INTERNATIONAL WILDLIFE REHABILITATION COUNCIL

Volume 33, Number 1, 2013

JOURNAL OF WILDLIFE REHABILITATION

IN THIS ISSUE:

The *Journal of Wildlife Rehabilitation* is published by the International Wildlife Rehabilitation Council (IWRC), P.O. Box 3197, Eugene, OR 97403, USA. (ISSN: 2166-9198).

JOURNAL OF WILDLIFE REHABILITATION

Volume 33(1)

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PEER-REVIEWED PAPERS

DEPARTMENTS

Background Music to Reduce Startle Response in Wild Avian Species During Rehabilitation

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Bonin Petrel (*Petrodroma hypoleuca*).

ABSTRACT: In accordance with traditional standards, wildlife rehabilitation facilities strive to keep their patient environment quiet and stimuli free. However, nature is not silent nor do all stimuli cause stress. Auditory stimuli can trigger the hypothalamic-pituitary-adrenal axis (HPA), leading to the production of corticosteroids. This study was established to determine if background music acts as a reducer of auditory stressors as indicated by a reduction of visible startle responses. Through an observational study over 2 yr, with various avian species, Three Ring Ranch keepers monitored the number of startle responses while radio music played in an adjacent room and when no music was played. Easy listening music was played at 50–63 decibels (dB), as measured in the animal treatment room by an LAS (slow, A-weighted sound level; collectively dBA) handheld meter. A noticeably lessened startle response to extraneous sounds produced during day-to-day facility operation was observed. Furthermore, our data suggest that background music may reduce the frequency of startle response and the severity of the response and may, therefore, be advantageous in the rehabilitation of wild avian species.

KEY WORDS: Auditory stimuli, avian, background noise, minimum standards of care, music, startle response, wildlife, wildlife rehabilitation

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J. Wildlife Rehab. 33(1): 13-18.

Introduction

Widely accepted standards for the care and treatment of injured wildlife incorporate recommendations for the appropriate enclosures within rehabilitation facilities. These recommendations include covering cage doors, providing visual barriers, positioning cage fronts away from human activity, removal of radios, and placing cages far from areas of high traffic noise (Miller 2000). Although most wildlife rehabilitators follow these methods to the best of their ability, it is neither physically possible nor psychologically beneficial to the animal to eliminate all sound from the environment. In fact, it has been found to be detrimental to the animal, a phenomenon known as sensory deprivation (Gravel and Ruben 1995). During stages of critical development, it is especially harmful for an animal to experience sensory deprivation because it can impede the development of neural synapses in the brain (Schierloh *et al.* 2003). Eliminating sound altogether is also unrealistic due to the fact that nature is not silent. In nature, sound pressures range from 20–40 dB (Morgan and Tromborg 2007), depending on the natural habitat of the animal. In rehabilitation facilities, sound pressures can be within a much higher range and may cause animals to exhibit stress.

The goal of a rehabilitator is to let the wild animal recover in a stress-free environment; this fact causes us to re-evaluate accepted stressors. A stressor is any external factor that disrupts the overall well-being of the animal, including homeostasis, thus setting off a sequence of physiological events that prepare the body for a "fight or flight" response (Morgan and Tromborg 2007). Short-term stressors, such as sudden noises, can cause observable behavioral responses including looking in the direction of the stimulus, startling off a perch, alarm vocalizations, or animals battering their bodies against the sides of an enclosure (Morgan and Tromborg 2007).

In order to reduce the number of startle responses caused by abrupt noises, background radio music is now utilized at the Three Ring Ranch Exotic Animal Sanctuary to mask the effect of such noises and attempt to reduce startle responses. Facility personnel observed that having the radio on in an adjacent room appeared to reduce stress-related behaviors of the animals, presumably by lessening the impact of sudden noises at higher decibel levels. Previous studies with various species indicate the positive effects of music on captive animal health and welfare. A study testing the effect of stereo music on chimpanzees showed a reduction in aggressive behavior and an increase in relaxed social behavior (Howell *et al.* 2003). Similarly, classical music used as a form of auditory stimulation—as opposed to bio-specific rainforest sounds or no music at all—for zoo-housed gorillas caused gorillas to exhibit more-relaxed behavior (Wells *et al.* 2006). Originally designed as behavioral enrichment, this study also suggests that using music may not be as much a form of sensory enrichment as it is a "mask" for everyday background noises experienced in a public zoo environment (Wells *et al.* 2006). Another study found that cotton-top tamarins (***Saguinus oedipus***) did not respond to emotional aspects of human-based music but did react emotionally to music composed in their frequency range and tempo (Snowdon and Teie 2010), which led to the use of species-specific music. Some may argue that, because the species involved in these studies are primates, their response to music may be more similar to that of humans than of other animal species (Howell *et al.* 2003). However, further studies with non-primates have comparable findings, showing that some other mammal species respond similarly to background music.

One such study involved the housing of canines in a stressful environment. Dogs in a kennel environment that were exposed to classical music selections exhibited less body shaking, and more time sleeping rather than moving around and vocalizing (Kogan *et al.* 2011). A sector of the animal husbandry community already supports, and even encourages, the use of background music to reduce stress in species prone to hyperarousal (van de Weerd and Baumans 1995). In a resource created for laboratory animal caretakers, van de Weerd and Baumans (1995) suggested radio music be used as background noise for small prey animals, such as guinea pigs, because they seem to startle easily.

We were unable to locate any studies that provided data (related to avian species) which indicated that background music had the same effect on birds. However, we believe that the cited mammal studies, along with our observations, suggest there may be similar benefits to birds. To our knowledge, our study is the first to examine wild avian species through 1) use of background music to mask acute auditory stressors, and 2) an evaluation if background music reduced the startle response in birds.

TABLE 1. TESTED AND MEASURED SOUNDS REPRESENTING ACUTE AUDITORY STIMULI DURING ROUTINE FACILITY OPERATION. ALL SOUNDS WERE MEASURED WITH A HAND-HELD LAS METER SET ON SLOW- WEIGHTED A SOUND LEVEL (=DBA).

MEASURED SOUNDS	DECIBEL (DBA)	CHANGE IN DBA FROM BASELINE WITH RADIO
Radio	<50–63	0
Car door closing	63	<1–10
Feed room door closing	69	<0–7
Volunteers speaking	53–65	<0–15
Car horn	66	<3–16
Walking on gravel	54	<0–4
Dishes clattering or dropped	64–71	<1–21

Materials and Methods

The study took place over a 2-yr period and consisted of observing the startle responses of varying avian species in rehabilitation at the Three Ring Ranch Exotic Animal Sanctuary. All wildlife being rehabilitated was kept in a treatment room within our barn facility; the door to this room was kept closed at all times. All patients were kept in species- and injury-appropriate caging following the accepted standards for wildlife rehabilitation (Miller 2000). All patients observed during this study were presented a single variable: radio off or radio on. All other conditions such as habitat, visual, and olfactory stimuli were kept constant for the duration of the observation period. The radio was also kept on the same easy-listening station and the volume level on the radio was kept constant, with a range of 50–63 dBA determined by fluctuations within songs measured in the treatment room. The decision to use either a sound level ("Fast" or "Slow") or an Leq/Lavg is usually determined by any measurement regulations that are being followed or by the nature of the noise being measured. The sound level, expressed in decibels (dB), is the basic measurement used for many applications. Under "Slow weighting" (dBA), the needle would be damped to smooth out the noise so it is easier to read. Hand-held meters of this kind produce accurate readings and are reasonably priced. The more advanced Leq/Lavg equipment begins at over US$5,000 and is usually only required for OSHA or commercial applications. For the purpose of this discussion only, white noise is defined as a base auditory stimulus and ranges from approximately 50–63 dBA. The distance from the radio to the treatment area remained constant at 10.36 meters. All wildlife species observed were studied under the same "everyday facility" sounds listed in Table 1 under both periods of care. Testing began on day one post-arrival for care. This allowed us to see the responses prior to any habituation to facility noises. To monitor the patients' startle responses, a mirror was set up in the barn's treatment room

TABLE 2. THE RECORDED STARTLE RESPONSE FOR INDIVIDUALS OF EACH SPECIES OBSERVED UNDER TWO, 30-MIN OBSERVATION PERIODS.

ORDER, SPECIES, AND TOTAL	TEST PERIOD A RADIO OFF			TEST PERIOD B RADIO ON		
	NO STARTLE	BRIEF STARTLE	FULL STARTLE	NO STARTLE	BRIEF STARTLE	FULL STARTLE
PASSERIFORMES						
HOUSE FINCH *(Haemorhous mexicanus)*	0	0	2	0	0	2
NORTHERN CARDINAL *(Cardinalis cardinalis)*	0	0	1	1	0	0
TOTAL	**0**	**0**	**3**	**1**	**0**	**2**
FALCONIFORMES						
HAWAIIAN HAWK *(Buteo solitaries)*	0	0	7	7	0	0
HAWAIIAN OWL *(Asio flammeus sandwichensis)*	0	0	1	0	1	0
BARN OWL *(Tyto alba)*	0	0	6	6	0	0
TOTAL	**0**	**0**	**14**	**13**	**1**	**0**
ANSERIFORMES						
NENE (*Branta sandvicensis*)	0	0	4	4	0	0
TOTAL	**0**	**0**	**4**	**4**	**0**	**0**
PHAETHONTIFORMES						
WHITE-TAILED TROPIC BIRD (*Phaethon lepturus*)	0	0	1	1	0	0
TOTAL	**0**	**0**	**1**	**1**	**0**	**0**
CHARADRIIFORMES						
SOOTY TERN (*Onychoprion fuscatus*)	0	0	3	1	0	2
TOTAL	**0**	**0**	**3**	**1**	**0**	**2**
PROCELLARIIFORMES						
CHRISTMAS ISLAND SHEARWATER (*Puffinus nativitatis*)	0	0	1	1	0	0
WEDGE TAILED SHEARWATER (*Puffinus pacificus*)	0	0	5	3	2	0
NEWELL'S SHERWATER (*Puffinus auricularis newelli*)	0	0	1	1	0	0
HAWAIIAN PETREL (*Pterodroma sandwichensis*)	0	0	3	3	0	0
BAND-RUMPED STORM PETREL (*Oceanodroma castro*)	0	0	1	0	1	0
SOOTY STORM PETREL (*Oceanodroma tristrami*)	0	0	5	5	0	0
BONIN PETREL (*Petrodroma hypoleuca*)	0	0	1	1	0	0
TOTAL	**0**	**0**	**17**	**14**	**3**	**0**
TOTAL	**0**	**0**	**42**	**34**	**4**	**4**

Juvenile barn owls *(Tyto alba)*.

and a chair was placed outside that afforded a view of the mirror. The door to the treatment room was opened just enough to see both the mirror and the sound meter. The setup was maintained so that there would be no disturbance when preparing for observation periods. Birds were first observed with the music off and, when facility noises occurred, the bird's behavior was noted. The startle response to each sound was recorded and categorized as no startle response, brief startle, and full startle response. A quick turn of head or slight postural change of less than 3 sec duration, which exhibited a mild stress behavior at the moment of noise but returned to normal behavior very rapidly, was defined as "brief." A full postural change, stepping off perch or moving back for more than 3 sec, was defined as "full" startle behavior. A "no startle" response was assigned to patients that did not exhibit any of the startle behaviors described above. When the facility was quiet during an observation period, routine noises (examples include car door, footfalls on gravel, and dropping water pans) were deliberately created at a distance from the treatment room. Then music was turned on, the same noises were made, and observations of any response was noted. At the end of the 30-min observational period, data were compiled and grouped by order based on the degree of response for each species (Table 2). Each 30-min observation period included multiple auditory stimuli that had the potential to cause significant startle responses during both the periods of music on and music off. During their rehabilitation, each bird was assessed twice for 30 min. Observations were made on a wide variety of avian species under rehabilitation, as this accurately reflects our avian patient population. While startle responses vary based on species, all experience auditory stimuli while in care and all species exhibit measurable startle responses (Cockrem 2007; see further discussion in Results).

To analyze the results, a Wilcoxon signed-rank test for nonparametric data was run. The data were grouped according to species to give a sample size of $n = 15$ (Table 2). The three categories of no startle, brief startle, and full startle response were organized into two categories in order to perform the test. The no startle and brief startle categories were combined to create a new "lessened startle" category in order to compare the change in response of the patients with an emphasis on whether one treatment is more likely to cause a high degree of startle. This allowed us to perform the directional Wilcoxon signed-rank test on the difference between the discrete number of lessened startle responses and full startle responses for all species observed. The null hypothesis was that there would be no difference in startle response between the radio being on and radio off.

Results

The compiled data showed an observable difference in startle response between the two groups, with radio on showing less startle than radio off. Of the 42 individuals observed, all 42 showed a full startle response to the tested sounds without a radio playing background music. In contrast, with the radio on, only 4 of the 42 individuals showed a full startle response, 4 showed a brief startle response, and 34 showed no observable startle response. However, not all species or individuals responded identically to the test (Cockrem 2007). Some species, particularly the "flighty" species such as finches, showed full startle responses within both periods. Within some species, certain individuals responded differently to the two periods, with some exhibiting an improvement in startle response and some exhibiting no difference. Despite this, there was an overall decrease in startle response among the observed wildlife from full startle, to brief or no startle, when changing from the radio off to the radio on.

We established significance at a value of $P \leq 0.05$. The Wilcoxon signed-rank test showed a significant non-zero difference between the two observational periods, with startle response from having the radio off being greater than that when the radio was on ($Z = 3.28$; $n = 15$; $P < 0.001$). Because the probability of obtaining these results by chance is below the critical value, we rejected our null hypothesis and concluded that there was a statistically significant difference between the two observational periods within our sample population.

Discussion

We believe that our results suggest the beneficial effects of using music as a masking sound to lessen the startle effect in rehabilitating wildlife. Intense noise can be frightening, especially to naive individuals. With repeated exposure, all vertebrates habituate or adapt behaviorally and physiologically to noise (Bowles 1995). It is not unusual to see a difference in responses, even within a species, because corticosterone stress responses and behavioral responses to stimuli vary markedly between individual birds (Cockrem 2007). Instead of striving for an absolutely silent environment, we suggest that wildlife rehabilitators focus on minimizing potential stressors caused by sudden auditory stimuli. At Three Ring Ranch, background radio music proved to be an effective method for minimizing the response to startling noises. We do not wish to imply that the radio music should be used in such a way that wildlife could become habituated to humans. The usual precautions of visual screens and avoidance of handling must be followed. We simply present our observations in order to demonstrate the impact that background music had on lessening startle responses in birds during our study. It has been demonstrated that long-term noise stress can lead to increased blood pressure and tachycardia due to the extended activation of the hypothalamic-pituitary-adrenal axis (Morgan and Tromborg 2007). These conditions put excess metabolic demands on the body, diverting crucial resources away from the healing process (Gage and Duerr 2007). With further research, it may be proven that reducing the startle response will also reduce stress.

At Three Ring Ranch, animals brought for care are eventually moved from the treatment room to aviaries, mews, or a flight cage—where they experience normal auditory stimuli as they recuperate. These structures are distant from the sound of the radio. We used background radio music during the initial rehabilitation period to prevent overwhelming the animal by the sounds that occurred within the confines of the barn.

The decibel level of the background music is generally lower than that of many sudden noises produced around the facility. Although the sound pressure from the radio is lower, it appears to mask any potential pressure created by sudden sound fluctuations. When a sudden noise occurs, the animal has already habituated itself to a certain level of sound (Bowles 1995). The jump in sound pressure caused by the sudden noise would be less than if there were complete silence. For example, if a volunteer slammed a door at a level of greater than 60 dBA, and the radio was playing at 50 dBA, the change in sound level would only be 10 dBA. If the radio was off, the change in sound pressure would be much greater—a jump from 0 to 60 dBA, which is much more startling to an already tense animal.

In a veterinary clinic setting, isolation rooms may be used for wildlife rehabilitation but they are not completely sound-proof. The predatory sounds of dogs barking and cats meowing may be present in these rooms and are potential auditory stressors (Hendrie and Neill 1991; Remage-Healey et. al. 2006; Morgan and Tromborg 2007). Background music may help to mask these sounds and, thus, minimize adverse effects.

Despite the limited conclusions available from other qualitative research, this study was purely observational in order to ensure the well-being and success of the rehabilitated patients at Three Ring Ranch. Many of the patients are endangered or fragile species (or both) that should not be put under the excess stress of multiple blood draws during the study. Further studies (at a rehabilitation facility treating non-endangered species) testing physiological and psychological changes, including blood work with corticosteroid levels as well as species-specific background sounds, are needed to confirm the true effectiveness of using background music as a tool to reduce stress arising from sudden noises.

Conclusion

Even though the commonly accepted practice during wildlife rehabilitation is to remove the animal to a quiet room away from auditory stimuli, our data indicate that using background radio music to decrease the frequency of startle events in avian species is a viable treatment option. While further experimental research is required to confirm the observed benefits of background music, the statistical significance of our data suggests that use of music as background noise in wildlife rehabilitation facilities may be advantageous.

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PHOTO © NORM GOODY.

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