Soundscape Enrichment for the Southern White Rhinoceros *(Ceratotherium simum simum)*

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Abstract

For species like rhinoceri that do not breed readily in zoos and are fast disappearing in the wild due to extreme poaching and habitat loss, understanding and removing any stress that might inhibit breeding is crucial. Zoological associations mandate environmental enrichment to "enhance the quality of captive animal care by identifying and providing the environmental stimuli necessary for optimal psychological and physiological well-being" [1]. Zoo policy may forbid unnatural-looking enrichment materials and physical space and budgets are limited. Rhinos have highly sensitive hearing but little is known about their response to sound events, including those to which they may be exposed in everyday zoo life. Enrichment was trialled using selected sound recordings, and behavioural response to a variety of soundscape elements was documented according to conventional enrichment guidelines. Direct responses and immediate enrichment were noted. Sound may prove a cost effective and practical enrichment tool, and understanding soundscape response and controlling noise may provide a new concept in animal care.

Introduction

In the wild rhinos are nimble, active and vocalize frequently. In a single night a male may patrol 65 square kilometres and run at over 55 kilometres per hour [2]. In a small confined exhibit they may do little more than lie or stand. They are extremely myopic but have exquisite senses of hearing and smell. However there has been minimal study of rhino soundscapes and even less of using sound for enrichment.

Figure 1: A male rhino may patrol 65 km^2 of dense bush or open grassland savannah a night. URL: http://www.rhinos-irf.org/rhinoinformation/whiterhino/index.htm

Animals are attracted or deterred by specific sounds, and even a tiny sound can provoke flight or frightened freeze. Physiological changes may occur due to sound, for example farmers testify that cows produce more milk when certain music is played [3]. The World Health Organization warns how not only extreme or chronic noise can impact humans, aspects of sounds can cause both mental and physiological stress [4]. Chronic noise, high amplitudes and low frequencies have been shown to negatively impact the behaviour and hormone levels of captive giant pandas, particularly during certain stages of their breeding cycle [5] [6], demonstrating that non-human mammals may be impacted by the same aspects of noise as humans. In the only study to consider the impact of environmental noise on rhinos, stress-provoking aspects of captive environments were implicated as potentially serious obstacles to captive breeding programs for black rhinoceros *(diceros bicornis)* [7]. While the soundscape analysis was limited, it indicated general trends relating noise levels to early mortality, unnatural behaviour, diminished well-being and diminished reproductive success.

Modifying the soundscape can provide positive responses in humans and in animal species, as is well recognised in music therapy for example. Music, especially if it incorporates a strong rhythmical element, can affect human heart rate and breathing, promote the release of endorphins, reduce muscle tension and promote relaxation, release memories or negative feelings that may have been repressed and thus improve behavioural issues, and improve physical coordination [8]. And not only is music being produced for dairy cows, re-orchestrated recordings with species specific tempos, harmonics, frequency ranges and rhythms for cats and dogs are increasingly popular, such as the "Through a Dog's Ear" series aimed at calming stressed pets during specific circumstances such as storms or car travel [9].

Natural soundscapes are information-rich and directly and indirectly essential to survival [10], being the basis of diverse essential behaviours [11]. Urban soundscapes are anthrophonic, with vastly different physical and semantic characteristics, and information is buried in pervasive noise.

Little is known about safe sound levels and frequency exposure for animals, but the only extreme amplitudes in nature are potentially disastrous so to be feared, and studies reveal substantial changes in the behaviour and survival of an ever growing number of populations that have been chronically exposed to noise. Captive animals cannot avoid ambient noise and are often exposed to high levels of unnatural noise at frequencies and pressure levels that would never exist in the wild.

Methodology

Study Site

For over a decade a Texan university summer school offered a popular course in Enrichment for Captive Animals in conjunction with an urban zoo. In 2003 the chief mammal curator mentioned that little effective enrichment had been created for their three white rhinos, two wild-born and one from a U.S. wildlife park. As with many other zoos, policy excluded the use of unnatural-looking materials.

Situated on a river in a huge natural-bush park in a city of about 125,000 people, the zoo offers a quiet oasis but careful listening discloses its distinctly urban character, with the almost constant sound of unseen traffic and frequent distant aeroplanes, trains and cars crossing river bridges, dogs barking, and emergency sirens. Throughout the day one hears ongoing zoo activities from feeding and cleaning to general maintenance, and the sounds of children and adults of all ages and moods.

Goals

Since few zoos have the resources to supply anything like natural habitat for such large animals, this project sought to cost effectively draw the rhinos' minds if not their bodies out of the confines of their exhibit by introducing elements of their natural soundscape. It also sought responses to many sounds to which zoo animals are regularly exposed, and to a selection of music that could potentially form therapy for the rhinos and a pleasant background for zoo visitors.

Specific goals were to explore response to frequent zoo sounds to determine whether they may alter behaviour or apparent stress levels, and whether the soundscape may be modified to stimulate or calm.

Process

For this preliminary study recording equipment was unavailable. CDs and cassette tapes of music and radio sound files from the library of the British Broadcasting Commission were presented on seven consecutive nights in the rhinos' nighthouse using a simple portable stereo player with internal speakers. For minimal ambient noise I arrived about 5pm while the rhinos were fed and after zoo visitors had left so they would become accustomed to my presence. I played the recordings approximately 7-10pm after zoo staff had also departed and urban traffic had subsided, and until all the animals appeared to sleep deeply. I noted behaviour well before, during and after each sound challenge, and on later nights and in completely different scenarios I repeated sounds to which they had strongly responded initially. The animals were free to move inside or out at all times.

Geophonic and biophonic sounds likely to occur regularly at the zoo or in natural white rhino habitats were explored first - such as weather events, waterfalls and running creeks, and appropriate insects, birds, and inter- and intra-species' calls. Anthrophonic recordings were gradually added, including children and adults in many different moods, or simply as pedestrians or playing. Next recordings of many types of transportation and machinery that was likely to be used in zoo maintenance and reconstruction were interspersed, and later instrumental, vocal, ethnic and mood music. Rest time was provided between each sound clip so the rhinos could re-assume accustomed behaviours.

Results

Responses were almost all immediate and frequently the same from all three animals, although not always from the captive-born male. This was especially the case following biophonic recordings from African savannah habitats, likely similar to those from which the females had been taken about two decades earlier. The females appeared particularly curious about those recordings, walking along their moat or putting their heads in bushes and sniffing the air.

In contrast to the midsummer drought at the time, the first recordings included wind, an approaching storm, gentle rain, and later hail on a tin roof. All the rhinos got up for each of these to sniff the air and explore outside. They responded similarly for most birds, for some insects and other creatures, for pedestrians, crowds and some singers. For a number of other anthrophonic sounds such as road vehicles, planes and barking dogs they simply pricked their ears and looked in the direction of the CD player, and often stepped towards it. They would rarely if ever see the true sources of such sounds, so it may be that they were not prompted to look for them in their exhibit.

In the wild birds sit on rhinos and pluck at parasites. Should the birds suddenly startle and fly away, it is a warning to the myopic rhinos that they may need to alert to a potential danger. Thus rhinos and some birds are interdependent and this may be a reason why the wild-born females in particular appeared soothed by many bird calls.

They were also calmed by slow, rhythmic, deeper tones including baritone singers (they appeared to like Elvis Presley's crooning the most), often coming inside and standing quietly near the sound source with ears and eyes in its direction, sometimes swaying slightly, or sitting or lying down during such recordings, and on later nights occasionally appearing to go to sleep during them. Deeper toned instrumental music, qigong and meditation music, Indian pipes and light classical piano provoked similar responses. The opposite occurred in response to high frequencies such as high speed drilling, high or loud or irregular or non-rhythmic music, to violins and to soprano voices and instruments. Sometimes they moved as far away as possible from these, to the extremities of their enclosure.

In daily life the male rhino would interact little with the two females, however all three interacted more following some bird calls and some music. They also vocalised more, particularly in response to some bird calls, some animals, some female singers, and to a recording of a human baby. Vocalizations ranged from their low exhaled huff greeting to loud challenging roars. Most zoo rhino keepers interviewed reported hearing only a few different vocalizations, but wildlife park rhino keepers reported several types. Textbooks claim a dozen, all of which I heard throughout the week and notated phonetically since recording equipment was unavailable. It is most unusual for zoo rhinos to be so

vocal and to use so many varied expressions, so this in itself is a significant achievement of the enrichment.

For the first few days all three rhinos appeared immediately curious and responded actively to most recordings, and also interacted with each other and used more, and more varied vocalisations than previously observed. Such stimulation of mind and body are desired goals of an enrichment protocol. Later they started focusing on me or in the direction of the CD player rather than searching outside, especially for previously played recordings. Their acute hearing provided the correct sense of direction, since all the sounds emanated from one section of their nighthouse. At the end of the week apparently pleasant or unpleasant sounds, particularly music, still caused them to move inside or outside respectively, and they sometimes moved inside to investigate a new recording.

The most significant responses were firstly to a strident marsh frogs' chorus which may have been an alarm, as when an upstream flood approached. On the first two nights this was played they rapidly went to their moat and walked up and down it, vocalising repeatedly. But the final night they responded little.

However they were extremely agitated all three times they heard the tiny sound of a six week old human baby sneezing, then crying for a few seconds and finally gurgling happily. The first time they jumped up from lying and seated positions and rushed to the bars nearest the recorder, snorting and snarling loudly and remaining agitated for at least an hour despite my playing other recordings that had previously seemed to have calmed them. On the next playing they again came up to the bars panting loudly and fast**,** pawing the ground and stomping, then all three rushed outside to the most distant location and formed a star, crouched with their backs to each other. Despite some rain they stayed in this protective formation throughout the night and until their keepers moved them at 7am. The night watchmen passed them every twenty minutes since they had never seen such a response, and reported that the rhinos stayed on guard all night, never lowering their heads. They were defiant when I arrived at their nighthouse the next afternoon, leaving their food and coming direct up to me at the bars, legs braced apart, with their heads pumping up & down. There was no soft huff greeting, but a much stronger vocalisation. They did not return to their food that evening. Their third exposure to that extremely quiet recording of the tiny baby sneezing then crying was on the sixth night. As with all replays for the third time, their response was not as dramatic but was quite different. They had appeared to all be in a deep sleep with long, regular breathing and no movement for over half an hour. The recording was so quiet that someone entering the nighthouse may not have heard it. However it broke their sleep and all three jumped up, froze in an alert position looking straight at me, then came direct to me at the bars. They seemed to search behind and around me with their eyes, moving their ears and sniffing. Then the two females exited to the furthermost point of their enclosure, and the male stayed on guard, legs apart and head down, vocalising and staring at me without moving until I left about an hour later. None of the rhinos responded to any other recordings that evening. When I arrived the next afternoon the senior female boomed defiantly and all three remained agitated throughout the evening, responding little to any recordings.

The chief mammal curator and other staff had never seen such response and were extremely concerned that the sound of a six week old baby sneezing then crying could cause such prolonged and repeated stress. When no-one could offer a good explanation, I emailed over a dozen zoos and wildlife parks around the world that had successfully bred this species. None could offer a confident explanation, but all were concerned as zoo and wildlife rhinos were likely to hear babies on a frequent basis. Eventually Dame Daphne Sheldrick, who has hand raised and reintegrated orphaned elephants and rhinos back into the wild for over 30 years and was the first person to develop a solution similar to a rhino mother's milk, suggested the rhinos' response to the baby recording was because the sneeze was very similar to a frightened rhino mother summonsing her calf when lions or hyenas approach, giving a tiny "psst" so quiet that even the big cats are unlikely to hear.

Discussion

The degree of response to these acoustic challenges warrants repeating the project over longer time with multiple hidden sound sources, random remotely controlled playback, and with acoustic and video recorders to verify and quantify results, particularly regarding the number and frequency of vocalisations since even the expert rhino keepers had not heard as many types of vocalisations in zoo rhinos. Retesting at a variety of zoos in unexpected circumstances and with the assistance of zoologists to monitor physiological changes such as cortisol levels would help identify a library of useful sounds to enrich and to promote well-being. Ground vibration could be similarly tested to explore seismic communication and response. Since the captive born male did not respond to some African bird and animal recordings, acoustic stimuli should be individually selected, as with other enrichment tools.

As well as adding to the soundscape by the addition of selected sound tracks, noise reducers such as sound barriers may prove beneficial to reduce ambient noise that animals appear to dislike. Sound absorbing walls or banks could be planted with appropriate graze and above that with vegetation selected to attract appropriate bird and insect species, whose calls would in turn enrich the enclosure soundscape. It may be possible to attract birds that would interact with the rhinos as in their natural habitat, to peck at parasites and warn of danger.

A similar protocol could be used to explore appropriate soundscape enrichment for a wide variety of species. The two main goals of modern zoos are species conservation and public education. With greater understanding of captive soundscapes and how they may be manipulated, it may be possible to modify them for each species, benefiting both the animals and zoo visitors.

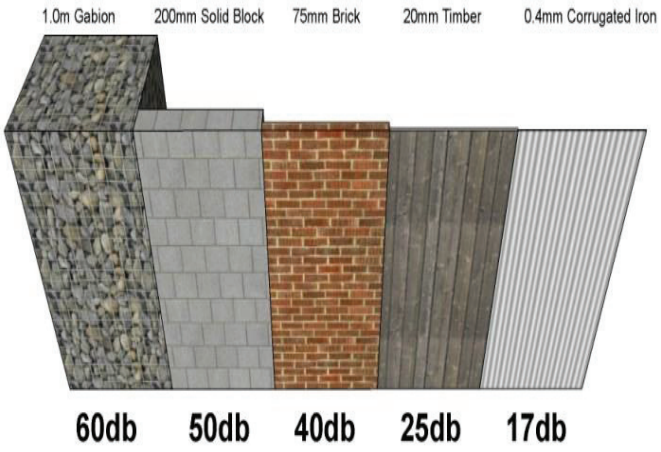

Figure 2: Sound absorbing walls and banks could protect animals from the often pervasive ambient noise in urban zoos. URL: http://www.gabion1.co.uk/gabion_noise_barriers.htm

Figure 3: Walls could become attractive vertical gardens, planted below with graze for the species concerned and above with vegetation selected to attract appropriate birds. URL: https://www.pinterest.com/pin/210050770092858725/

Conclusions

This study showed that rhinos and probably many other taxa directly respond to their soundscape and that soundscape enrichment may be used to stimulate healthy behaviour, to calm before potentially stressful situations such as veterinary treatment, and to thereby promote psychological and physiological well-being. Soundscape modification may prove a useful tool in animal husbandry even in confined space and in zoos that do not wish visitors to see unnatural-looking enrichment tools.

Thus this project revealed an alternative, potentially cost effective and manageable form of enrichment that may provide a new concept in animal care.

Acknowledgements

Dr. Heidi Marcum, Baylor University, Texas, for developing the Enrichment for Captive Animals course and for giving me the opportunity to undertake this project.

Zoo personnel, especially the then chief mammal curator, zookeepers and night security wardens.

Dame Daphne Sheldrick, Anna Merz, the International Rhinoceros Foundation, sanctuaries, and the conservation and zoological societies which corresponded regarding these findings.

Prof. Dr. Brigitte Schulte-Fortkamp, Technische Universität Berlin, for her active development of soundscape research and for inviting me to present this paper.

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