Dr. Aaron Ellison,

Executive Editor,

Methods in Ecology and Evolution

Dear Dr. Ellison

We would like to thank the two reviewers for their thoughtful and helpful comments, and for your willingness to consider revisions on our manuscript **“Quantifying degradation in animal acoustic signals with the R package baRulho”** MEE-23-12-736.R1 We are grateful for the reviewer’s detailed and constructive input and think that their suggestions substantially improved our manuscript.

Below, we address the reviewers’ comments and suggestions regarding the resubmission of our manuscript. We believe we have thoroughly addressed their concerns. Reviewer concerns are shown in italic and our responses in normal font in this letter and have used Microsoft track changes to document revisions throughout the document.

We hope that the revised version of the manuscript proves suitable for MEE and look forward to hearing from you in due course.

Sincerely,

Marcelo Araya-Salas

Centro de Investigación en Neurociencias & Escuela de Biología,

Universidad de Costa Rica, San José, Costa Rica

12-Sep-2024

MEE-23-12-736.R1 Quantifying degradation in animal acoustic signals with the R package baRulho

Dear Dr Marcelo Araya-Salas,

Thank you for submitting your manuscript to Methods in Ecology and Evolution. I have now received the reviewers' reports and a recommendation from the Associate Editor who handled the review process of your revision. Copies of their reports are included below. The reviewers recognize that the manuscript has the potential to make a valuable contribution to the area, but Reviewer 3 identifies a number of significant concerns that still need to be addressed. I have considered your paper in light of the comments received and I would like to invite you to prepare a new major revision.

In your revision, please make sure that you take full account of the above comments and those made in the reports below. Please note that Methods in Ecology and Evolution does not automatically accept papers after revision, and an invitation to revise a manuscript does not represent commitment to eventual publication on our part. We will reject revised manuscripts if they are returned without satisfactory responses to the reviewers' comments. When returning the revised paper, please show point-by-point how you have dealt with the various comments in the appropriate section of the submission form.

This journal offers a number of license options for published papers; information about this is available here:<https://authorservices.wiley.com/author-resources/Journal-Authors/licensing/index.html>. The submitting author has confirmed that all co-authors have the necessary rights to grant in the submission, including in light of each co-author’s funder policies. If any author’s funder has a policy that restricts which kinds of license they can sign, for example if the funder is a member of Coalition S, please make sure the submitting author is aware.

Please return your revision by 24-Oct-2024. If you need longer, please let us know so we can update our system accordingly. Please read the resubmission instructions at the end of this email before submitting your updated manuscript.

We look forward to hearing from you in due course.

Sincerely,

Aaron Ellison

Executive Editor, Methods in Ecology and Evolution

Comments to the Author:

One of the original reviewers was unable to review the revised version so we invited a third expert. Both reviewers found the manuscript was substantially improved. However, the logic of writing can be clearer for the audience who are not familiar with sound degradation analyses if the authors can first introduce how to make a sound degradation experiment and how to measure the sound degradation parameters and then present Table 1. Reviewer #3 also provide many detailed comments about the sound analyses that should be carefully revised in the following version.

Reviewer(s)' Comments to Author:

Reviewer: 2

Comments to the Corresponding Author

*The authors have revised the ms accordingly.*

**RESPONSE:**  
Thank you.

**Reviewer: 3**

Comments to the Corresponding Author

Comments to authors (MEE-23-12-736.R1)

*I support the idea of making a program that makes analysis of sound degradation more accessible to the research community. The procedure of aligning recordings using marker sounds certainly has potential, but also poses potential flaws, which the current manuscript does not address.*

**RESPONSE:**

There are two potential problems that users might face: markers might not be found or might not be perfectly aligned. The markers are unlikely to be undetected unless they are highly degraded. However, if this happens it is also very likely that the test sounds are totally degraded at that point and then no degradation measure should be taken anyways. This is because, by default, markers have low frequency and higher amplitude than the test sounds, two characteristics that ensure they will be less degraded. The imperfect alignment, on the other hand, is quite common. When alignment is off by a few milliseconds, the manual\_realign() and auto\_realign()l functions can be used to further improve aligning accuracy . The manual\_realign() function is particularly helpful as users can manually adjust the match of the master and test recording spectrograms, being able to move the spectrogram a single time window at the time, until a perfect alignment is reached. Furthermore, the alignment accuracy is obviously improved as the users actually see it. Since this is done for only one of the markers per sound file, it is also a highly efficient process that ensures the quality of the alignment. auto\_realgin() is mostly useful to align individual sounds in cases in which the time difference between sounds is not exactly the same across all recordings, as can be the case when using a bluetooth wireless speaker which may add short delays to the playbacks.

We have added the following sentences to the main text:

**“When aligning test files users might face two potential problems: the markers are not found or are not perfectly aligned. Not finding the markers only occurs when the markers are highly degraded. However, in such a case it is likely that the test sounds have not been registered and then no degradation measure should be taken. This is due to the low frequency and relative high amplitude of markers, which ensure they will be less degraded. In cases in which alignments are slightly off by a few milliseconds, which can be quite common, they can be manually adjusted with the function *manual\_realign* (Table 1). The function generates a multipanel interactive graph with a spectrogram of the master sound file on top of that from test sound files (one at a time). This highlights the position of correspondent test sounds on both in order to assess and adjust the alignment. …”**

**“The function *auto\_realign* can be used to improve the alignment of individual test sounds one at a time. This is mostly helpful when the time difference between sounds varies between different recordings, as can be the case when the playback equipment adds short delays (e.g., bluetooth speakers)**

*In addition, the authors need to provide a thorough description of how to conduct a sound degradation experiment or clearly state where such a description could be found. Otherwise, the manuscript will only make sense for readers already familiar with sound degradation studies.*

**RESPONSE:**

We have added the following paragraph to the manuscript:

**“Sound propagation experiments follow a common experimental design in which model sounds that have been previously gathered and compiled into a single (master) sound file are broadcast and re-recorded at increasing distance on several transects (Morton, 1975; Dabelsteen et al. 1993). The location of the model sounds in the re-recorded files is then determined in order to quantify degradation. The latter is done by comparing against a reference sound file recorded at a short distance (usually 1m) from the speaker. The reference file also serves to account for any distortion coming from the playback equipment.”**

The authors give a fine description of the various steps of the program.

**RESPONSE:**

Thank you!

General comments

*Detailed descriptions of the procedure for conducting the sound degradation analysis are missing, so if the reader is not familiar with SIGPRO I would imagine that the analysis of sound degradation would still be a bit blurry after reading the paper.*

**RESPONSE:**

We disagree. The entire manuscript is full of detailed instructions and annotated code on how to conduct sound degradation analyses. Nevertheless, we added that: **“The location of the model sounds in the re-recorded files is then determined, which is used to find the sounds of interest in order to quantify degradation. The latter is done by comparing against a reference sound file recorded at 1m from the speaker.”**

*The authors should carefully explain how the cross-correlation procedure or the use of marker sounds align the model and the test sounds.*

**RESPONSE:**

We added that: **“**The function find\_markers uses spectrographic cross-correlation to locate, in test files, the start and end acoustic markers added by master\_sound\_file. **To do this the function correlates a spectrogram (i.e. a time by frequency matrix of power spectral density) of the marker in the master sound file as a sliding window along the spectrogram of the test file. The time of the highest correlation is used as the position of the marker in a test file”**

*The list of functions (table 1) is presented in the manuscript before the reader is presented with the different possibilities for aligning test and model sounds.*

**RESPONSE:**

The paragraph explaining the experimental design of sound propagation experiments has been placed right before the first mention of the table and the table itself. So we now considered the location of table 1 to be appropriate.

*The building of sequences of sound looks useful. However, for alignment you often need to choose the best of the rerecorded model sounds. Note even the master sound files needs to be rerecorded because the playback equipment unavoidably will distort /modify the sounds slightly. It is so far not clear from the description that this was done. This is another argument for moving table1 to later in the manuscript.*

**RESPONSE:**

As mentioned in the previous answer the paragraph explaining the experimental design of sound propagation experiments has been placed above table 1. Note that this paragraph states that: **“The reference file is also re-recorded to account for any distortion coming from the playback equipment.”**

*It appears that the use of marker sounds ignores the fact that only some of the rerecorded (if that was even done) test sound that should serve as undegraded model sounds will provide a proper model sound for analysis because of overlapping sounds in the surroundings and temporary fluctuations in the stationary background noise. The problem of overlapping sounds and fluctuations in the stationary background noise also applies to the sounds recorded at various combinations of sender/receiver height and distances. So, while I really like the idea to ease navigation of the recordings of degraded sounds, I fear that the accuracy of the measurements will be considerably flawed because the program appears to use all sounds and pair them with the (hopefully) rerecorded model sounds (line 216-221 indicate that this was done). The use of all rerecorded sounds may cause flaws in the results, if some of the sounds suffered from inferior quality due to overlapping sounds or changes in the background noise. The inferior quality of model sounds or the degraded sounds may not be an issue in the current paper, but it needs to be addressed to make users of the program aware of these issues. Otherwise, the results from using this program will be flawed.*

**RESPONSE:** This is a good point. We added that:

“**The occurrence of overlapping sounds and fluctuations in the stationary background noise can make some re-recorded sounds (both reference and test sounds) unfit for assessing degradation. Therefore we recommend inspecting the spectrogram of the aligned sounds to spot problematic sounds.** The format of the output annotations from *align\_test\_files*, *manual\_realign* and *auto\_realign* is shared by other bioacoustics R packages, which enables the use of additional functionalities, like exporting annotations to external software for further inspection (Rraven; Araya-Salas 2017) or signal structure quantification and additional visualizations (warbleR; Araya-Salas & Smith-Vidaurre 2017).”

*It appears that there is no filter option in the program. Both high and low pass filters are important to properly assess sound degradation. So, authors should describe how researchers should deal with filters. Oftentimes filters are specific to song and call types.*

**RESPONSE:**

Both high and low pass filters are applied to every sound before quantifying any degradation metric. The top and bottom frequency of the annotations used to create the master sound file are used as the cutoff values for the high and low pass filter respectively. We have added this to the main text: **“All functions compute degradation measures after applying a bandpass filter with the frequency range of model sounds provided in the annotations used for creating the master sound file.”**

*Some tables such as line 173, 183. Should have a legend.*

**RESPONSE:**

Those are the printed outputs of the previous code chunks, and they do not require a legend.

Specific comments.

*Line 20. I stumble upon the term adequately. The argument should not just be that it finds some measure. It should also quantify the accuracy of the measures relative to existing programs.*

**RESPONSE:**

We agree. Note that in the next paragraph we state that **“Notably, baRulho offers similar results to other sound analysis software but with significantly reduced processing time.**”

*Line 62. It is not just the height from the ground of the signaler, the receiver height has larger effect on the degradation that signaler height as shown in both Dabelsteen et al. 1993 and Balsby et al. 2003.*

**RESPONSE:**

We have modified the sentence: **“the height from the ground of both signalers and receivers, which leads to additional attenuation (Dabelsteen et al. 1993; Balsby et al. 2003; Darden et al. 2008; Arasco et al. 2022)”**

*Line 88-94. Too early to present the measures. The methods must be described properly first. Otherwise, the measures and their description in table1 will only partly make sense for people unfamiliar with sound degradation measures.*

**RESPONSE:**

We agree with the reviewer. However, other functions are already introduced at this point. Having several tables for each step of the process is unfeasible due to format limitations. Therefore we considered that placing the table when it is first mentioned is the best approach.

*Table 1. References to papers that have used the various degradation measures would be appropriate.*

**RESPONSE:**

We added references to the measures when available.

*Table 1. “blur ratio”. Technically yes blur ratio is a mismatch between amplitude envelopes. However, the authors should explain what this means and how blur ratio indicates a change in the sound. That higher blur-ratio indicate more degradation is only remotely helpful.*

**RESPONSE:**

We modified the description: **“Measures the distortion of the distribution of sound energy in the time domain** as the mismatch between amplitude envelopes (expressed as probability mass functions) of reference and test sounds.**”**

*Table 1. “excess\_attenuation()”. Which type of envelope does barulho use to estimate this.*

**RESPONSE:**

It uses absolute amplitude envelopes. We added: **“Absolute amplitude envelopes are used to represent energy distribution in time.”**

*Table 1. “signal\_to\_noise\_ratio”. Somewhere the authors should explain how the Barulho program selects the background noise for this measure.*

**RESPONSE:**

We added this to the main text: **“The *tail\_to\_signal\_ratio* and *signal\_to\_noise\_ratio* functions allow users to set the duration of the segment adjacent to each test sound in which to measure the tail (right after the sound) or noise (right before the sound) respectively (argument mar). In addition, *signal\_to\_noise\_ratio* allows defining a single segment, including it as an additional annotation, to be used as the noise reference for all sounds in a file”**

*Table1. “spcc()”. The spectrographic cross-correlation depends on the settings for the spectrogram. Authors could consider emphasizing this and caution that comparisons necessarily require the same settings. So, it is important the setting is reported.*

**RESPONSE:**

We agree. And that is true for any representation of sound. We added this paragraph to the main text: **“All measures might vary when modifying the parameters controlling the computation of the acoustic dimension (i.e. time, frequency) used to represent the structure of the sounds, such as hop size (power spectrum and spectrograms) or envelope smoothing (amplitude envelopes). Hence these values should be kept constant across analyses to ensure comparability. They can be set globally (i.e. they will be used by all baRulho functions) with the function options.”**

*Line 136. How much time between sounds did you allow the program to use. Is this adjustable so forward masking could be avoided in habitats with substantial degradation.*

**RESPONSE:**

**This was partially explained in the next paragraph when describing the function *master\_sound\_file.* We modify the text to make it explicit: “**The output of *synth\_sounds* can be used by the function *master\_sound\_file* to create a master sound file for playback experiments (i.e. a sound file with all the model sounds in which propagation will be quantified). This function concatenates all sounds into a single sound file, adding silence between sounds. The duration of the silence can be controlled with the argument *gaps*.**”**

*Line 161-162. I disagree strongly with the statement that “position of test sounds has been determined by visual inspection of waveforms”. The initial steps in sound degradation analyses using SIGPRO involve alignment of sounds to maximize the cross-correlation after pointing the cross-correlation to the area of interest where you try different positions and assess the cross-correlation. The pointing, to an area for the cross-correlation followed by inspection of cross-correlation values cannot be considered just visual inspection in fairness it should at least be noted that the alignment is supported by cross-correlation. SIGPRO accounts for many papers (of which at least six are referred to in the current manuscript) on sound degradation. I would also be seriously worried about unassisted visual inspection of waveforms to align sounds.*

**RESPONSE:**

Note that we are not specifically referring to SIGPRO in this sentence. Other software like Signal and Avisoft have also been used for measuring degradation. The sentence tries to summarize the process across all available options. Nonetheless, we modify the sentence as follows: **“Traditionally, the position of test sounds has relied on visual inspection of waveforms, sometimes aided by automatic alignment of individual sounds, which can be time consuming and prone to user error.”**

*Figure 2. Should provide parameter settings for the spectrograms.*

**RESPONSE:**

We added this to the figure caption: **“**Figure 2. Output from function plot\_degradation that shows the Fourier spectrogram **(hop size = 11.6 ms, 95% overlap)**, amplitude envelope, and power spectrum**”**

*Figure 3. One of the better illustrations of blur ratio that I have seen.*

**RESPONSE:**

Thank you!

*Figure 4. I am not sure how the Bayesian approach fits with the use of p- values.*

**RESPONSE:**

You are correct. We removed the graph legend and left only the table caption: **“Values in gray indicate effects that did not differ from zero.”**

*Line 323. What are “original test files”? In the earlier experiments using SIGPRO, which I am familiar with, these are rerecorded sounds and should be the default procedure.*

**RESPONSE:**

We modified the text to make it clearer: **“In Sigpro, we tested sounds in two ways. First, we used the re-recorded sound files, which is the default procedure in Sigpro. This required manually setting the time location for test sounds within the entire re-recorded file.”**

*Line 394-395. Part of the mismatch undoubtedly relates to differences in the alignment of sounds. But what about filters and overlapping sounds where the latter would result in discarding of some of the recorded sounds?*

**RESPONSE:**

We use the exact same acoustic data set on both baRulho and SIGPRO so the mismatch cannot be due to the discarting of some of the recorded sounds. This is further supported by the fact that when we used clips of the re-recorded sounds, which excludes the need to align sounds in SIGPRO, the corrrespondence between the two software increase markedly.