Things that Sing in the Night: Melodic and Rhythmic Intervals in a Nocturnal Bird

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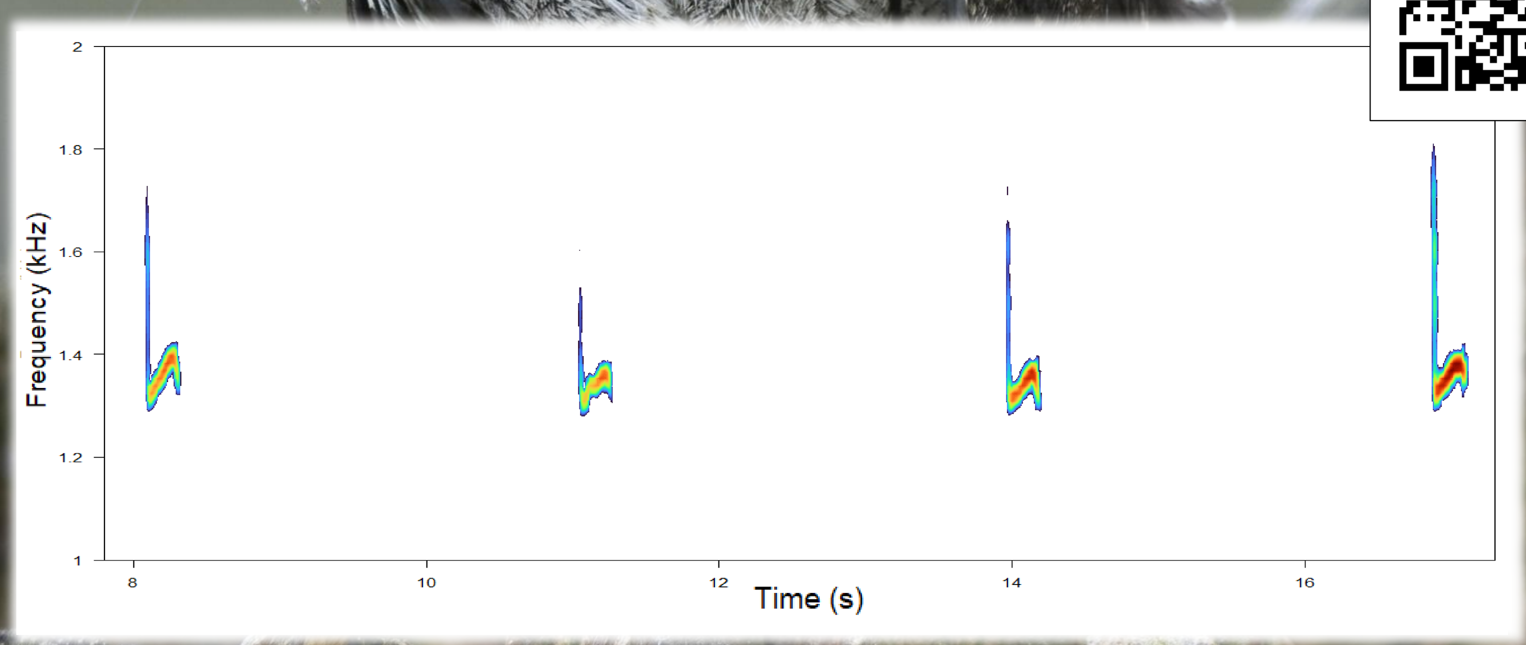
MUSIC & THE MIND

Have a listen!



Background

Do birds sing notes with specific melodic and rhythmic intervals? The use of small intervals of less than 750 cents and rhythmic categories such as isochrony are some of the cross-cultural statistical **universals** that characterise human musical production [1]. However, a growing body of research has shown that different species of songbirds also use similar musical properties in their songs [2-3]. Notably, these studies have focused only on diurnal species, leaving out **nocturnal birds**, which also have extensive vocal repertoires.

To address this knowledge gap and demonstrate that these musical characteristics extend beyond songbirds, in this study we decided to test whether similar universal statistics were also present in nocturnal species. For this purpose, we chose the song of the **Eurasian Scops Owl** (*Otus scops*).

Methods

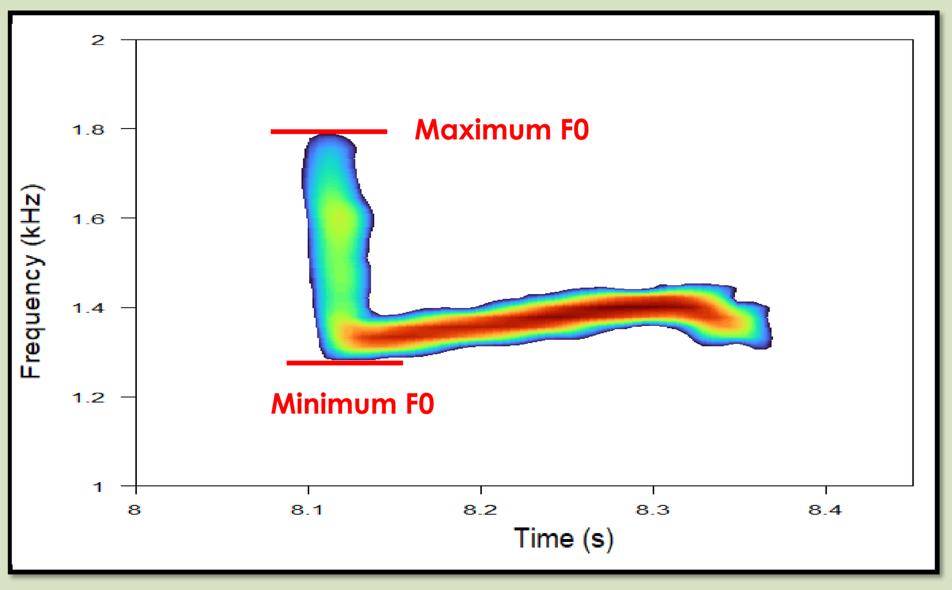
Vocalization Type

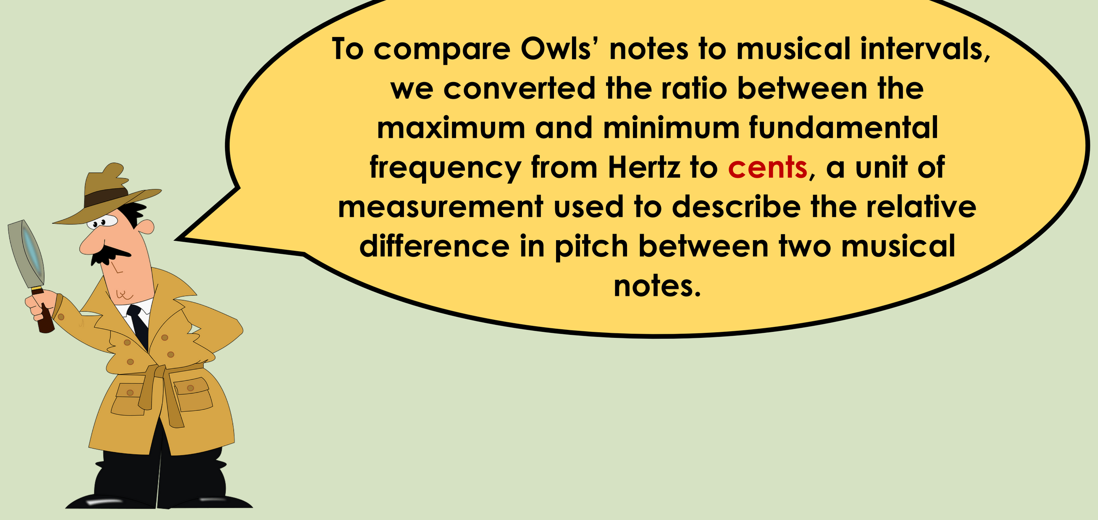
Eurasian Scops Owl songs, predominantly performed by males, comprise extended sequences of single, monosyllabic notes marked by a distinctive downward inflection, serving the dual role of defending territory and attracting potential mates during the breeding season.

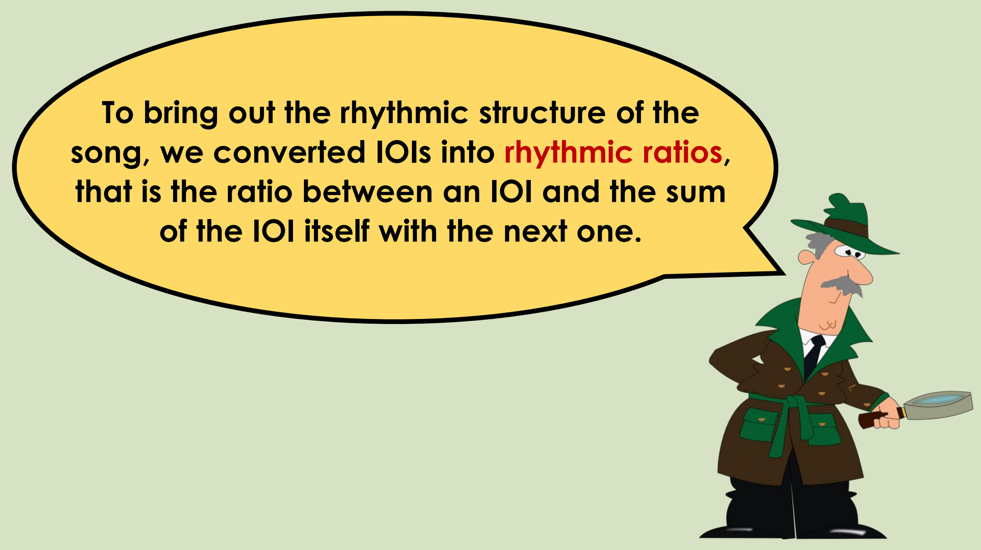
Recordings and Acoustic Analysis

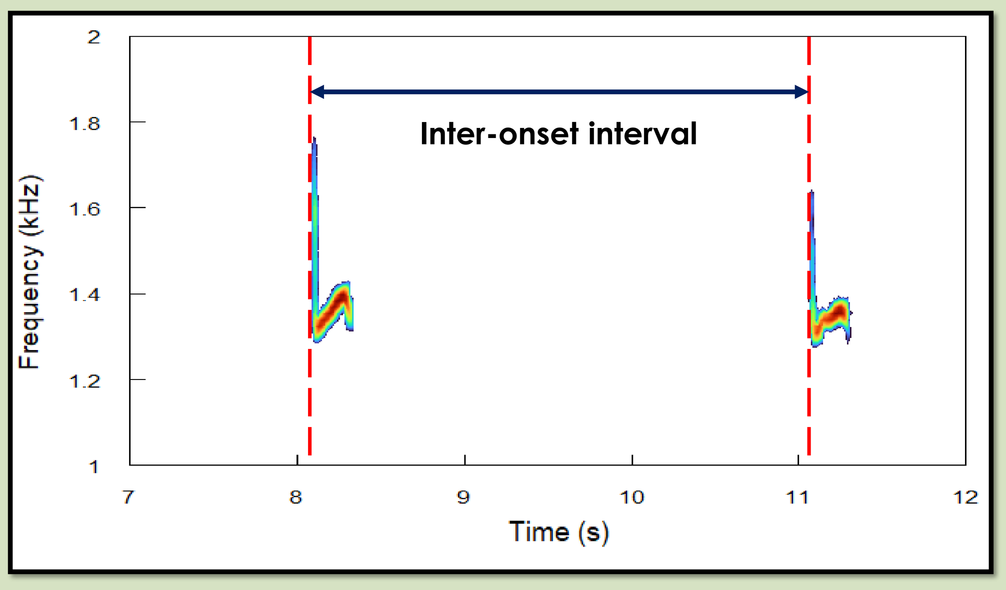
We performed our analysis on a dataset of 1,374 notes extracted from songs emitted by 26 individuals of Eurasian Scops Owl coming from 9 different Eurasian countries. These recordings were sourced from three distinct bioacoustics online repositories: Xeno-Canto, AvoCet, and Animal Sound Archive of the Museum für Naturkunde Berlin.

To perform acoustic analysis, we used Praat software. In particular - in accordance with the previous literature [4] - due to the rapid pitch modulation of the notes, we extracted their maximum and minimum fundamental frequency and then calculated the ratio between these values. On the other hand, we also annotated the onset of each vocalisation in order to extract the inter-onset interval, that is the amount of time between the beginning of an acoustic element and that of the next one.



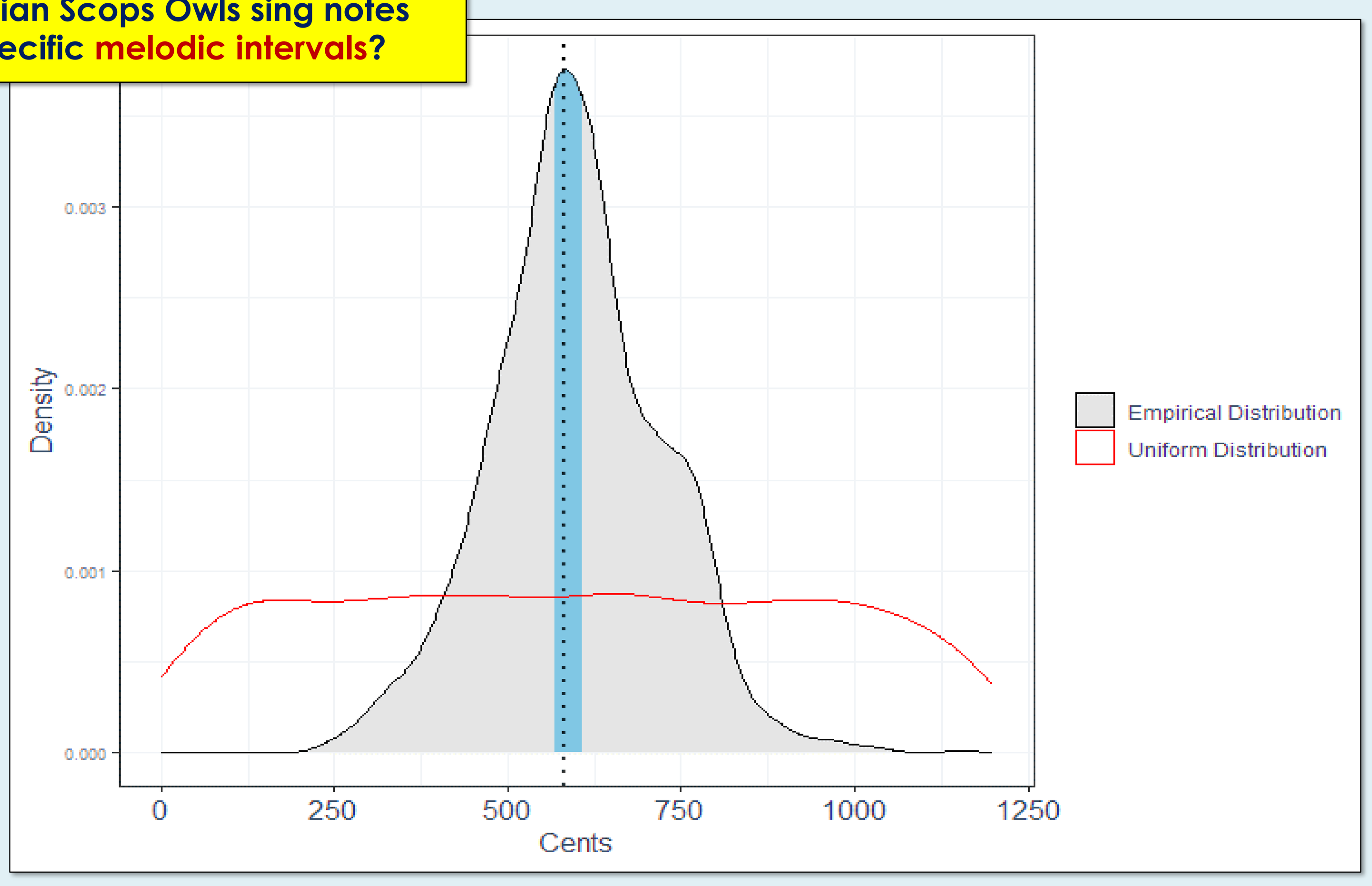






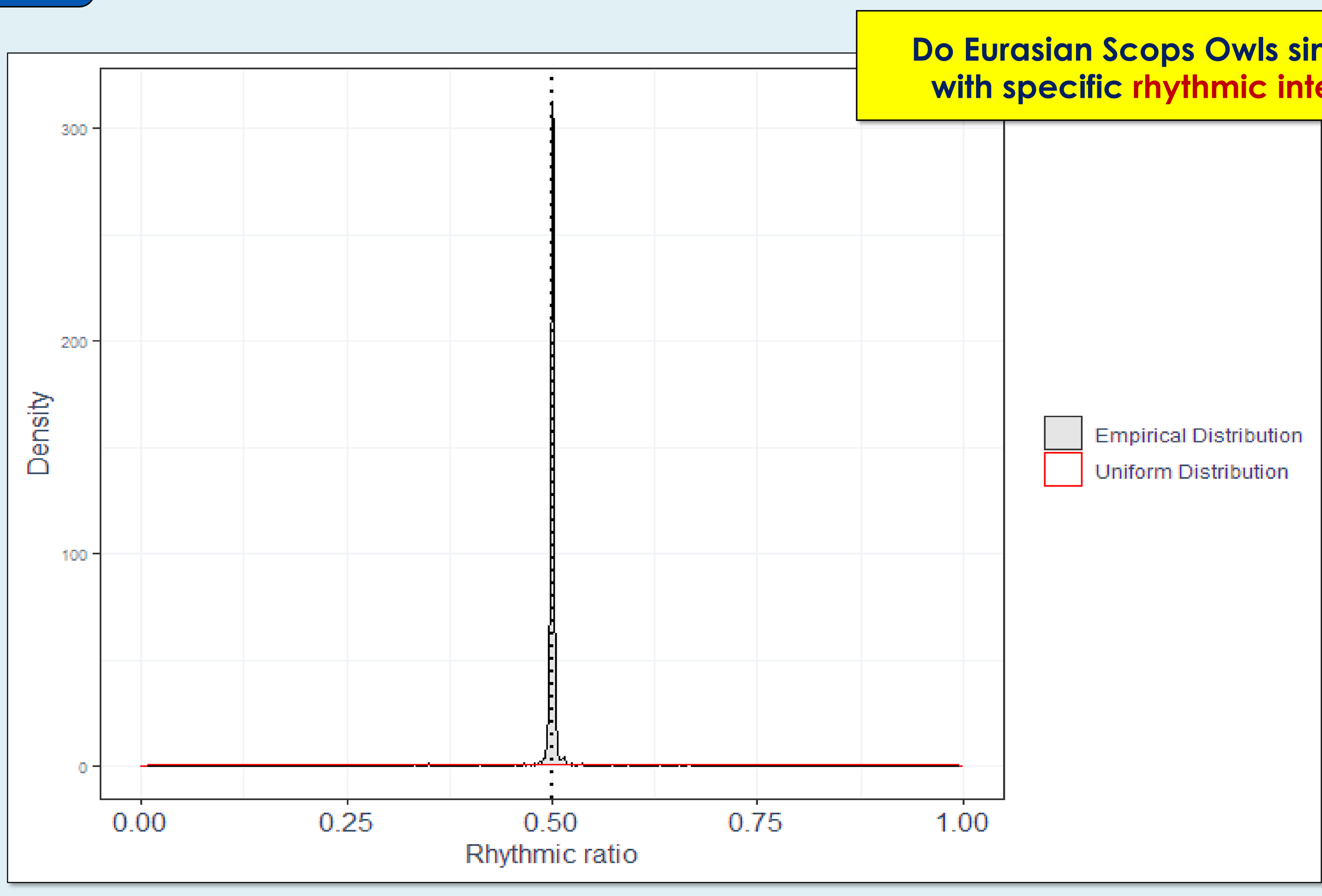
Results

Do Eurasian Scops Owls sing notes with specific melodic intervals?



The distribution of cents exhibits its peak at **582 cents**. So, to obtain the 95% confidence interval and hence assess the significance of the observed peak, we conducted bootstrapping with one million iterations on the empirical distribution, resulting in a range of 570 to 604 cents (in light blue in the image above). As a result, the distribution's peak comfortably resides within this interval. Lastly, to enhance the robustness of our results, we also generated a null ratio distribution with the same number of observations as the empirical one - which is 1374 - and then subjected it to a Kolmogorov-Smirnov test against the empirical distribution, yielding a significant result ($D = 0.28894$, p-value $< .001$).

Do Eurasian Scops Owls sing notes with specific rhythmic intervals?



From visual inspection, we observe a pronounced bias towards an **isochronous beat** (1:1), while other categorical rhythms with small integer ratios, such as 1:2 and 2:1, do not exhibit prominent peaks in the distribution. To assess the significance of the 1:1 peak, we performed a paired Wilcoxon signed-rank test ($V = 351$, p-value $= 0.003906$). To increase the robustness of our results, we also generated a null ratio distribution with 100,000 observations and then subjected it to a Kolmogorov-Smirnov test against the empirical distribution ($D = 0.45956$, p-value $< .001$).

So what?

Our study has shown that owls are capable of producing songs characterised by the use of well-defined melodic and rhythmic intervals. In particular, the notes emitted by this species fall within the lesser septimal tritone (also known as **Huygens' tritone**), a dissonant melodic interval corresponding to 582.51 cents. Rhythmically, the songs of these animals appear to be extremely regular, following an **isochronous rhythm**. These results are similar to those found not only in humans but also in other songbird species, which also use small intervals of less than 750 cents - often consonant - and well-defined rhythmic categories - in particular isochrony. However, the fact that they are present in a species of the order *Strigiformes* suggests that these features may have already existed in the common ancestor of owls and passerines and may well represent acoustic universals that characterise vocal communication, at least in vertebrates, an ability shared by species that has reached a unique level of complexity in human musical production. *But why do Eurasian Scops Owls use Huygens' tritone and isochrony in their songs?* While the use of isochronous, well-spaced notes may **promote coordinated displays** by facilitating turn-taking in both aggressive interactions with rival males and duets with the breeding partner, the preference for dissonance is more difficult. One possible answer is that dissonant intervals in owl songs, since they create tension, may be used to **attract listener attention** and **increase arousal**, especially when this vocalisation is used for territorial defence. However, further studies are needed, particularly to investigate whether this species perceives dissonant and consonant intervals like we do.

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References

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