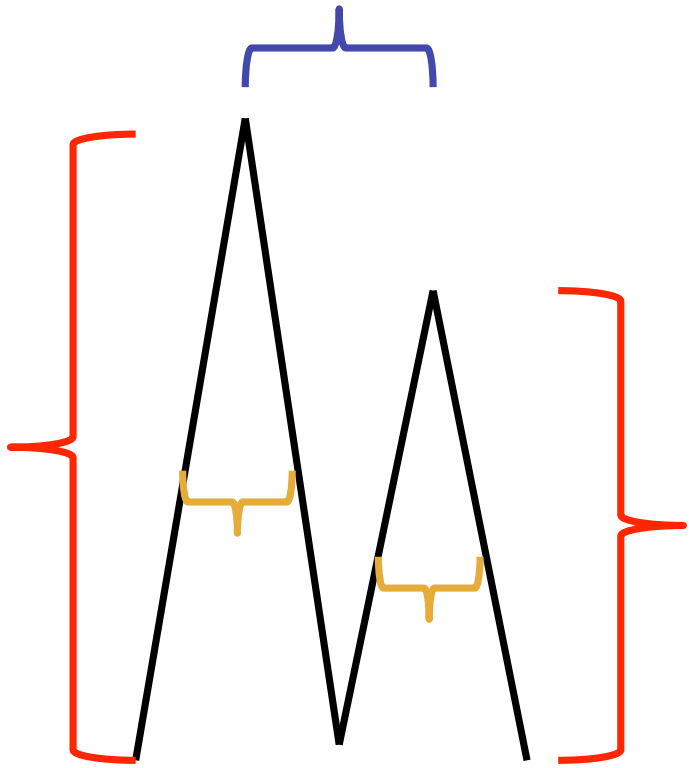
4. for 10 subsequent chewing bouts: calculation of standard deviation of Peak interval (s), Peak height (no unit)



Methods

Rumiwatch measurements (additional software):

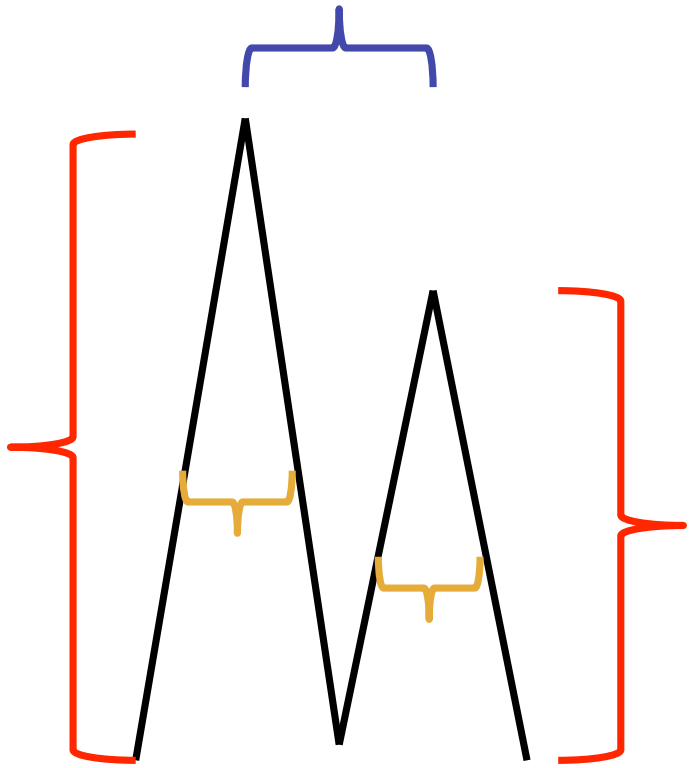
4. for 10 subsequent chewing bouts: calculation of standard deviation of Peak interval (s), Peak height (no unit), Peak breadth (s)



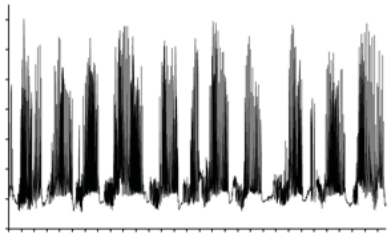
Methods

Rumiwatch measurements (additional software):

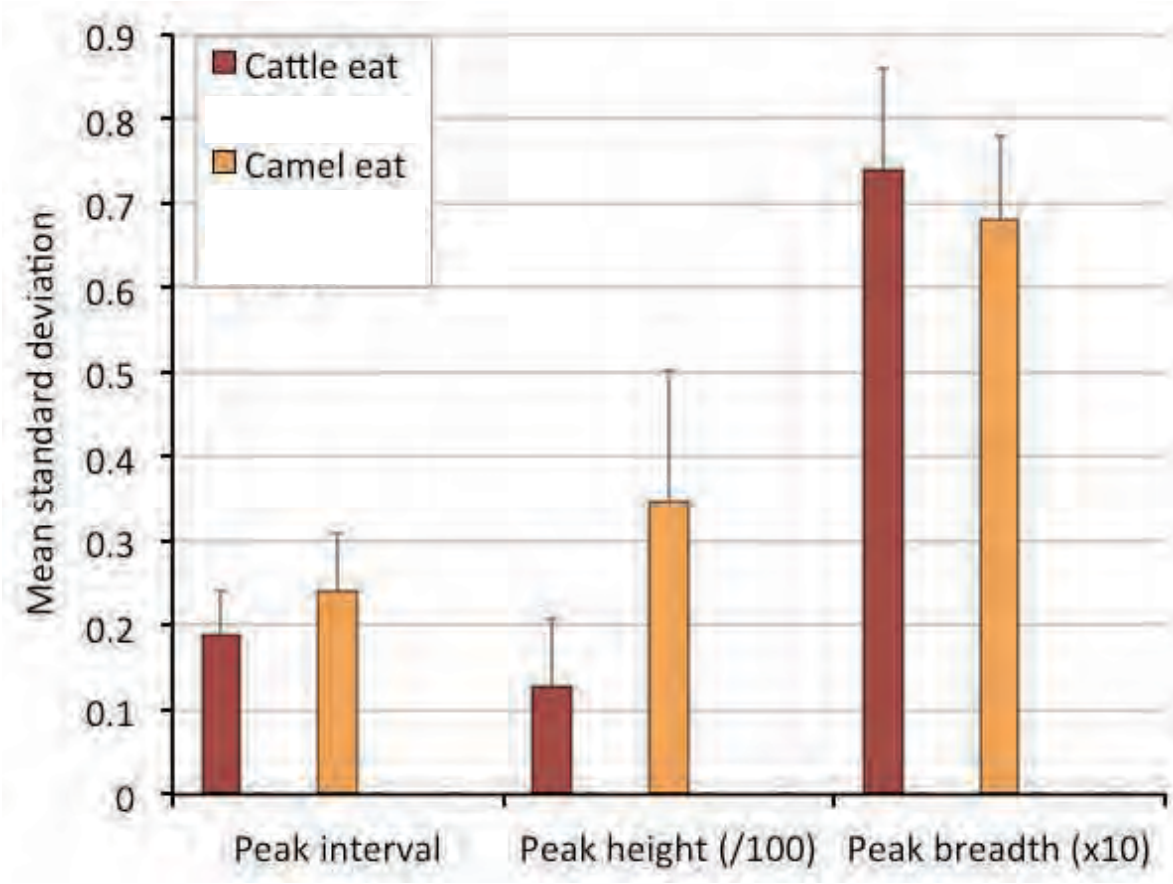
4. for 10 subsequent chewing bouts: calculation of standard deviation of Peak interval (s), Peak height (no unit), Peak breadth (s)

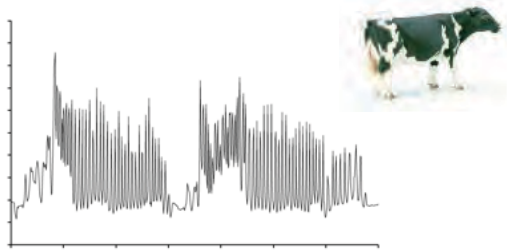


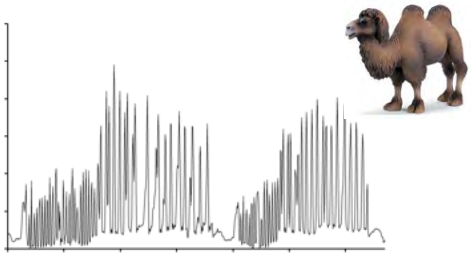
5. Calculation of the average SD of the 10 chewing bouts



Results: Chewing regularity







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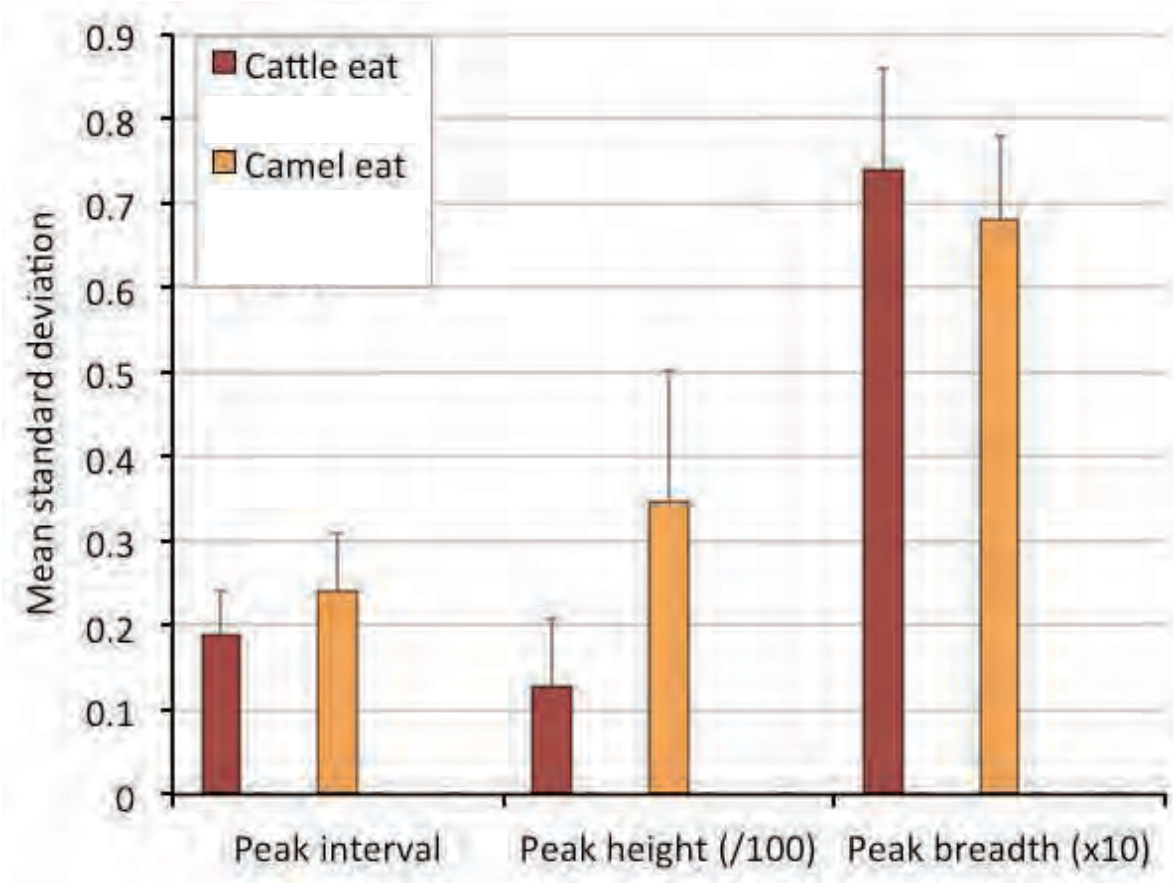

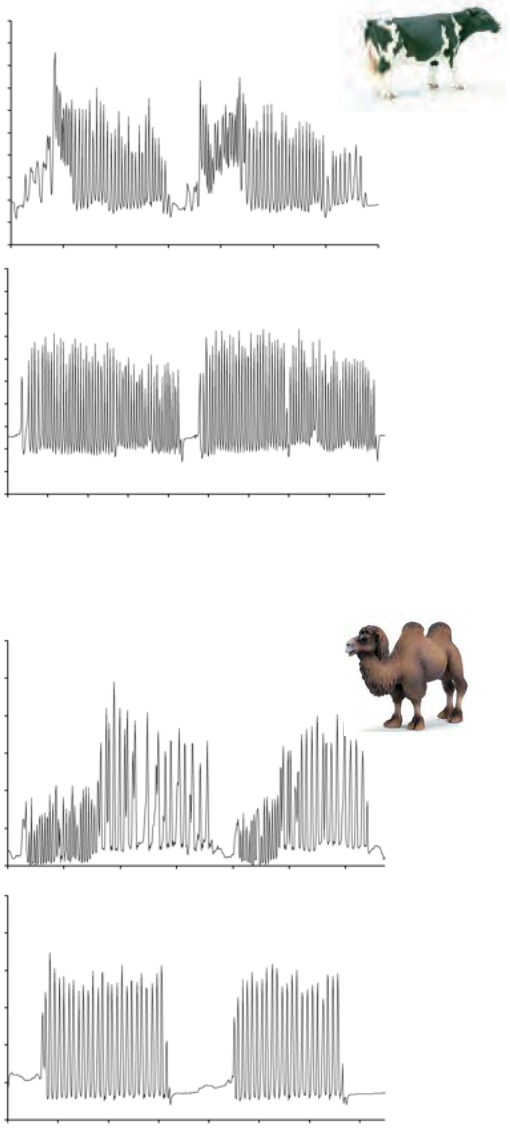

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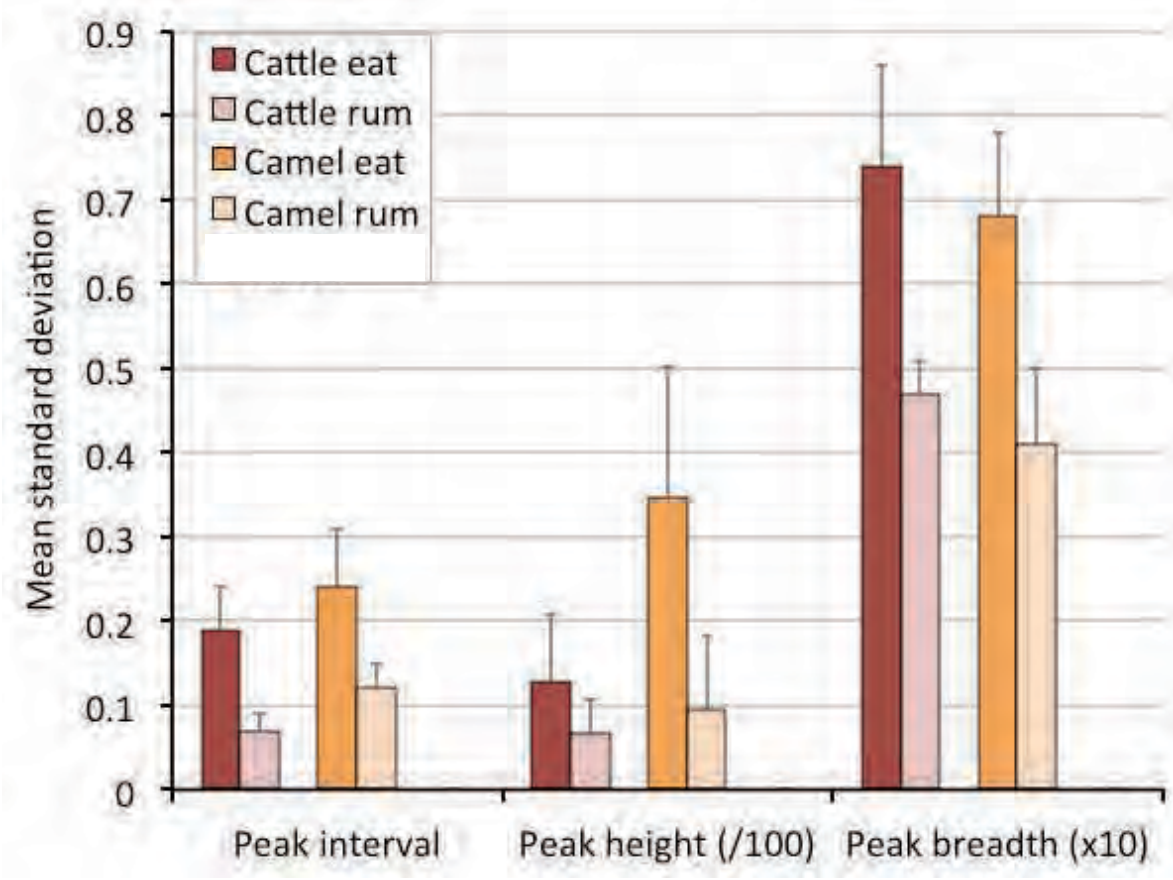

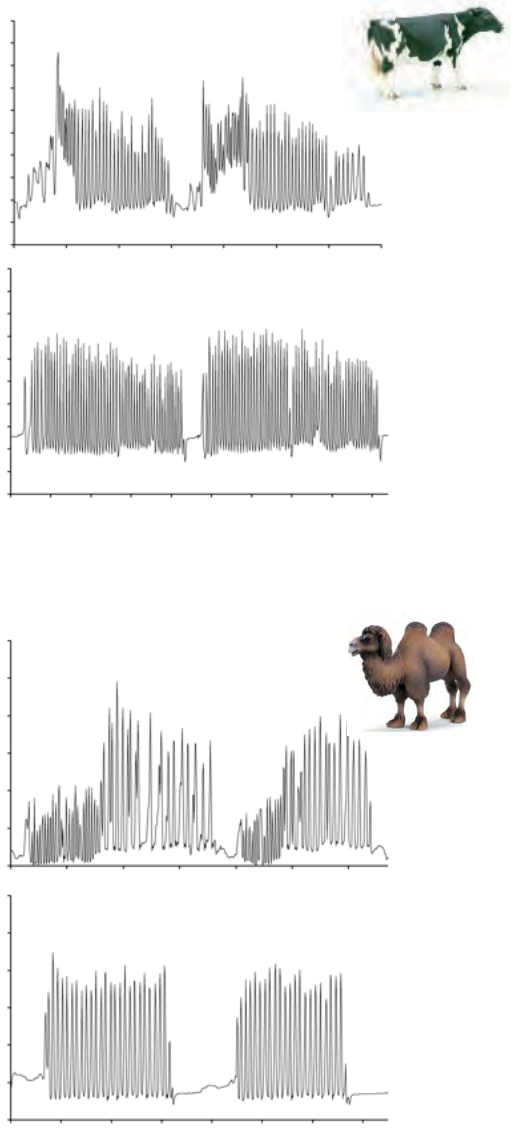

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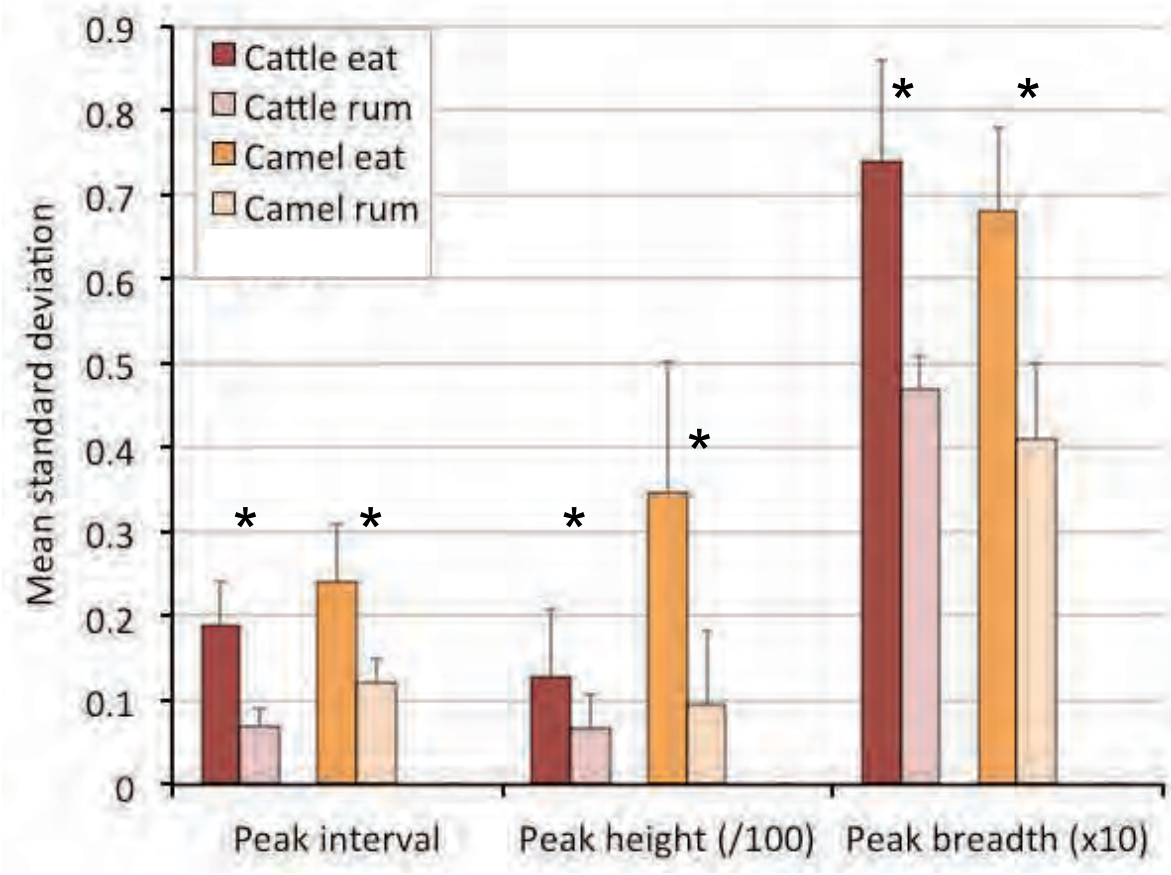

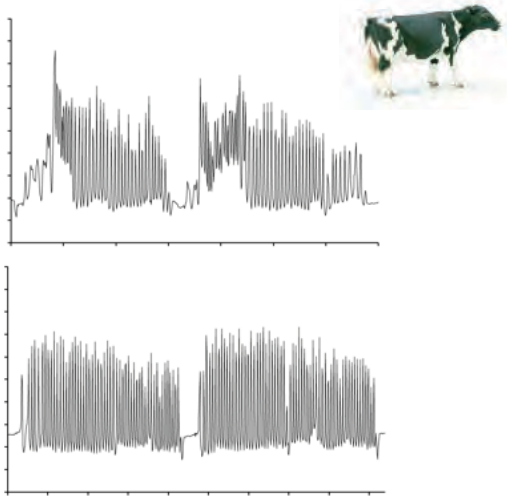

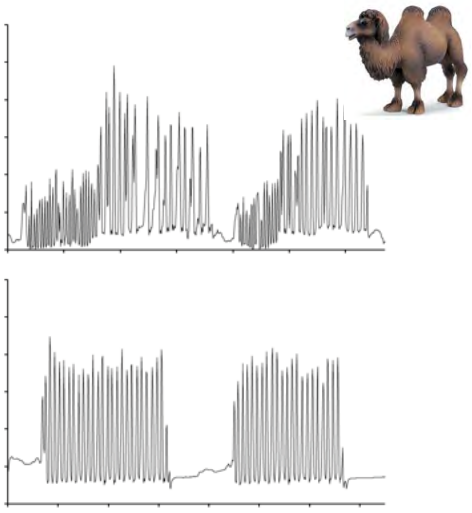

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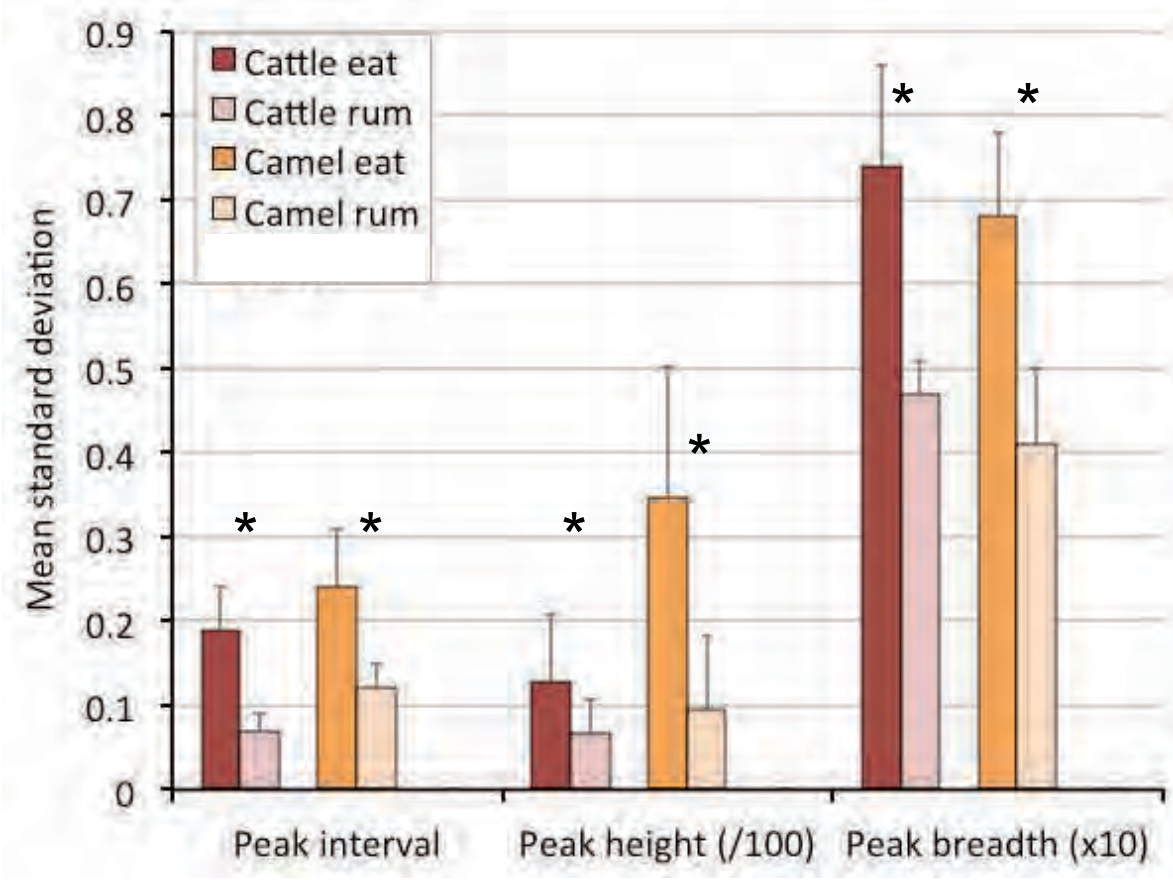

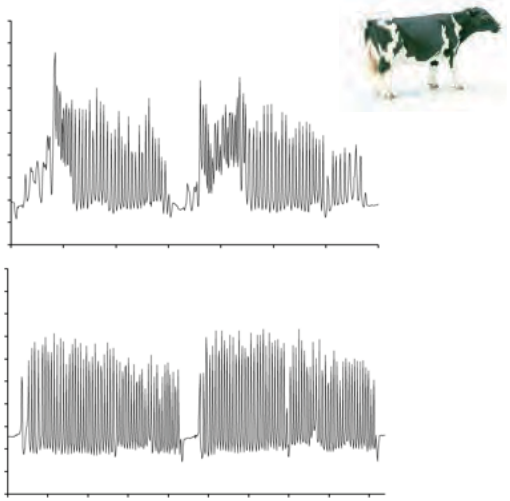

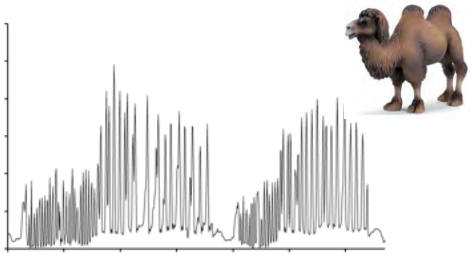

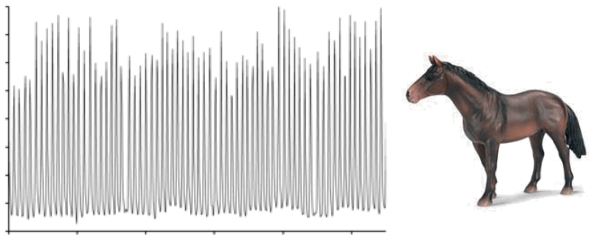

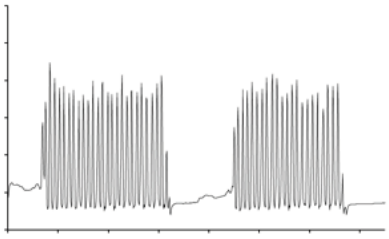

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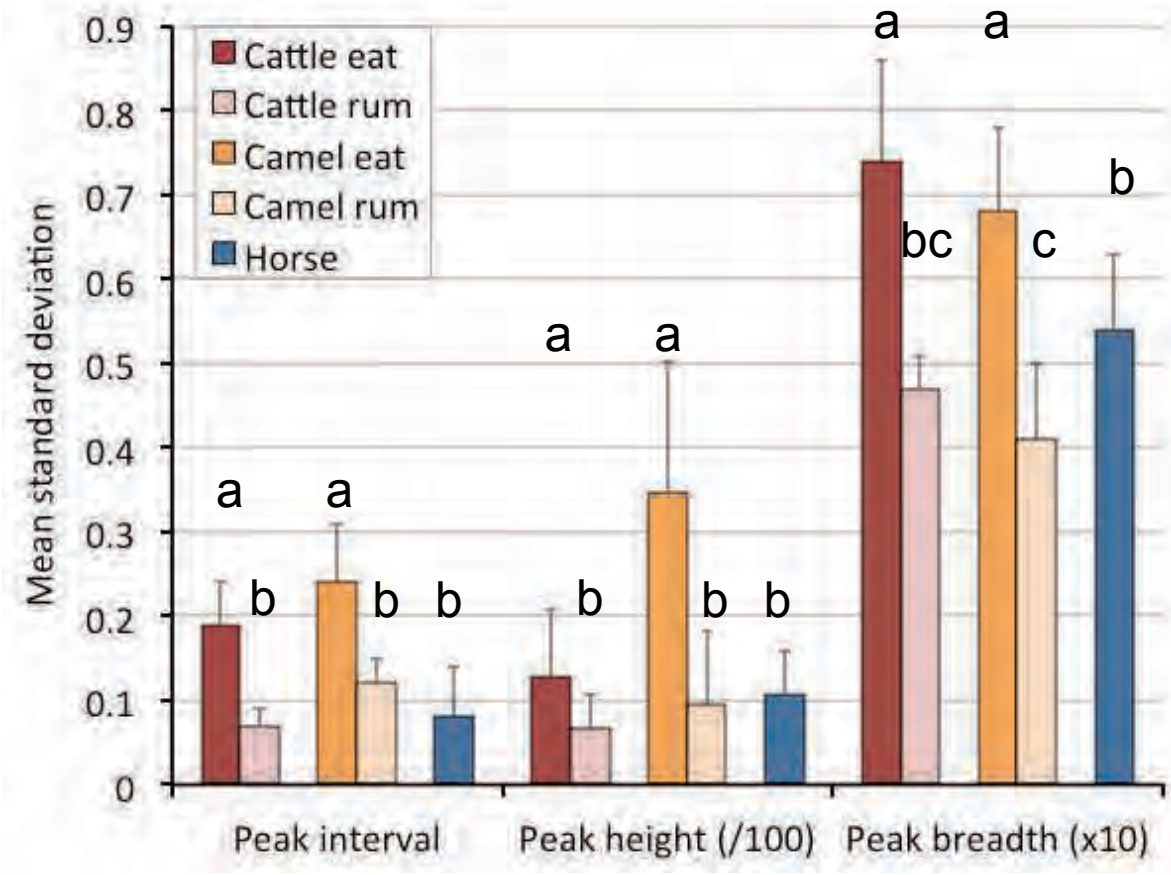
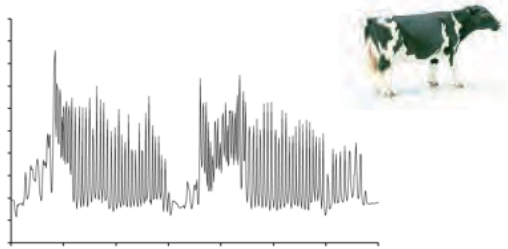
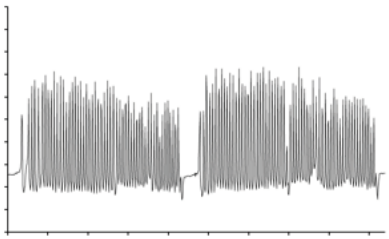
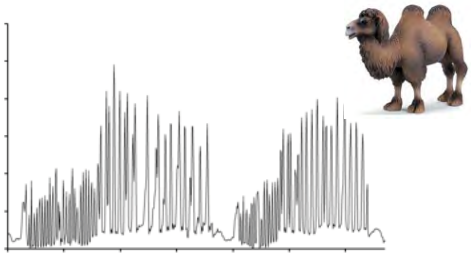
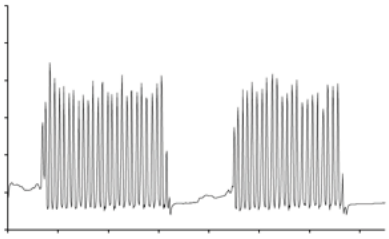
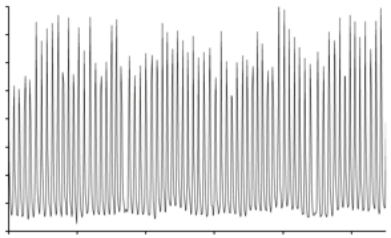




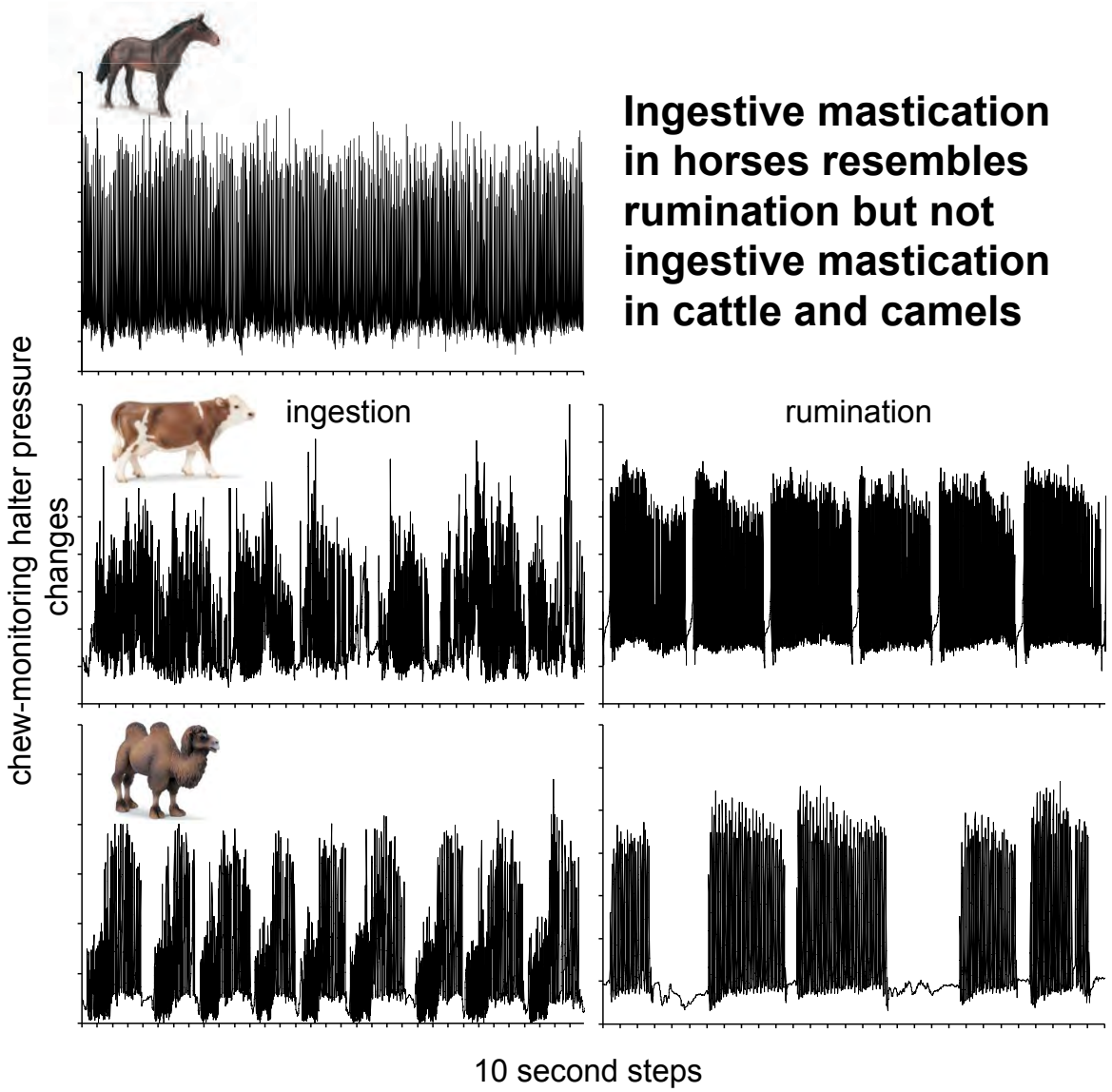






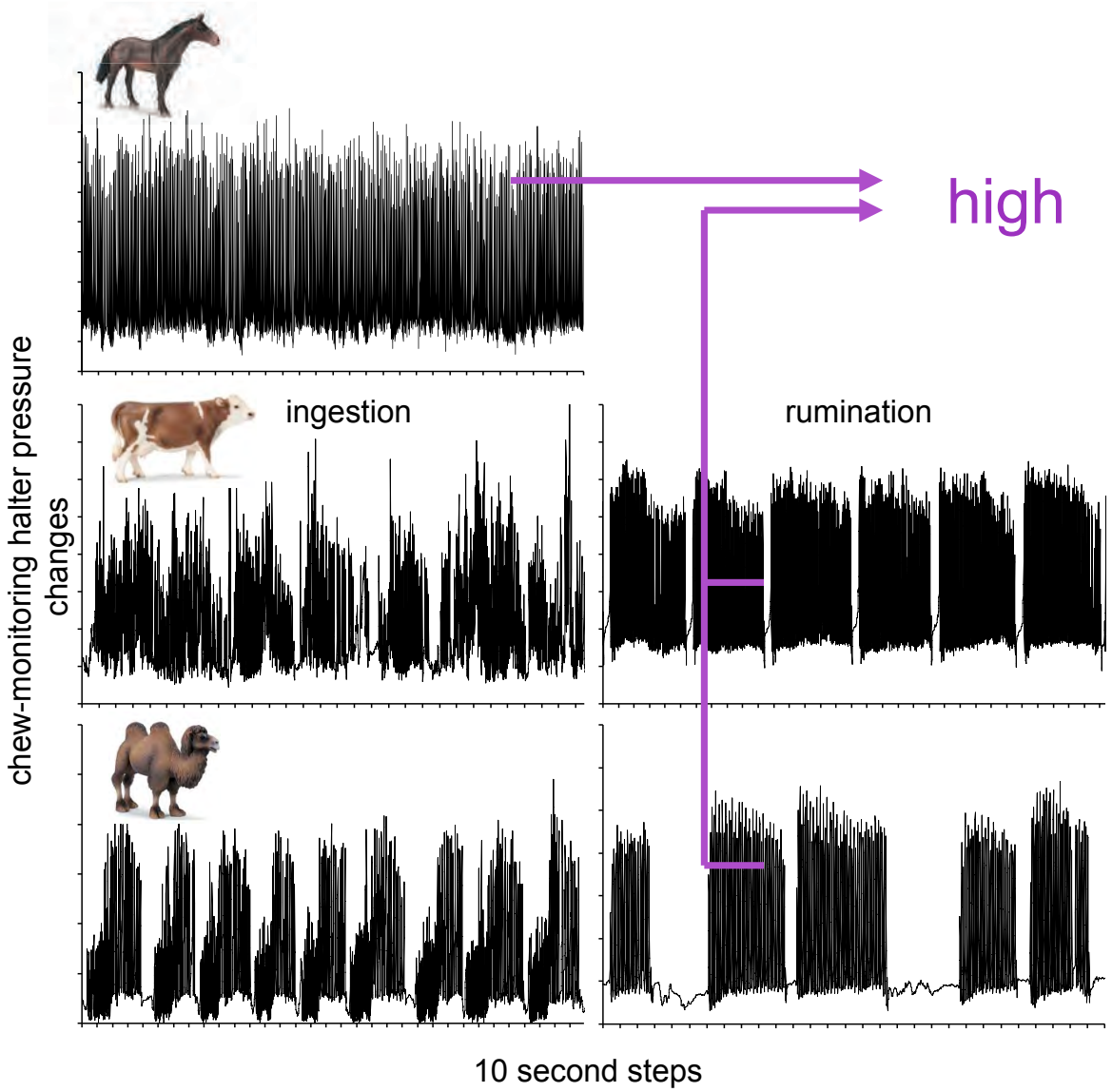


Conclusion



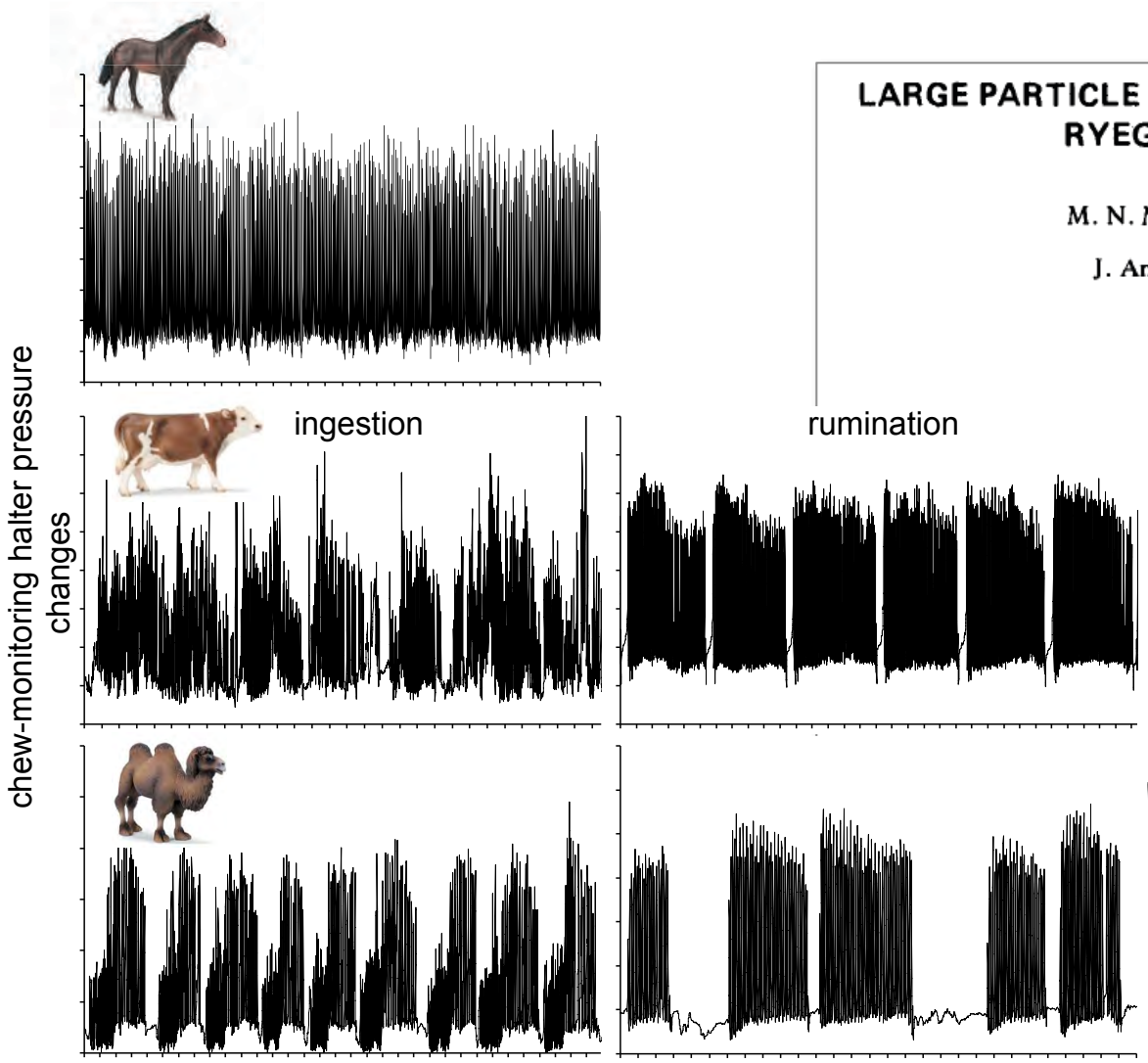
Ingestive mastication in horses resembles rumination but not ingestive mastication in cattle and camels

Conclusion



degree of particle size reduction

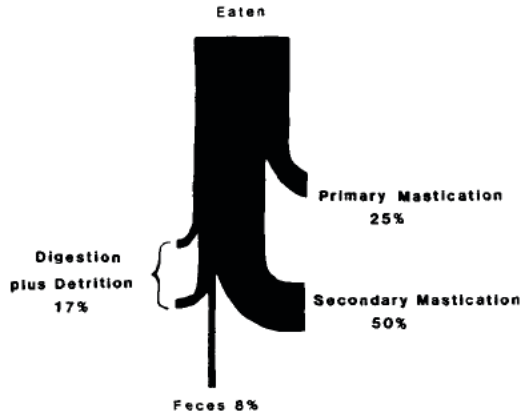
Conclusion



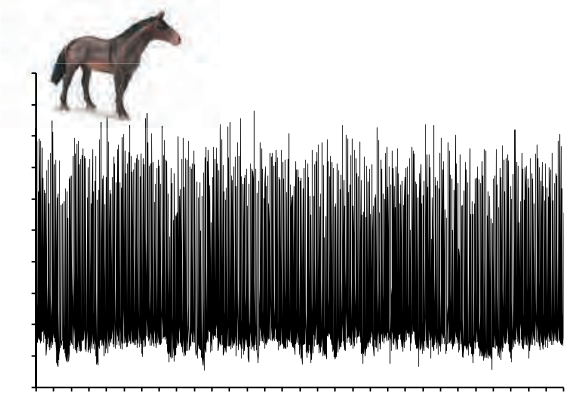
LARGE PARTICLE BREAKDOWN BY CATTLE EATING RYEGRASS AND ALFALFA

M. N. McLeod[1] and D. J. Minson[1]

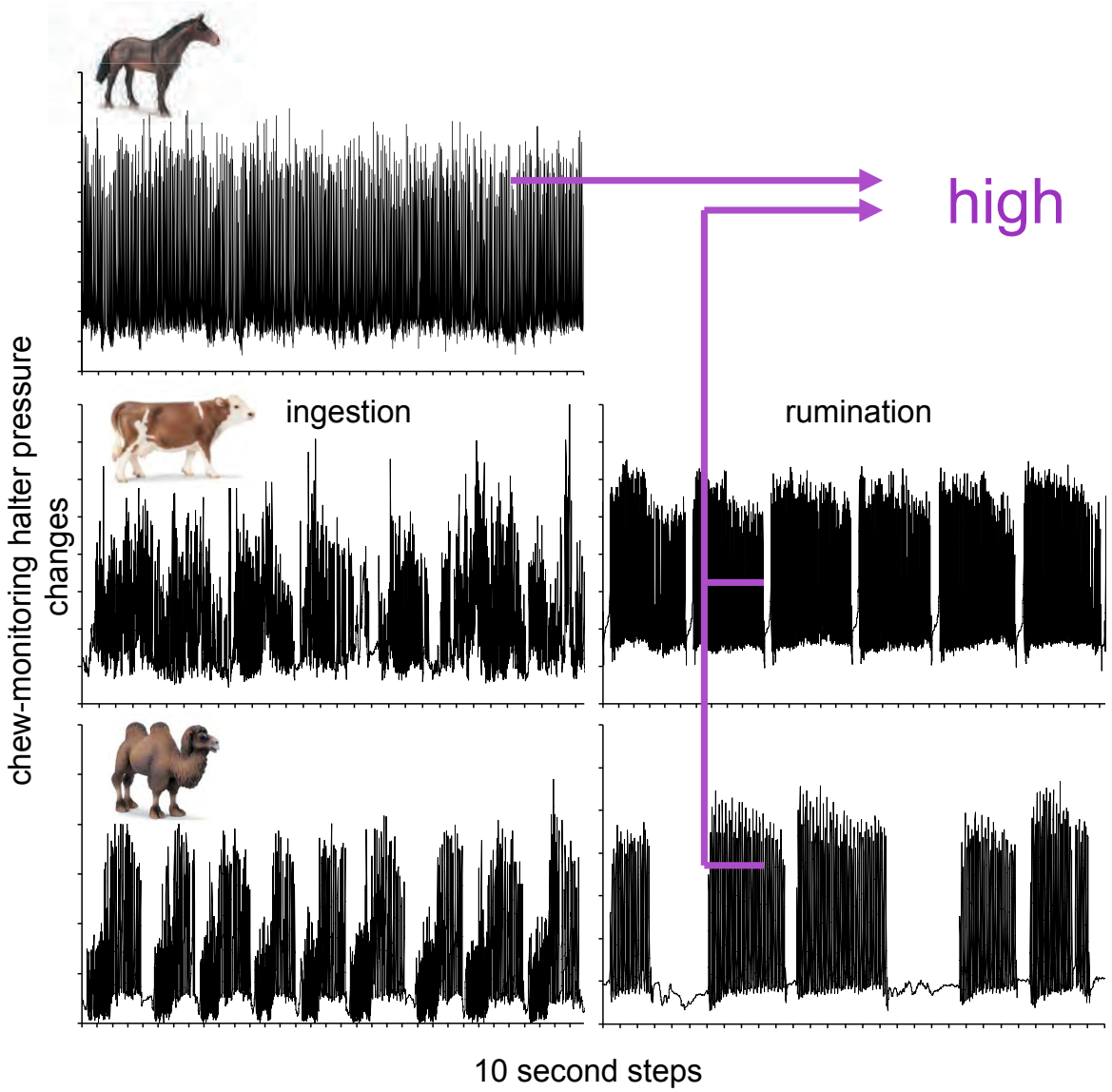
J. Anim. Sci. 1988. 66:992–999



Conclusion



but the really intriguing question is ...



degree of particle size reduction

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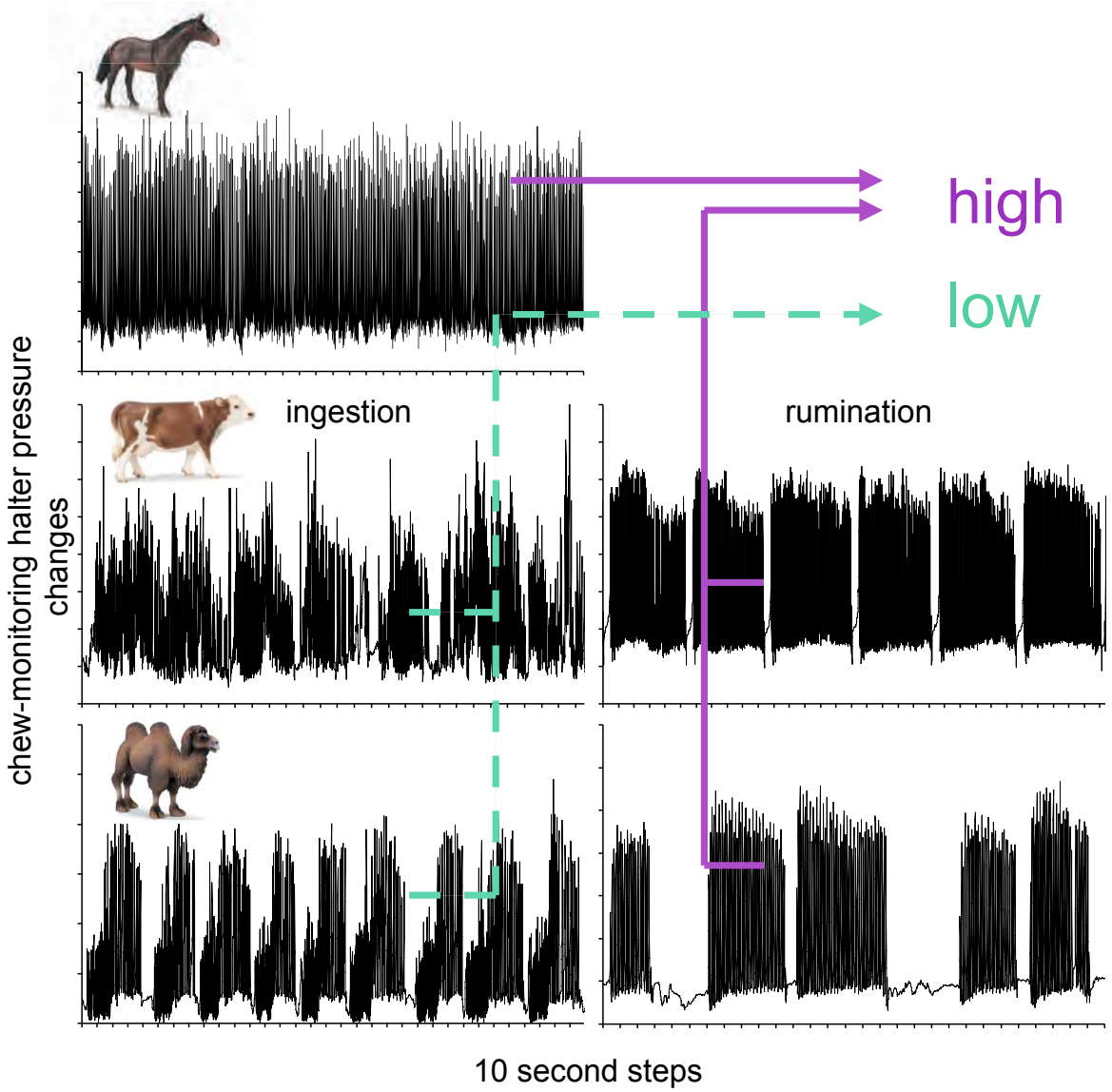
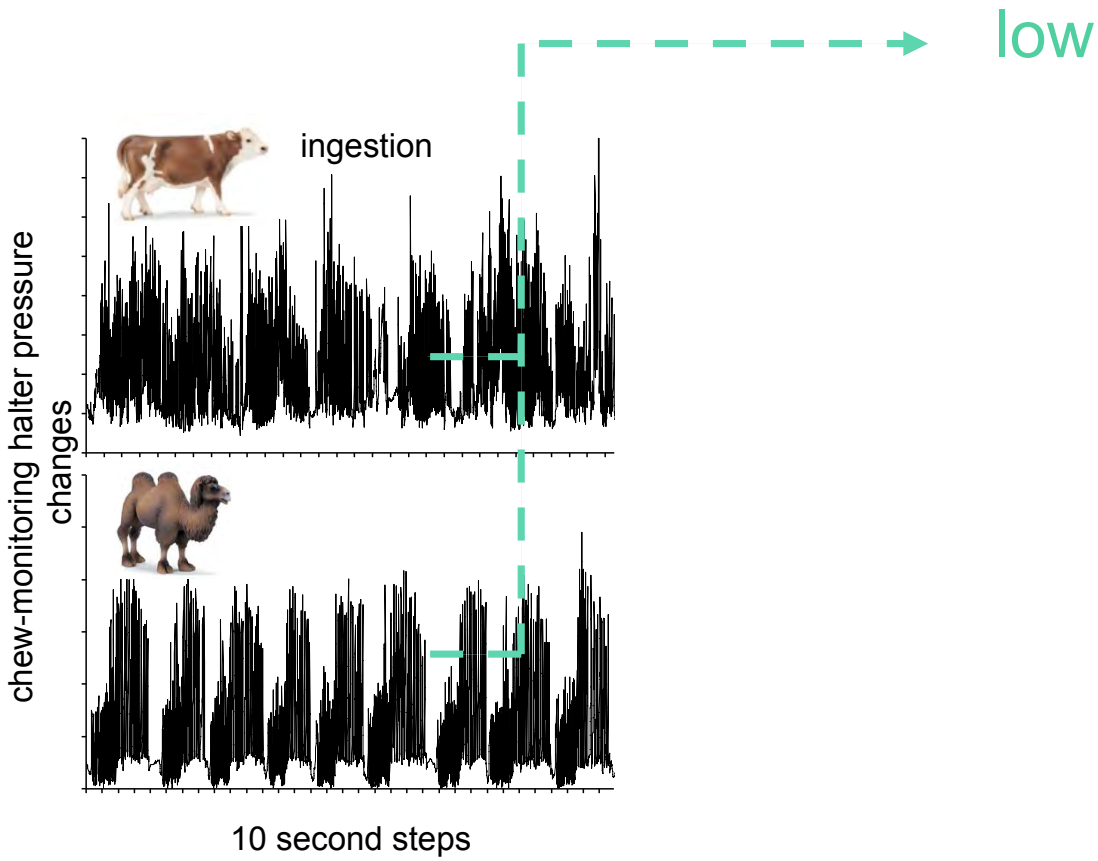


degree of particle size reduction

but the really intriguing question is ...

... why do ruminants chew so 'erratically' during ingestion?



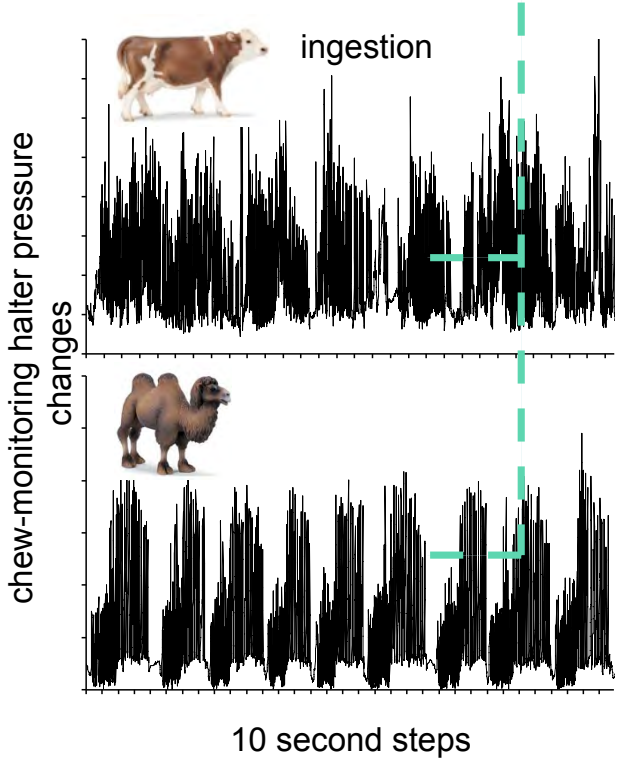
degree of particle size reduction

but the really intriguing question is ...

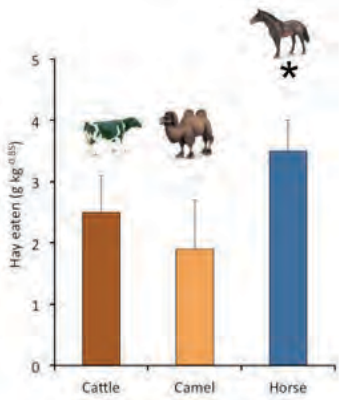
... why do ruminants chew so 'erratically' during ingestion ...

degree of particle size reduction

low



... when it is not for a higher food intake?



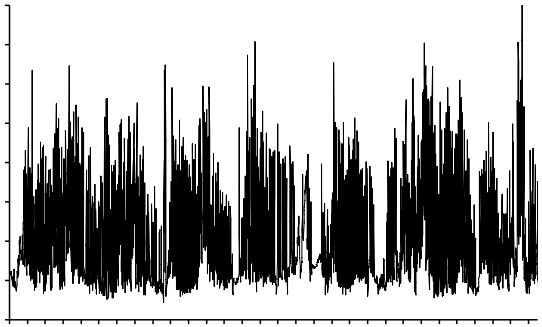
but the really intriguing question is ...

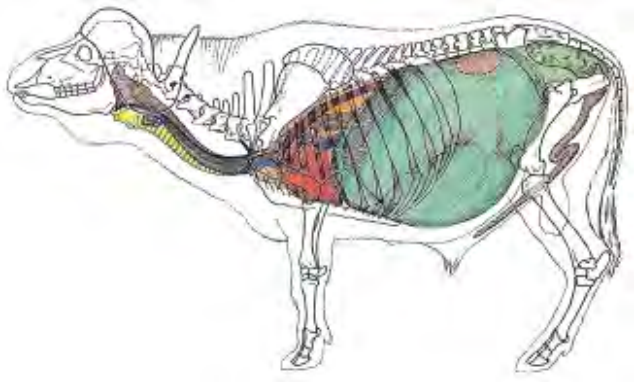
If an optimization of the particle size reduction rate was the sole aim of the ruminants' digestive physiology, they should employ a regular, grinding stroke already during ingestion.

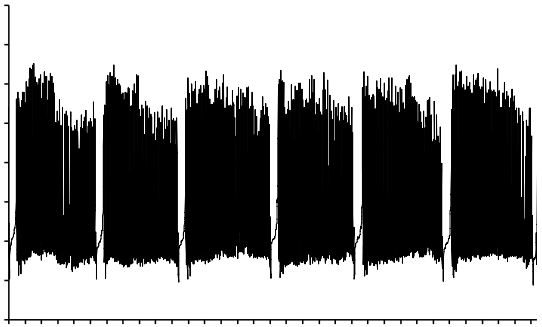
An additional ruminant advantage?

Ruminant chewing strategy:

Employ wear-intensive regular grinding strokes only after ingesta has been washed, i.e. cleared of grit and dust, in the rumen?







Research question

Does ruminant ingestive chewing vary systematically with the degree of grit/dust contamination?

Thank you for your attention

FNSNF
Swiss National Science Foundation