The Physiological and Behavioral Effects of Radio Music on Singly Housed Baboons

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ABSTRACT

The response of four singly caged baboons to radio music was measured using behavioral and physiological Indices. Heart rate and blood pressure, measured through a tether system, as well as behavior, were recorded during a two-week period in which radio music was available in half of the samples. The behavior of the subjects, as well as their blood pressure, did not vary in relation to radio music. Heart rate was significantly lower when the radio was on.

Key words: sound - Papio - environment enrichment

INTRODUCTION

The effect of environmental stimuli on the captive animal has been of great interest to those working with laboratory, zoo, and farm animals. The increased emphasis on environmental enrichment and the relation between environmental factors and an animal's physical and psychological well-being have been studied, particularly in nonhuman primates. Many studies have produced important findings on the impact of social, structural, and feeding variables on captive animals, and how enrichment techniques can be used to increase the subject's well-being [14.21]. However, less information is available on sensory stimulation, such as the effect of different olfactory and auditory environments.

Although lighting, temperature, and housing structure and size are strictly regulated in most lab and zoo facilities, the acoustic environment is rarely monitored or controlled [13]. Many laboratory animals, including rodents, cats, dogs, and small primates, are sensitive to high-frequency sounds, outside the range audible to humans [3,20]. Conventional housing, with surfaces that are very reflective acoustically, results in high noise levels, especially during working hours [13,18]. The type, frequency, and strength of the noise can have important consequences for captive animals. For instance, audiogenic seizures, behavioral disturbance, and physiological changes have been related to loud sound in rodents [6]. In rhesus macaques. 100 dB sounds were associated with increased cortisol levels during the first hour of exposure to the noise [8]. After nine months of exposure to loud noise, rhesus had significantly higher blood pressures [18]. Opening the door between adjacent rooms housing cotton-top tamarins, which increased the relative amplitude of the vocalizations by 5 dB. simulated territorial encounters between groups, with increased and directed vocalizations [11].

Using sounds as enrichment has been attempted in a number of settings but the physiological and behavioral effects still remain unclear. Radio music has been related to a decrease in abnormal behavior in rhesus monkeys [16]. However, increased arousal levels were noted in adult gorillas when rain forest tapes were played, and more stress- related

behaviors were noted when sounds of caretakers and bonobo vocalizations were available [17].

More information is available on the effect of music in humans. For example, students performed significantly better on arithmetic problems when music was played, in comparison to industrial noise [23]. Music has both psychological and physiological effects, often depending on the type of music. Stimulating or arousing music has been related during test-taking to increased worry and increased galvanic skin response and pupil dilation, while sedative or calming music had no effect or an opposite effect [22]. Arousing or calming music had different effects on skin temperature changes in human subjects [12].

Control over the sound may be an important factor. Monkeys that were able to control continuous white noise had lower cortisol levels, and lower levels of aggression later in a group setting, than yoked control monkeys without the ability to turn the sound on or off [7]. Markowitz and Line [10] reported that rhesus monkeys continued to operate a radio throughout a 20-week period, and played the radio about half the time. A carefully controlled study reported by Novak and Drewsen [14] compared monkeys with access to a music box, which allowed them to turn music on and off, to monkeys with a box but without music. They found that the music box group had higher affiliative behaviors during the music condition. No other behaviors were significantly altered, and no cortisol changes were found.

Constant low-level sounds can make other noises appear less loud. a phenomenon called masking. Anecdotal reports indicate that music may have a calming effect on nonhuman primates [l], possibly due to the masking of other, more stressful sounds. However, Ogden and colleagues [17] reported that in two adult gorillas the playing of rain forest sounds was associated with increased arousal, indicating that the sounds did not mask other noise, but may have increased vigilance in the animals due to an inability to locate the sounds. The rain forest sounds were associated with lower arousal in two infants.

Certainly more information is necessary to determine the effect of the acoustic environment on nonhuman primates. The purpose of this study was to determine the behavioral and physiological effects of radio music on singly caged baboons. Radios were available in indoor housing areas because the staff reported a calming effect, and it was expected that heart rate, blood pressure, activity, and social behaviors directed outside the room might be lower when the radios were played.

MATERIALS AND METHODS

Subjects

The subjects of this study were four baboons (three Papio hamadiyas anubis and one P. h. anubis-hybrid). Two were males and two were females between 2.53 and 2.87 years old. They were housed in standard cages, measuring 87.6 cm wide x 101.6 cm deep x 127 cm high, and had a cage toy available. The subjects were fed a commercially available monkey diet once daily and the cages were washed once daily.

Radio

Radio music was available to the baboons through a speaker mounted above the doorway in their room and connected to a receiver in an adjacent room. The music available during this study was a local radio station playing "oldies." The radio was normally available to all the baboons in this building during daytime hours, from 0600-1800, and was turned on and off with a timer. Thus, the baboons were previously familiar with the radio music. During this study, the radio schedule was

altered to allow measurement of behavioral and physiological variables during both "radio on" and "radio off' conditions. The radio was turned off during ten half-day periods randomly selected during the two- week study and balanced for morning or afternoon.

Behavioral measures

The behavior of each of the subjects was recorded during 20 15-min. focal animal samples collected during the two-week period, half when the radio was on and half when the radio was off. The samples were balanced for morning (1000-1200 hr) and afternoon (1400- 1630 hr) data collection. Individual behaviors were recorded with a portable computer and grouped into 11 behavior categories (see Table 1).

Table 1. Behaviors and behavior categories

Behavioral categories	Examples of behaviors
Abnormal	Clasping self, eye-poking, floating limb, pacing, pull or eat hair, regurgitation, self-aggression, stereotyped locomotion
Cage-directed	Oral, manual, or olfactory cage manipulation
Tether-directed	Oral, manual, or olfactory manipulation of the tether jacket or apparatus
Inactive	Crouch, hang, lie, sit, stand
Locomotion	Walk, bounce, climb, crawl, jump, run, swing, walk
Normal	Drink, eat, food-wash, urinate, defecate
Self-directed	Bite nails, groom, lick, manipulate self
Socially-directed - baboon - observer - outside room - unknown	Display, threaten, groom, present, watch, vocalize

Physiological measures

The subjects were taking part in a biomedical research project that required frequent monitoring of heart rate and blood pressure. This was accomplished with a tether system, which allowed continuous monitoring of physiological variables in conscious baboons. The tether consisted of a backpack and a stainless steel flexible cable that attached with a swivel at the top of the cage. The backpack was held in place by a cloth jacket fitted to the animal and held on by straps. The backpack held the arterial and venous catheters, electrical cables, and transducers. Cables and catheters exited the backpack and went up through the flexible cable to the top of the cage. A pump above the cage infused saline into both catheters.

Arterial pressures and heart rates were continuously recorded through a catheter implanted in the internal iliac artery. A Cobe pressure transducer was located in the backpack. which measured beat by beat measures of pressure. The analog signal was transmitted to an adjacent room where the signal was digitized. recorded once per second, and averaged over five-minute intervals.

Prior to the initiation of the study. the baboon subjects had been fitted with a sham tether system consistently of the jacket, backpack, and cable, but without the catheter implanted, to determine if the subject would tolerate the procedure. After two weeks of successful tethering, the baboons were catheterized and measurements began. Each subject was

immobilized once per week for a physical examination and calibration of the equipment (see [4] for a detailed description of the tether procedure).

During two-week study, measurements of arterial pressure and heart rate were obtained from 0900 to 1600 hr daily, except during calibration days. The weekday measurements were categorized into radio on or off conditions, resulting in 16 separate samples, balanced for condition and time of day.

Analysis

The behavioral data were collapsed into behavioral categories for each subject during the 20 behavioral samples. The physiological measures were collapsed into means for heart rate and blood pressure for each subject for each of the 16 samples. Repeated measures analysis of variance was used to analyze the data, using radio condition as the grouping factor. In addition, a comparison of the five 5-min intervals before the radio was turned on or off to the five intervals immediately after the radio was turned on or off was completed with a repeated measures ANOVA, and further contrasts compared the single interval in which the radio was turned on or off to the five preceding intervals. A significance level of $p < 0.05$ was determined.

RESULTS

Behavioral data

Analysis by behavior category did not indicate any significant differences in relation to the radio condition ($p > 0.05$), with behaviors similar in both conditions (Fig. 1). The frequency of vocalizations was analyzed separately. Only grunts and barks were displayed during the study, with the total number of vocalizations almost twice as high in the radio off condition (off = 106, on = 55). However, this difference was not statistically significant.

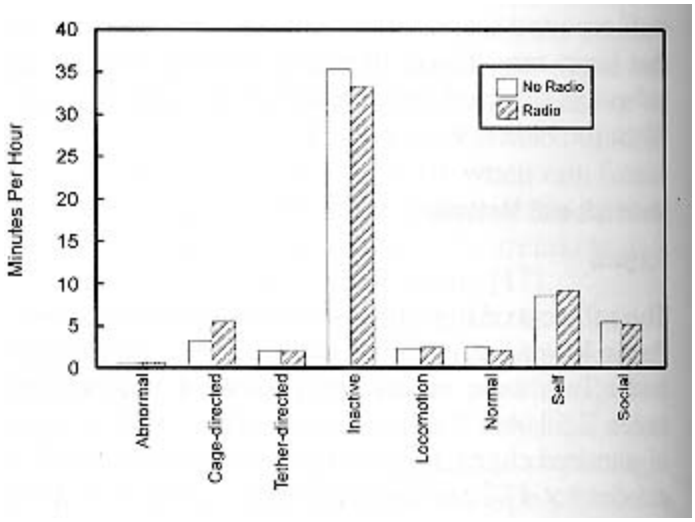

Figure 1. Behavior of the baboon subjects while the radio was off or on. No significant differences were found in relation to radio condition.

Physiological data

Mean heart rate was significantly lower during the radio on condition ($F = 52.541$, $p < 0.005$). While the radio was on, heart rate was an average of 100.4 beats/min (SD = 7.13) but while the radio was off, heart rate was 104.1 beats/min (SID = 6.18) (see Fig. 2). Mean blood pressure did not show a significant difference associated with radio condition (on = 90.95 mm Hg,

SID = 5.26, off = 93.39 mm Hg, SID = 4.32) (see Fig. 3). Systolic and diastolic pressures analyzed separately did not indicate any significant differences either ($p > 0.05$).

As physiological measures may be expected to change when the radio music was turned on or off, the 5-min intervals before and after a radio change was made were compared. No significant differences for either heart rate or blood pressure were found when the radio was turned on or off, and comparison of the single interval to previous intervals again produced no significant findings.

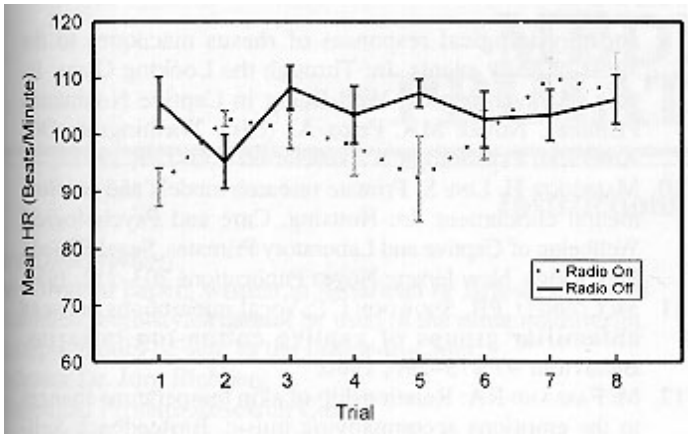

Figure 2. Mean heart rate of the baboon subjects over eight trials with the radio off or on. Heart rate was significantly lower when the radio was on.

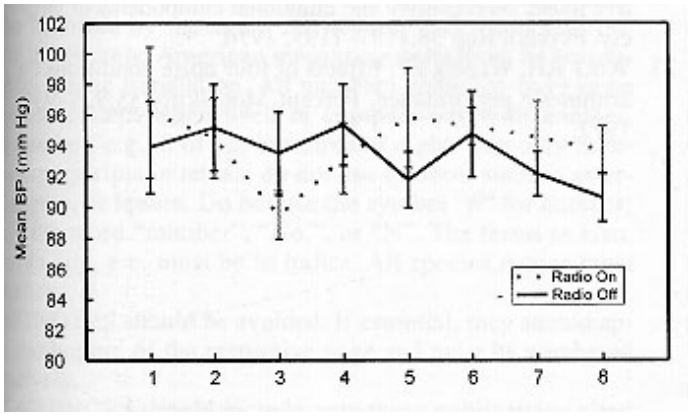

Figure 3. Mean blood pressure of the baboon subjects over eight trials with the radio off or on. No significant difference was found in relation ot radio condition.

DISCUSSION

In an assessment of the impact of environmental variables on a captive animal, a variety of measures may provide better information than a single measure. Especially when considering a passive environmental stimulation such as radio music, the use of physiological as well as behavioral measures may be necessary to detect an effect. In this study, no behavioral changes in response to radio music were found, although heart rate was lower when the radio was on.

Radio music and auditory stimulation have been used as enrichment in laboratory and zoo nonhuman primate housing areas. However, only a handful of studies have empirically evaluated the benefit of such enrichment. The few studies that have been completed have yielded results difficult to generalize to other settings due to methodological differences, but

have indicated significant behavioral effects [16,14,17]. It is important to note that these studies all used group-housed subjects. Perhaps behavioral effects related to radio music are more likely to be found in group- living subjects. Other reasons for differences between studies, such as species differences, radio control, and study design, are probably influential. However, it seems likely that the radios may not elicit as much overt behavioral response as other, more active forms of enrichment. A similar finding was reported for chimpanzees, who showed changes in abnormal and other behaviors when presented with simple toys, but did not display any significant behavioral changes when a television was provided [2].

The physiological data were thus an important additional measure of the impact of auditory stimulation. Cardiovascular measures are sensitive to environmental manipulations. Heart rate and blood pressure differences were noted in relation to the social environment in baboons [5]. Individual caging and housing with strangers were related to higher mean blood pressure than housing with familiar companions. and subjects housed with strangers had the highest heart rate and those in individual cages had the lowest [5]. Routine husbandry events were related to increased heart rate in rhesus macaques [9]. Heart rate thus appears to reflect general arousal, and may be sensitive to changes not apparent in behavior. The subjective observation that our baboons appeared calmer when the radio was on was supported with the finding of a decreased heart rate, which can be interpreted as a positive effect on well-being. Although loud noise has been shown to increase blood pressure in rhesus monkeys [18], the radio music played in this study was not associated with significant changes in blood pressure. The lack of significant changes in heart rate or blood pressure immediately after the radio was turned on or off indicate that the physiological change in heart rate is a more generalized effect, and not simply an immediate reaction to a change in the acoustic environment.

A reduction in the levels of loud, monotonous. or high-frequency sounds may be desirable in some laboratory settings. In this study, the reason for decreased heart rate may have been related to the masking effect of the radio on the sound coming from other animal rooms, the ventilation system, and the caretaking staff. The decrease in vocalizations, although not statistically significant in this small sample, may have been related to decreased extra-room communication. The use of music or sound to mask other environmental noises has not always had positive results, however, Pfaff and Stecker [19] reported that radio music was of limited value to mask noises in a rat room, because it did not mask the changes in the noise level. Increased activity and arousal were related to the rain forest sounds provided to adult gorillas, and only youngsters seemed to benefit from the masking effect [17]. Other methods to reduce extraneous and animal-generated noises may be useful [18].

The acoustic environment and its effect on nonhuman primates is an area in need of further study. This research project provided evidence for a decrease in heart rate in baboons when radios were played. This information is important for those interested in collecting physiological measurements, as radio music or other auditory stimulation may impact research results. As an enrichment option, the radios may be useful as an addition to other enrichments. Also, allowing the subjects to control the radio music may elicit more involvement [10], but behavioral effects may not reflect decreased stress or abnormal behavior [14]. Future studies on the impact of control, loudness, type, and masking ability of music may help to provide a clearer picture of the impact of radio music on nonhuman primates.

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