



BRIDGING THE GAP BETWEEN NON-VOCAL BEHAVIOURAL STUDIES AND BIOACOUSTICS USING BORIS

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ABSTRACT

Information technology's role in studying animal behavior is becoming increasingly important. Thanks to the high quality of portable instruments such as video cameras and recorders and the associated microphone equipment, studies of non-vocal behavior are often combined with studies of vocal behavior, involving specific screening and editing of the sound component of recordings. BORIS, one of the most widely used software tools for behavior studies in recent years, is a free, open-source program that allows video and audio components to be easily managed. The purpose of this work is threefold. The first is to guide users using BORIS to screen audio signals using sonograms and waveforms. The second is to introduce the editing of those portions of the video that contain signals useful for further processing in other environments. The third objective is to explain how BORIS can be used with PRAAT to facilitate audio portions' extraction and measure particular characteristics annotated in TextGrids. Finally, we show how the interaction of open-source software can enable the easy handling of large amounts of recordings and how studies on non-vocal and vocal behavior can find a comprehensive working framework.

Keywords: *ethology, video analysis, quantitative approaches, acoustics, vocal communication.*

1. INTRODUCTION

The study of behavior has sometimes been based on vocal behavior and sometimes interpreted in the light of interactions mediated by acoustic signals [1]. Rarely have the

two aspects been treated equally within individual studies. However, the new tools for video and audio analyses are inaugurating a new wave of studies in which the interplay between vocal and non-vocal behavior appears to be tighter and better considered [2].

BORIS is an open-source, multiplatform standalone program that allows a user-specific coding environment for a computer-based review of previously recorded videos or live observations. BORIS enables you to work with the audio and video component separately or to harmonize the analysis of the two, also displaying spectrograms and waveforms [3].

The program allows for defining a highly-customized, project-based ethogram that can then be shared with collaborators or can be imported or modified. Once the coding process is completed, the program can automatically extract a time budget or single or grouped observations and present an at-a-glance summary of the emerging behavioural features. In addition, we can export observation data and analyses in various formats (e.g., CSV or XLS) and events and plots (e.g., PNG, EPS, and PDF). BORIS is currently used worldwide for strikingly different approaches to studying animal and human behavior.

This paper has three aims. The first is to guide users using BORIS to screen audio signals using sonograms and waveforms. This is an easy option to switch on, but it remains obscure for many users. The second is to introduce the editing of those portions of the video that contain signals useful for further processing in other environments. Qualitative selection of critical behaviours is helpful for many reasons during a quantitative study (e.g., to portray particular displays and exemplify what is described elsewhere). The third objective is to explain how we can use BORIS with PRAAT [4] to facilitate the extraction of audio

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portions and measure particular characteristics annotated in TextGrids. This last aim will include using BORIS and PRAAT. The interaction of open-source software can enable the easy handling of extensive recordings and how studies on non-vocal and vocal behavior can find a comprehensive working framework.

2. USING BORIS FOR BIOACOUSTICS

The following descriptions refers to BORIS 7.12.2 and PRAAT 6.1.40.

2.1 Visualizing spectrograms and waveforms

The spectrogram and waveform displays are set when the user creates a new observation. The user can decide whether to display the spectrogram or the waveform, but they can also be displayed together. Displaying the spectrogram or the waveform for a particular observation does not imply that all project observations must include the sound component's display. When starting an observation for which the user has opted to display the spectrogram, waveform, or both, these will appear on the screen in separate windows from the main BORIS screen (Figure 1). The sound visualizations will scroll simultaneously and at the same speed; if the media in question is a video, they will scroll at the speed indicated for the video component.

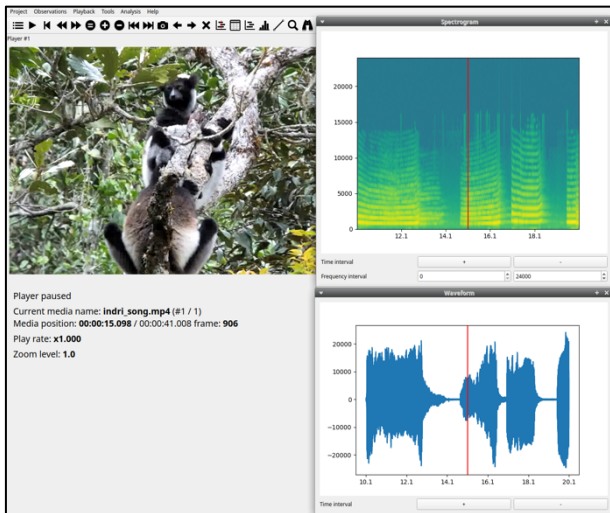


Figure 1. Visualizing spectrograms and waveforms in BORIS along video media.

2.2 Extraction of critical media parts

An essential component in presenting behavioural and speech-related events is extracting segments from the videos that effectively portray the behavioural display. BORIS can do this thanks to built-in functions (Figure 2).

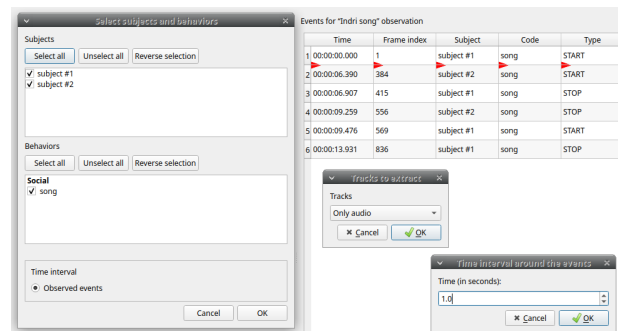


Figure 2. Selecting subjects and behaviors to extract target video and audio clips using BORIS.

2.3 Exporting observations to PRAAT TextGrids

Let us imagine that we have completed encoding a video media for which we have indicated three behaviors identified as states (i.e., behaviors with duration): Scent-marking, Vocalization, and Gesture. With Scent-marking, we indicated scent-marking (e.g., an animal's rubbing of the anogenital area on a tree); with Vocalization, we stated the emission of a vocal signal (e.g., an alarm vocalization), and with Gesture, we noted a gesture (e.g., the flapping of an upper limb, the opening of the mouth showing teeth). All these behaviors, as mentioned before, have been identified as states, and therefore the start and end times of the behavior will be indicated in the coding (i.e., in addition to the subject). In the main BORIS bar, we can now click on Observations and move down to Export Events, choosing Praat TextGrid as Praat. BORIS will prompt choosing a particular observation (or multiple observations) for which we want to export the coding in Praat TextGrid format. Once the observation has been chosen, the following window (i.e., Select subjects and behaviors) will allow us to determine the subjects and behaviors we wish to export. It is important to remember that the Praat TextGrid format allows for multiple tiers (Figure 3). BORIS is capable of exporting coding of different individuals as different tiers. Portions of the media that do not show coded behavior will correspond to empty ranges in the annotation of a particular tier in PRAAT. Intervals with coding will contain the code of the behavior

chosen in BORIS (i.e., code in the Ethogram window) as annotation. Given the established practice of having media files and TextGrids with the same name, BORIS will not ask how you would like to save the file but will impose the same name as the reference media file.

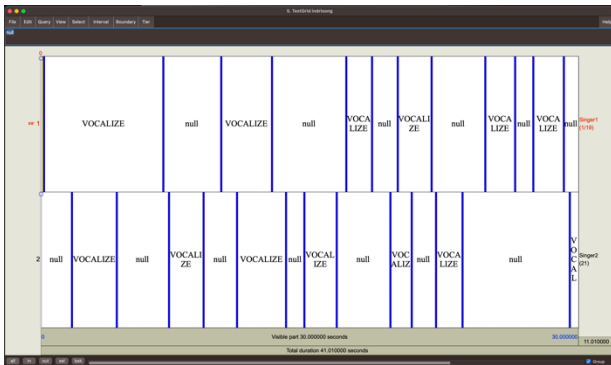


Figure 3. Praat TextGrid with two tiers as exported from BORIS and read in PRAAT.

2.4 Using PRAAT TextGrids to extract audio segments

Following the previous example, we selected a video medium and exported our audio content, with the same name as the original file, in WAV format. We can now open the audio file in PRAAT and then open the file in TextGrid format that we exported from BORIS. We can view these two objects individually or together in PRAAT. Visualizing them together can be very useful to adjust boundaries where needed (e.g., to fit the start and the end of the target portions better). We can also have an overview of what we intend to export from the WAV file, now the Sound object in PRAAT. Depending on our capabilities and needs, we can proceed in two different ways to extract the segments of interest.

By selecting the Sound object and the TextGrid object, we can extract all segments corresponding to a particular annotation (or behavior in this case, e.g., Vocalization) using *Extract: Extract intervals where...* We must insert the Tier number (e.g., 1), the logic variable (e.g., “is equal to”), and the text we want PRAAT to search for in the intervals (e.g., “VOCALIZE”). This operation will bring individual segments corresponding to intervals in Tier 1 whose annotation was “Vocalization” in the Praat Objects window (Figure 4). We can then save each of those objects to files manually. Alternatively, we can proceed by using a Praat Script. We can set up a folder to put all the media files and the corresponding TextGrids. Then, we can create a list of

the TextGrid files in the folder and call each TextGrid and the WAV file with the same name. For example, we can script to identify all intervals whose annotation text is “VOCALIZE” and get their starting points and endpoints. Then, we can iterate a function to extract all those intervals and save them as individual WAV files in a particular folder. We can easily add characters at the beginning of the filename and a number indicating the position of a particular segment.

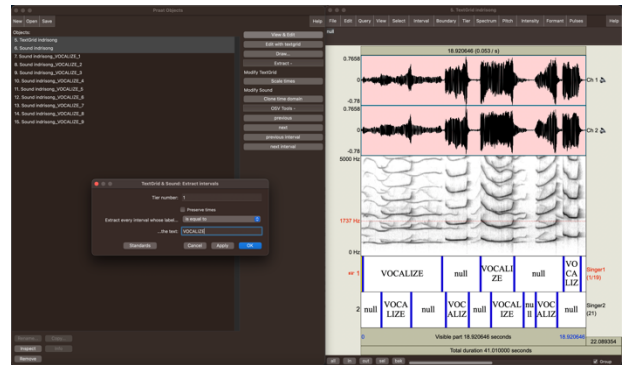


Figure 4. Manual object extraction using a soundfile and the respective TextGrid in Praat.

3. CONCLUSION

In this contribution, we have shown how it is possible to integrate behavioural observations not strictly related to vocal behavior by extracting files corresponding to the vocalizations emitted by the study subjects. This process may involve the need to display spectrograms and waveforms in BORIS; it may also include extracting parts of a video. Whereas the most experienced users may want to work with advanced tools such as PARSELMOUTH [5], here we show how it is easily viable to use BORIS and PRAAT to achieve saving individual vocalizations as sound files in a target folder. We want to point out that users can look at this procedure broadly when considering the relationship between behavior and vocal emissions. It would be possible to think of the extraction, not of vocalizations emitted by a subject, but of the acoustic environment in which a particular behavior was observed, for example. It is also possible that in the future, BORIS should be able to export annotation files that could be easily processed with other tools besides PRAAT, such as the Seewave package [6] or the Warbler package [7], both working in R [8].

4. REFERENCES

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