






Peer Community In Animal Science

A guide to improving the use of activity data in animal research

Matteo Chincarini  based on peer reviews by **Birte L Nielsen**  and **Anna Olsson** 

Ingrid D.E. van Dixhoorn, Lydiane Aubé, Coenraad van Zyl, Rudi de Mol, Joop van der Werf, Romain Lardy, Marie Madeleine Mialon, Kees C.G. van Reenen, and Isabelle Veissier (2024) From data on gross activity to the characterization of animal behaviour: which metrics for which purposes? Zenodo, ver. 5, peer-reviewed and recommended by Peer Community in Animal Science. <https://doi.org/10.5281/zenodo.10420600>

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In production animals, behavioural activity plays a crucial role across a wide range of scientific disciplines and is often measured for various purposes depending on the field: ethology, animal welfare, reproduction, animal production, and so on. Historically, direct observation was the primary method of collecting such data, a process that was time-consuming and prone to possible observer bias. With the advent of automated systems and sensors, behavioural activity can now be recorded continuously and non-invasively, leading to a growing body of more reliable data (1). However, the lack of standardisation in how these data are calculated and interpreted has created challenges for cross-study comparisons. To fully harness the potential of studying behavioural activity, scientific studies must harmonise the methods used to calculate this measure. Standardising these methods would make it easier to compare results and identify possible gaps in knowledge.

In the work by van Dixhoorn et al.(2), the authors examine the various metrics most commonly used to study behavioural activity. Through a series of examples, they address the definitions, calculation methods, and biological significance of metrics such as overall activity, fluctuations around mean activity, cyclicity of activity, and synchrony between animals. The authors suggest how these different metrics can be applied in specific contexts and guide readers in using appropriate terminology to ensure future studies are more easily comparable. In addition, by clarifying these concepts, the authors provide researchers with the tools to make informed decisions about which metric best suits their study's objectives.

A key contribution of this work is its emphasis on standardising the metrics and terminology used in behavioural activity studies. Studies using different metrics may arrive at conclusions that appear contradictory, not because of actual differences in animal behaviour, but due to inconsistencies in how behaviour is quantified.

By advocating for a common framework, the authors aim to improve the replicability of studies, facilitate meta-analyses, and allow for a more cohesive understanding of animal behaviour across different research groups. This, in turn, could accelerate the identification of key behavioural indicators, ultimately leading to better animal management practices and welfare assessments.

This article provides a timely and valuable contribution to the field of animal science. As technology continues to evolve, so too must our methods for interpreting the vast amounts of data it generates (3). By ensuring that studies are comparable and data is interpreted consistently, the research community can work towards more meaningful discoveries in animal behaviour. I highly recommend this paper to researchers looking to deepen their understanding of activity metrics in animal behaviour studies.

References:

1. Rushen J, Chapinal N, de Passilé AM (2012). Automated monitoring of behavioural-based animal welfare indicators. *Animal Welfare* 21(3):339-50. <https://doi.org/10.7120/09627286.21.3.339>
2. van Dixhoorn IDE, Aubé L, van Zyl C, de Mol R, van der Werf J, Lardy R, Mialon MM, van Reenen CG, and Veissier I (2024). From data on gross activity to the characterization of animal behaviour: which metrics for which purposes?. Zenodo, 10420600, ver.5 peer-reviewed and recommended by PCI Animal Science. <https://doi.org/10.5281/zenodo.10420600>
3. Riaboff L, Shalloo L, Smeaton AF, Couvreur S, Madouasse A, Keane MT (2022). Predicting livestock behaviour using accelerometers: A systematic review of processing techniques for ruminant behaviour prediction from raw accelerometer data. *Computers and Electronics in Agriculture* 192:106610. <https://doi.org/10.1016/j.compag.2021.106610>

Reviews

Evaluation round #2

DOI or URL of the preprint: <https://doi.org/10.5281/zenodo.10420600>

Version of the preprint: 4

Authors' reply, 01 October 2024

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Decision by Matteo Chincarini , posted 23 September 2024, validated 24 September 2024

Dear authors,

Thank you for thoroughly addressing the reviewers' comments. The manuscript is both interesting and valuable, and it is nearly ready for recommendation. I have just a few final suggestions to ask you.

As one of the previous reviewers suggested, please consider replacing the term "review" with another term (maybe "overview?") that better reflects the nature of the manuscript. Additionally, there are still inconsistencies in font styles and bold text throughout the document; please harmonize the formatting. Lastly, please double-check the reference list, as not all cited works appear to be included.

Please refer to the attached PDF for my detailed comments.

Best regards, [Download recommender's annotations](#)

Evaluation round #1

DOI or URL of the preprint: <https://doi.org/10.5281/zenodo.10420600>

Version of the preprint: 2

Authors' reply, 06 September 2024

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Decision by [Matteo Chincarini](#) , posted 30 April 2024, validated 30 April 2024

Revision_1

Dear authors,

thanks for submitting your paper.

The reviewers have provided valuable feedback, and I kindly ask you to consider their suggestions.

Please, revise your manuscript accordingly and submit the revised version.

Best regards,

Matteo

Reviewed by [Anna Olsson](#) , 18 March 2024

Review by Anna Olsson and Gabriela Morello

Does the title clearly reflect the content of the article? x Yes

Does the abstract present the main findings of the study? x Yes

Are the research questions/hypotheses/predictions clearly presented? n/a

Does the introduction build on relevant research in the field? x Yes

Are the methods and analyses sufficiently detailed to allow replication by other researchers? Not really applicable, but see our comment on the value of illustrating the formulas with examples.

Are the methods and statistical analyses appropriate and well described? n/a

In the case of negative results, is there a statistical power analysis (or an adequate Bayesian analysis or equivalence testing)? n/a

Are the results described and interpreted correctly? n/a

Have the authors appropriately emphasized the strengths and limitations of their study/theory/methods/argument? Yes

Are the conclusions adequately supported by the results (without overstating the implications of the findings)? Yes

This paper gives an overview of how to use activity metrics to make inferences about animals' behaviour, health, physiological status and social relations.

The paper provides a useful introduction to / overview of methods. It doesn't seem appropriate to refer to it as a "review", as there is no attempt to systematically and comprehensively review the literature in the field, and very little critical discussion of different approaches. This is not a criticism against the paper itself, but in order not to misrepresent what this is, the term review when referring to the paper itself (e.g. on lines 88-89) should be avoided.

The paper assumes that the reader is familiar with the language of mathematical formulas. It would be helpful for readers who are not if a calculated example was given for each of the formulas. It would make the paper more interesting if these examples were from real research, especially perhaps that of the authors, so that they would be able to reflect briefly on the outcome of the metrics. This could be summarized in a table.

Line 39 The second sentence of the introduction should refer to farm animals (e.g. "In farm animals, activity measurements have long been used to identify". Activity levels can be and are measured in all sorts of animals and contexts, but all the cited examples are of farm animals, and they are also the focus of the paper.

Line 58 "creates a high workload" or "requires a lot of work"

Line 95: Typo "proces"

Line 98: Typo "obbservations"

Lines 107-108 For the context, the important aspect is not "focal" (meaning it focuses on one animal) but "continuous". The definition you provide is "[observers] note changes in activity with reference to the time of the change occurrence". This is a difficult sentence to read and probably not enough to explain the concept to somebody who doesn't already know what continuous sampling is.

Line 137 Does the number within parentheses to the right refer to the formula? If so, one would expect formulas to be 1, 2, 3, 4, 5, 6, 7, 8, but the numbers now are 1, 1, 2, 3, 4, 5, 6, 9.

Line 157: Could you please explain "edge effects", perhaps between parenthesis, just in case readers have not an ecology background.

Line 164 and 171:" ...number of times an animal changes OF activity". Please, re-word (e.g. number of times an animal changes between activities).

Line 164: Please clarify "same level of details" as what?

Lines 166-167 This is not clear. Please define gross activity. Also, it is not obvious why sensors would provide adequate measures of gross activity and direct observations wouldn't, so please explain.

Lines 190 onwards The section on activity level is written as if there is one single consensual way of defining activity level, which is based on attributing a weight to each type of activity according to the level of arousal it is perceived to represent. This is not the case. There are many ways of defining "activity level". For example, this paper (shelter dogs) uses step count <https://doi.org/10.1016/j.applanim.2022.105614>. This paper (wild animals) defines activity level much more generally, simply as whether animals are moving about so that they will be captured by an activity camera <https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/2041-210X.12278>. You may want to cover only your own definition but you need to say that this is one way of defining activity level, and perhaps justify why this is the one you consider most relevant in the context.

Line 210: "... in case of" – Please re-word (eg. Lying time is reduced when lying areas are uncomfortable).

Line 246-247: This is not always true. Distressed animals due to a disease, for example, may change between activities less often.

Line 258-259: Repeated information of Lines 246-247.

Line 269: Please clarify what is meant by "at animal level". Do you mean it instead of at the herd level? If so, please state that, so that this is not confused with level being an information of position within the animals' surroundings (as for example in the statement: temperature measurements were done at top of the pen, instead of at the animal's level).

Line 270: Please replace "at least several days" for the actual number of days (or a range).

Line 282: typo "re".

Line 312: I suggest "at some time-points throughout the day" or "sometimes" during the day (without "at").

Line 329: Please, clarify what is meant by "disturbed". Do you mean if their homeostasis is disturbed? Or if anything may happen with the animals (such as an activity is interrupted)?

Line 354: Please, state somewhere between parenthesis what is AFC (e.g. Autocorrelation Function (AFC)).

Also, for those with no math background, X may be easily thought to be the independent variable, often represented in the x-axis, which is not the case in these functions. I suggest that somewhere x is explained as

in “Let x be the number of measured behaviour events (e.g. duration, frequency, etc), and “ l ” the amount of time that has passed (lag l)”.

Line 375: Please, clarify what are the units of measurement of the terms exemplified for the application of the Fourier Transform (for example, fundamental (h_0) is the average activity in terms of frequency? Duration?).

Line 416: Post-partum periods may not always be high-risk, please replace this term.

Figure 2: Please, add unit of lag (seconds?). Please, write in full Root Mean Squared Error (RMSE).

Line 445 something is wrong with this sentence?

Line 505 Please rewrite to something like “It must be considered whether social facilitation of an activity can be expected”

Line 509-510 This sentence is difficult to understand

Line 511 “bond”, not “bound”

Line 522 You probably mean “bonded” rather than “bound”?

Line 483: Please add somewhere between parenthesis that capital P refers to proportion.

Reviewed by [Birte L Nielsen](#) , 23 April 2024

The article is a timely and useful contribution to help with the analysis and interpretation of the ever-increasing data flow coming from livestock production systems that includes behavioural and physiological measures. Their aim to improve comparisons between studies, and to extend the use of activity data beyond ethologists, as well as ease the re-use of datasets, is highly commendable.

Although the paper doesn't cover the data collection and data validation per se, the authors wisely raise some of the issues that need to be considered when analysing data from animals monitored within a housed environment. For example, when using data on lying time in cows, the authors emphasise that in cubicle housing the length of the space provided may affect whether or not the animal remain standing or not. The inclusion of biological meaning for each of the four groups of metrics, makes this article an even more useful tool for the analysis and interpretation of behavioural activities within and between individual animals.

In the attached PDF file, I have added my comments and suggestions – most of which are minor, and related to the use of language.

Best wishes,

Birte Nielsen

[Download the review](#)