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What Does the Lyrebird Hear? Trouble With Birdsong in the Anthropocene

Introduction

The following paper aims at presenting various issues related to Anthropocenic birdsong research based on the symbolic case of the lyrebird. Comparing the ecological acoustics of Hans Slabbekoorn with certain basic concepts from music theory and cognitive musicology provokes new speculative concepts. Such a speculation may help future researchers not to anthropomorphise songbirds and recognise their extraordinary perceptual abilities.

Human activities inevitably produce sound, similarly to any animal movements and actions. The development of industrial culture, however, saw an unprecedented rise in the volume of human-made noise. Machines indispensable for industrial prosperity launched a new era of widespread sonic invasion, hurting both humans and non-human animals alike. The direct, unrecoverable damage done to the hearing organs is a separate issue, but possible further consequences of noise pollution in the biosphere should be analysed as well.

Human-made noise is everywhere. Even the depths of the oceans are polluted with machine sounds.[1] Therefore, investigating a single animal breed

1 C.M. Duarte et al., 'The soundscape of the Anthropocene ocean', *Science*, 6529 (2021), 6.

may help one get greater insight into the impact of human noise on living organisms. A graphic display of human-made sonic violence can be found in birdsong, and the most vocal culprit is the Australian lyrebird.

The lyrebird

If the collection of experiences and reminiscences of the early Australian pioneers from the 1920s, entitled *The Land of the Lyre Bird* is to be trusted, the discussed creature owes its name mostly to its beautiful tail.[2] The fabled male tail resembles the ancient lyre—the same instrument that granted Orpheus a visit to the realm of Hades. Now, in a twist of fate, the Australian songbird itself stands on the brink of becoming a threatened species.[3]

Recent reports on the lyrebird appeared on BBC channel, in a programme hosted by David Attenborough.[4] Firstly, one sees a beautiful avian creature with an extraordinary tail—perhaps matched only by famous peacocks. After its first few original songs, the lyrebird sings the sounds of engines, chainsaws, toy laser guns, or even catcalling. This is a gruesome feedback of human behavior. The wonderful creature, mimicking sounds of gas-fueled destruction, inspires a shameful self-realisation: this is what humans really do, this is who humans really are.

The lyrebird is so talented at mimicry that watching it sing causes almost a feeling of disbelief—it reproduces the sounds of heavy machinery with stunning accuracy. One may wonder how it is possible; if it swallowed a loudspeaker or maybe it is all a hoax.

Reception of those industrial songs deserves its own specialised research. The amazing copying talent may have already become a curse. If humans can be fooled that they hear real chainsaws instead of a singing bird, perhaps non-human animals fall for it as well. We have to remember that for many forest dwellers, the sound of the chainsaw is the sound of death. The most reasonable reaction upon hearing it should be running away.

The repertoire of the lyrebird constitutes an interesting case for memetics. Memeticists such as Susan Blackmore or Daniel Dennett claim that the ability to mimic, or imitate, is at the very core of human culture.[5] Perhaps because

2 L. Waters, 'The Land of the Lyrebird', *Fusion Journal*, 19 (2021) 188-205; J.C. Stephens, *The Land of the Lyre Bird: A Story of Early Settlement in the Great Forest of South Gippsland* (J.C. STEPHENS PTY. LTD.: Melbourne, 1920).

3 A. Morton, 'Lyrebird may join threatened species, as scale of bird habitat lost to bushfires emerges', https://www.theguardian.com/environment/2020/jan/24/lyrebird-threatened-species-scale-bird-habitat-bushfires-emerges, accessed 1 May 2022.

4 BBC Earth, 'Attenborough: the amazing Lyre Bird sings like a chainsaw!', https://youtu.be/mSB71jNq-yQ, accessed 1 May 2022.

5 S. Blackmore, *The Meme Machine* (1st edn, Oxford: Oxford University Press, 1999); D. Dennett, *From Bacteria to Bach and Back: The Evolution of Minds* (J.C. STEPHENS

of the biases of the traditional nature-culture distinction, the authors do not seriously consider imitating cultural information between species. The case of the lyrebird shows that imitating human cultural information may have potentially harmful results to non-human animals. This not only indicates a beginning of a tangible web of inter-species culture, but also shows humans' contribution to it as at least controversial.

How do birds hear?

It is commonly known that humans suffer many different health problems because of exposure to noise. Various cases may lead to permanent hearing loss, increased risk of hearing disease or even decline in school performance.[6] It is rational to presume that other animals, such as birds, are also threatened by the intensifying Anthropocenic soundscape.

However, relating bird and human problems directly may lead to overanthropomorphisation. Is it possible to understand how to effectively minimise the negative influence of the industrial soundscape on birds? Fortunately, both birdsong per se and birdsong in the anthropocene are thriving areas of research. The works of professor Hans Slabbekoorn provide many practical examples of environmental birdsong research. Slabbekoorn believes that 'it is critical to listen to nature and that sound science can benefit decision making about the balance between ecology and economy.'[7]

While Slabbekoorn's research is mainly acoustics-oriented, it is important to notice that a lot of sound science is also done in the field of musicology.

Musicological investigations of birdsong focus also on more theoretical problems. For instance, there is a very prominent paper from the field of cognitive musicology, which tries to settle if birdsong is more similar to music or speech.[8] While such a research topic may sound intangible and far-fetched at first, the presented precise neuroscientific data holds its ground. The speech/song dilemma cannot be settled without researching *how* and *what* do birds hear—and learning about the neurobiology of bird hearing is indispensable in diagnosing their real-life problems. Without that perspective one is forced to anthropomorphise.

Shannon addresses an important issue about birdsong analysis, asking if a research should necessarily be looking for melody and wondering if birds

PTY. LTD.: Melbourne, 2017).

6 H. Slabbekoorn, and E.A.P. Ripmeester, 'Birdsong and anthropogenic noise: Implications and applications for conservation', *Molecular Ecology*, 17 (2008).

7 Slabbekoorn, and Ripmeester, 'Birdsong…',

8 R.V. Shannon, 'Is Birdsong More Like Speech or Music?', *Trends in Cognitive Sciences*, 4 (2016), 245–247.

perceive the essence of their songs as something completely different. It turns out that although birds and humans do share certain traits in perceiving musical pitch, there also are some fundamental differences. First of all, birds generally seem to perform very poorly in recognition of transposed melodies.

Transposition is a musical process of moving a certain melody or sound sequence to higher or lower pitch registers. In this process, the relative keyboard distance between notes stays the same. If a melodic sequence of notes is C D C D C and one transposes it one whole tone up, D E D E D would be a result. This process is very clear and intuitive for humans, especially in perception. In regular communicative and musical practice people listen to the so-called relative pitch, and so they can recognise melodies no matter if they are played by a bass guitar or a flute. Relative pitch is also used to decipher speech, even in tonal languages.

The alternative to relative pitch is absolute pitch, famously referred to as 'perfect pitch'. The term 'absolute pitch' is used both as a name for the plane of musical sounds paired strictly with the Hz values of the corresponding sound waves, and as a name for the skill used to perceptually recognise these connections. Absolute pitch is a very rare ability among humans. That is not necessarily the case with songbirds.

Pitch-rhythm-timbre

An interesting recent article by Micah R. Bregman, Aniruddh D. Patel, and Timothy Q. Gentner opens with a very strong statement:

> Decades of research have led to the widespread belief that songbirds, unlike humans, are strongly biased to use absolute pitch (AP) in melody recognition. This work relies almost exclusively on acoustically simple stimuli that may belie sensitivities to more complex spectral features.[9]

This paper suggests that general research trends for the preceding twenty years have been to identify if songbirds use relative pitch or absolute pitch. Relative pitch was ruled out because of the songbirds inability to recognise transposed melodies. The answer seemed simple—if it is not relative pitch, it must be absolute pitch. This now turns out to be an anthropomorphisation. Bregman, Patel and Gentner present experimentally confirmed suggestions that scholars should be looking for another sound parametre altogether. With a novel approach, the researchers investigated if songbirds recognise signals that keep the original, not transposed melody, but are played in a different timbre. It turns out that this kind of recognition is also very poor.

9 M. Bregman et al., 'Songbirds use spectral shape, not pitch, for sound pattern recognition', *PNAS*, 6 (2016).

Failure with recognition of both transposed pitches and shifted timbres inspired the team to look for more general sound information. The final and surprisingly successful experiment concerned rhythm, or rather microrhythm. Both previous attempts contained examples with generally unchanged tempo, but that was not enough data to draw any conclusions. The real breakthrough happened when researchers considered the spectral envelope.

The spectral envelope is a very precise account of loudness of sound over time. While that may generally work as a definition of rhythm, it is important to note that in this case we are investigating the sound at a microscopic perspective. A closer look at examples of sound waves may be useful to understand the significance of the micro rhythmic scale:

This is the spectrum of one note played on the piano. Traditionally sound spectrums are divided into four parts: the attack—the beginning of the sound, decay—the general decay of volume, sustain—the phase in which the lower volume remains steady, and release—the last part, where the sound dissolves into nothingness. The picture presented below does not present the ideal four stages, but it is possible to discern a few phases:

Ex. 1: Piano sample sound spectrum generated in FL Studio 20 demo.

The second picture presents the same spectrum, but now it is visibly divided into three stages. In the first, violet segment, we can see a loud opening that quickly loses volume. This part corresponds to the artist's finger impact on the key. This impact produces a percussive sound, which quickly goes away. The second, green stage, corresponds to the phase where the musician holds the finger pressed to the key. The sound is steady and the strings resonate

Ex. 2: Piano sample sound spectrum generated in FL studio 20 demo with three phases marked in color.

openly. The last, blue stage, indicates the slow decay of the sound. This may mean either that the musician's finger is no longer pressed to the key and the sound is forced to stop, or that the finger is still pressed firmly but that is the natural fade out of the vibrating strings.

This example shows clearly that even a single sound consists of a very intricate rhythmic pattern of subsequent amplitudes. These microrhythms change significantly if one chooses a different instrument or another sound source. It could be then generalised that timbre is expressed in rhythm. The musical pitch can also be thought of as a special case of rhythm—indeed, A=440 Hz is air vibrating at the steady velocity of 440 times per second. Therefore, a completely different approach is needed. Bregman, Patel, Gentner state explicitly:

> We find that small manipulations altering either pitch or timbre independently can drive melody recognition to chance, suggesting that both percepts are poor descriptors of the perceptual cues used by birds for this task. Instead we show that melody recognition can generalize even in the absence of pitch, as long as the spectral shapes of the constituent tones are preserved. These results challenge conventional views regarding the use of pitch cues in nonhuman auditory sequence recognition.[10]

The researchers experimented with melody recognition in the absence of pitch, which is very abstract and non-intuitive for human listeners. Humans recognise melodies by listening to the pitches. According to Bregman, Patel and Gentner, songbirds recognize spectral shapes by listening to the microrhythms. The spectral shape is an account of sound amplitudes over time. The process of pitch abstraction replaces the given pitches with noise, while keeping the same sound amplitudes over time.

Lastly, it is very important to understand the difference between the sound spectrum and the timbre, which are very often confused.[11] Timbre is a very general term, which is popularly described as the element which changes when one plays a note of the same pitch on two different instruments. The popular misunderstanding is that sound spectrum contains all information about the timbre. The more complex truth is that sound spectrum is just a snapshot of a momentary variant of a given timbre. For example, the sound spectrum of a note played on a real saxophone in a small room differs greatly from the sound spectrum obtained from listening to a saxophone note played outside from a recording on a smartphone. However, the human ear easily recognises those two as one timbre.[12] As timbre in this sense is a more

10 M. Bregman et al., 'Songbirds…'.

11 D. Deutsch, ed., *The Psychology of Music* (3rd edn, Elsevier Academic Press: New York, 2013).

12 S. McAdams, 'Musical Timbre Perception', in D. Deutsch, ed., *The Psychology…*

generalised phenomenon than sound spectrum, the study by Bregman, Patel and Gertner could benefit from including it in the conclusions. Keeping all these complex pitch-rhythm-timbre relationships in mind may surely enrich many practical birdsong researches by adding a deeper perspective.

Speculation

The intricacies of songbird sound perception can also help us fruitfully speculate about the problems concerning acoustical masking. Firstly, it is crucial to state a few more obvious facts. Masking is a process in which a certain object (or sound) becomes harder to perceive against a certain background. It may distort animal communication or render it completely impossible. And without child—parent communication, incoming danger alerts or courtship displays, whole populations may suffer irreversible damage. Unfortunately, that is what happens to birds in urban areas. The sounds of cars, planes or other Anthtropocenic noise generators render birdsong inaudible, which forces avian populations to desperately find a way around the problem. There are few available options. The victims may either fly away from the sound source or try to change their singing habits.

It is easy to imagine that the simplest and most brilliant solution would be to adjust singing patterns so that the noise and birdsong do not overlap. Unfortunately, the experimental research by Yang and Slabbekoorn shows that winter wrens do not use such a strategy.[13] That being said, such behavior in other birds has not yet been disproved.

Two other strategies for birdsong to avoid masking come to mind, and both must bring inevitable harm to the singer. The first behavior corresponds to the famous Lombard effect: when exposed to certain levels of noise, humans, birds, and many other animals have been observed to raise their voice. But how much louder can a bird sing? No bird can compete with an airplane. And more importantly, that cannot become a long-term strategy. Constantly singing louder than naturally inclined must result in syrinx damage—and such damage may potentially influence the timbre of the birdsong, thus rendering it unprocessable for conspecifics.

The second strategy would be to try to sing in an unnatural register, transposing the birdsong higher or lower, so as to avoid masking with noise. That does seem to be the case with South American wood wrens.[14] Unfortunately, experimental research shows that songbirds do not do well in recognising

13 X.-J. Yang, and H. Slabbekoorn, 'Timing vocal behavior: Lack of temporal overlap avoidance to fluctuating noise levels in singing Eurasian wrens', *Behavioral Processes*, 108 (2014).

14 H. Slabbekoorn, 'Soundscape Ecology in the Anthropocene', *Acoustics Today*, 1 (2018), 42–49.

transposed signals.[15] Also, singing in frequencies that are not typical for the species must put damaging stress on the syrinx.

Moreover, it has been established that some bird species are forced to use both of these damaging strategies at once.[16] Just like in humans, raising one's voice is biomechanically linked to using higher frequencies. In this case, it is predictable that the syrinx would be damaged even stronger, which may entirely block effective communication. This is also a situation in which we may expect memetic danger. Slabbekoorn writes:

> Because juvenile songbirds learn the songs of conspecifics, any masking will impact adult song development; juveniles will not copy what they cannot hear and are therefore likely to end up with adult songs that are well-audible given local noise conditions. Similarly, immediate feedback may yield even more rapid adjustments. If birds get no response from others when using a song type that is heavily masked but they get a response from another, they may continue to repeat the latter. These kinds of signal adjustments are not evolutionary changes, although the flexibility itself may be the result of an evolutionary adaptation.[17]

If juvenile songbirds do learn the songs of conspecifics, it means that the songs are distributed through imitation, and therefore are valid for memetic analysis. Strong noise-to-signal ratio such as the one in the urban soundscape is actually a very favorable environment for memetic development. Memetic evolution happens every time cultural information is imitated with any variation. It is easy to imagine a juvenile songbird listening in focus to a very intricate song, which somewhere in the middle got distorted by the sound of a car horn. It is not possible for the learner to mimic the distorted song in original shape, and so it gets a little twist. If this happens frequently enough, chaos may ensue and songs may lose all their meaning. In this regard, Slabbekoorn is wrong to say that these signal adjustments are not evolutionary changes. They may not be artifacts of genetic evolution, but they undoubtedly belong to the realm of the (memetic) evolution of culture.

Conclusions

The magnificent lyrebird must remain a symbol of Anthropocenic sonic violence done to all avians, or maybe even all non-human animals. The exact biomechanics of bird hearing are just being discovered and the future fate

15 M. Bregman et al., 'Songbirds…', 1–3; H. Brumm, 'The impact of environmental noise on song amplitude in a territorial bird', *Journal of Animal Ecology*, 73 (2004) 2–3.

16 H. Brumm, and Zollinger S.A., 'The evolution of the Lombard effect: 100 years of psychoacoustic research', Behaviour, 11/13 (2011), 1–11.

17 H. Slabbekoorn, 'Soundscape…', 42–49.

of songbirds remains unpredictable. The researchers are constantly amazed at just how different from ours can another sense of hearing work. What we do know for certain is that human-made noises introduce chaos to songbird communication, which inevitably leads to a challenge for their wellbeing and even survival. It is indispensable that scientists and scholars across disciplines join forces in the very intricate matter of birdsong. Perhaps, everybody would like to meet a lyrebird one day.

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Abstract

Human-made noise pollutes the Earth further every day. It is important to investigate how that process affects the whole biosphere. I present a symbolic case of the Australian lyrebird, which is a songbird that mimics the sounds of its surroundings. Today its songs sound like chainsaw and other heavy machinery. All animal species are polluted by human noise to some extent. There are many studies about sonic perception in animals, but it seems that this knowledge is still hardly popularised. The phenomenon of sharing sounds between humans and other animals may also be better understood by new approaches to studies on cultural evolution.

Keywords

Lyrebird, Anthropocene, birdsong, memetics