Auditory stimulation and control as sources of environmental enrichment for captive Rhesus monkeys.

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AUDITORY STIMULATION AND CONTROL AS SOURCES OF ENVIRONMENTAL ENRICHMENT FOR CAPTIVE RHESUS MONKEYS

A Thesis Presented
BY
KARLA HULL DREWSEN

Submitted to the Graduate School of the University of Massachusetts in partial fulfillment of the requirements for the degree of

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Psychology
AUDITORY STIMULATION AND CONTROL AS SOURCES
OF ENVIRONMENTAL ENRICHMENT FOR
CAPTIVE RHESUS MONKEYS

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CHAPTER I

INTRODUCTION

Undoubtedly, kindness to captive primates demands ample provision for amusement and entertainment as well as for exercise. If the captive cannot be given the opportunity to work for its living, it should at least have abundant chance to exercise its reactive ingenuity and love of playing with things.

The greatest possibility of improvement in our provision for captive primates lies in the invention and installation of apparatus which can be used for work or play.

This quotation of Yerkes (1925) borrowed from a chapter by Markowitz and Woodworth (1978) expresses some of the impetus behind this research. Because of their environment, captive primates necessarily have different needs than their feral counterparts. Many of the environments in which these animals find themselves are static and sterile, consisting of bare wire cages, unchanging weather conditions (except in cases of malfunction, constant light/dark cycles and an imposed
feeding regime. The unchanging nature of the captive environment may result in boredom, fatigue or even stress in monkey subjects. Boredom is often expressed as stereotyped behavior patterns and self directed activities. One goal of the environmental engineer would be to design an environment that would minimize these stereotypic tendencies and maximize exploration and social interaction in monkeys.

Control

Control over environmental events and freedom of choice are among the most highly valued concepts in human life. The question remains as to whether these goals and values are also present in nonhuman animals. Is it an important feature to the quality of life of these creatures?

The bulk of the work in this area has involved the control over the cessation of aversive stimulation. The major outcome of these studies of control, or lack thereof, has been the theory of "learned helplessness" originally outlined by Overmier and Seligman in 1967. These two researchers illustrated that giving animals experience with unavoidable shock made it less likely that they would be able to learn to avoid or escape the shock when placed in a new situation in which escape was
possible. Further, Overmier and Seligman (1967) say that there are motivational, cognitive and emotional effects of uncontrollability.

A few researchers have looked at the effects of the removal of control over aversive stimulation for animal subjects. Stroebel (1969), for example, gave rhesus monkeys (in restraining chairs) control over air conditioning their "overheated" cage, loud noises, "annoying" lights and mild shocks, all using the same lever. All animals became proficient at operating the lever, and when the lever was removed all aversive stimulation was discontinued. Some remarkable behavioral changes occurred. The animals no longer groomed themselves, seemed lazy, exhibited stereotypic behavior patterns and performed poorly on lever problems. This might indicate that the action of control itself is important and that it is not just the cessation of negative stimulation that is involved.

In contrast to the aversive stimulation literature, there are only a few researchers who have looked at the effects of the control over appetitive or positive stimulation. Neuringer (1969) found that pigeons continued to work for food (key pecking) even in the presence of identical free food. (See also Markowitz for
further discussion of behavior for food). Hineka, Gunnar
and Champoux (1983) have shown that rhesus monkeys given
control over food, water and treats are less fearful, less emotional and more exploratory in novel situations
than are animals who are yoked to the controlling group
or those animals reared in the standard laboratory environment and who therefore have no control over the
appearance of the reinforcement. Naive observers and caretakers also commented that the animals who had
control were friendlier and more positively interactive than the other animals.

Markowitz, an important pioneer in the area of
environmental enrichment in zoos, has designed and
installed various types of apparatus in the homecages of
captive animals which enable them to interact with part
of their environment to receive food (1975, 1978a, 1978b,
1979, 1982). For the most part, Markowitz has had great
success in getting these animals to be more active and in
decreasing stereotypic behaviors patterns that the
animals had tended to display. In addition, Markowitz
indicates that the human intervention involved in these
manipulations may have health related benefits, as the
interaction of the researchers with the animals allows
close evaluation of the animals.
If control should be a feature of the captive primate environment, then one must next consider what is the appropriate stimulus to be controlled.

**Environmental Enrichment**

Within the last several years, there has been increased interest in the kinds of stimulation (e.g. auditory, visual etc) that would enrich the captive animal's environment. Some researchers have been trying to learn what conditions are most beneficial to animals, as measured through learning rates, activity rates, weight gain and behavior (e.g. Mellen, Stevens and Markowitz 1979, Murphy 1976, Myers 1978, Schmidt and Moody 1978, Yanofsky and Markowitz 1978, for examples), and have also attempted to increase certain "normal" social behaviors and examine the consequences of this increase on the animal subject (e.g. Plimpton, Swartz and Rosenblum, 1981). The literature includes stimulation of the various sensory modalities.

**Enrichment: Visual and Tactile**

Most of the research that has been conducted in the area of enrichment has involved the visual and tactile
modalities. Researchers have found that stimulation for a variety of species such as moveable objects, observation of conspecifics, a search for food, receptive sexual partners, and alterations in lighting result in higher activity rates, greater food consumption, more rapid learning of a detour task, increases in paradoxical sleep, and a better recall for previously learned tasks (for examples see Gutwein and Fishbein 1980, Heaton and Klein 1981, Phil and Shore 1977, Warren, Zerweck and Anthony 1982).

In a further manipulation of the external environment Novak, Peters, Drewsen, and Meyer (submitted) were interested in the effects of full spectrum lighting on the behavior of captive rhesus monkeys. They found that levels of urinary cortisol were higher in the presence of ultra violet illumination, than without UV, across phases and between treatment groups. Contrary to the initial hypothesis, that natural sunlight with ultra violet radiation should decrease stress reactivity as might be indicated by lower levels of urinary cortisol, higher levels of cortisol were actually found. In addition, higher levels of aggression were also noted for the UV group.
Enrichment: Auditory Stimulation

Auditory stimulation in animals

Although the scope of the human literature on auditory stimulation is extensive, research with animal subjects is rather limited and outdated. In a chapter on the reactions of animals to music, Diserens (1937) cited numerous reports of the way in which animals seemed to be drawn to particular types of music. He began by citing Plato and Aelian in their reports that music tamed and affected animals. Many other examples were given of animals pursuing a musical source or being agitated by it depending upon the type of music being produced (e.g. Buchner 1880, Hall 1865, Jones 1807, Parker 1903, Weissmann 1892, Zanneck 1903 etc. as cited in Diserens 1937). For example, Dixon (1918) described a cobra who responded to violin music by shaking its head. The attitude of the head shaking changed with the type of music played. Lindsay (1871) stated that although most birds appeared agitated and involved in music, owls seemed to have an aversion to it. Rats and mice were particularly susceptible to minor chords (Weir, 1899), while felines became excited when exposed to jig music but were quiet and tranquil with soft music (Baker, 1897). Monkeys were reported not to respond definitively to
music. Most of the work before 1949 was cited in Diserens (1937). A commonly suggested folk remedy for a new or lonely pet is playing a soft radio or the rhythmic sound of a clock.

Changes in blood pressure (Dogiel, 1880) and metabolism in dogs and guinea pigs (Tarchanoff, 1894), appear to be associated with music. Dutto (1896) noted that while organ music increased thermogenesis in birds, it decreased thermogenesis in guinea pigs and chickens. As a summary of the effects of music on animals Lindsay noted the following; 1. calming in states of excitement or irritation, 2. exciting when depressed or fatigued or bored, 3. irritating when depressed, 4. stimulating to work that is uninteresting or disliked (all cited in Diserens (1937)).

The literature involving musical stimulation of animal subjects is very limited but there is some research regarding the effects of nonmusical stimuli, such as primate reactions to vocalization playbacks. Haraway, Maples and Tolson (1981) and Chivers and Mackinnon (1977) have reported that conspecific vocalizations are reinforcers for vocalization in the Siamang Gibbon (*Symphalangus syndactylus*), with a single (zoo) subject and a wild troop respectively. In summary, the work in
the area of auditory stimulation is at best vague, undefined and clearly not up to date. The human literature, however is extensive and we do know that music has a direct effect on humans.

Auditory stimulation in humans

The use of music in human society is commonplace. It is used as a mood setter in movies, plays, advertisements, in bars and restaurants. It is used as background in waiting rooms, doctors' offices and in stores. Sometimes, patients wear earphones during the appointment at the Dentist's office, presumably calming the patient. We find ourselves tuned into music when we are placed on hold on the telephone.

The history of the use of music in industry began in the United States in 1915 when Thomas Edison first experimented with the implementation of music in factories, but his results went unpublished. The factories that used music during work hours reported decreased boredom by workers, increased production, decreased absenteeism and decreased early departures by piece rate employees (Music and Medicine 1948, and Burris-Meyer 1943). Moderate to fast tempo music was found to be more effective in industrial settings than
slow tempos (Kerr, 1945). Today's secretaries may find background music in the earphones of their dictaphones. They report being able to type more quickly, with greater accuracy and for longer periods of time when music is present (Music aids quality of repetitive jobs. Administrative Management 1965, cited in Wolff 1941).

In academic settings students indicate a preference for background music, as opposed to none, music during class periods (Wolff 1941). No significant statistical differences in the learning of math and spelling in 4-6th graders with or without music were found, however (Herman, Engles, Kopp and Labach cited in Wolff, 1941).

Music is also commonly found in hospital settings. Ishiyama (1963) reports that a female catatonic patient responded to musical stimulation by becoming increasingly reactive to the environment. Long a part of religious and medicinal ceremonies, music has been found to have beneficial effects on the amount of time spent in hospitals.

Although severely autistic and retarded children often fail to relate to external stimulation, they do respond to music. Additionally, music is a vehicle which helps these children to learn cooperation (Alvin, 1965, 1978 and Werbner, 1966). Charlesworth (1982) mentions a
possible relationship between the type of music that an individual preferred and their tendency toward suicide. He argues that in this sense music is a helpful agent in psychotherapy in understanding the individual's pathology.

Music has long been thought to be anxiety reducing and relaxing. The results of a study by Rohner and Miller (1980) on psychology students indicates that music does not generally have an anxiety reducing effect, although highly anxious students did show some reduction of anxiety with sedative music. Smith and Morris (1976) found that although stimulative music increased levels of anxiety and emotionality, sedative music had no effect. So, although we are fairly certain that music does effect our emotional states (and physiology) we are not certain exactly how and under what conditions it does so.

Hyde (1923) reports that certain music has psychological and cardiovascular effects as measured by changes in electrocardiograms and blood pressure. Therefore music can be used as sedative or stimulative and "as a valuable agent to scientifically organized labor" (page 224). Landreth and Landreth (1974) note that the heart response to music stimuli seem to be linked to the presence or absence of learning (in music education).
The soothing and stimulative qualities of music seem to be the most well supported findings in this area and we would do well to wonder if this is also the case for nonhuman animals.

The Present Study

The purpose of the present study was to examine the effects of control over musical stimulation on the behavior of captive monkey groups. Unlike a visual or tactile stimulus, auditory stimulation is available to all subjects. Visual stimuli can be blocked from view or disregarded and tactile stimuli can be monopolized by a single individual, therefore the effects of these types of stimulation might not be apparent in all subjects. As the soothing and stimulative effects of music on humans was apparent, any possible similar effects on animals were of interest.

In addition to the directly observable behavior of the animal, a researcher will want to be aware of the moods and the emotional states of the animals involved. Jurgens (1979) associated particular vocalization types with the emotional states of animals. Although this is
dangerous and anthropomorphic, his perspective is valid;

Emotional terms....are not meant to say the animal subjectively experiences a certain emotion in the same way as a human being. Emotional terms, however, are often the only terms available for a brief description of complex motivational states of an animal, that is states which cannot be characterized by the probability of occurrence of a single behavior pattern, but only by the probabilities of occurrence of a great number of different behavior patterns (page 98).

In this fashion we wished to examine the emotional changes in rhesus monkeys. It was not so important to know the exact emotional states of these animals, but rather to understand the contexts in which certain behavior patterns occurred.

Music, a stimulus which is not intrinsically positive to nonhuman primates, but has been shown to be positive, or reinforcing in human life was used in this experiment. Rhesus monkeys were allowed to control the presence or absence of a single type of music during a limited period each day. The effects of control were explored through the use of three experimental groups of monkeys: 1) the Music Control (MC) group had control over the music through lever pressing, 2) the Yoked Control (YC) group heard the music that the MC group produced but had no direct control and were thus yoked to the first group, and 3) the No Music but access to the Box (NMB) group had
access to deactivated levers and thus could not control nor hear music.

Through their own behavior (lever pressing) these animals could indicate their preference for this music. Urinary cortisol was measured to investigate the effects that the music and control of the music might have on stress reactivity. General behavioral data were also collected in an attempt to look at changes in behavior as a function of the presence or absence of music, both within single days and across the duration of the experiment. This study was designed to determine if the control over auditory stimulation (in this case music) is a source of environmental enrichment to captively housed rhesus monkeys and would increase levels of affiliative behaviors and decrease levels of stress related behaviors. From the notion that music is thought to be soothing, it follows that an increase in positive, affiliative, type behaviors and a decrease in negative, agonistic, type behaviors would be expected to become apparent differentially in these three groups of monkeys.
CHAPTER II

METHODS

Subjects

The subjects were 13 adult rhesus monkeys (5 males and 8 females) approximately 5-15 years old. Two males and 4 females constituted Music Control (MC) breeding group located in one room. In this group there were, in addition to the 6 adults, 3 infants (2 females and 1 male) present during this study. The Yoked Control (YC) subjects, consisting of two breeding pairs each containing one adult male and one adult female, were located in a room adjoining the MC group. There were also 1 male infant and 1 juvenile female present in the YC group during this study. One adult male and two adult females belonged to the No Music but access to Box (NMB) group in a room distant from the MC group. There was 1 male infant present in the NMB group during this study. These breeding groups had been in existence at the University of Massachusetts since 1974. All animals were laboratory born and the rearing conditions of all subjects were well known and documented.

The chain link cages in which the animals were housed
varied in size according to the number of animals present, so that the space per animal was roughly equivalent. Three of the four groups were housed in floor to ceiling cages. The fourth group, part of the YC group, had roughly the same amount of floor space as the other group with the same number of adult animals, although the vertical dimensions were not the same with one breeding pair being limited in their vertical range. All animals had been housed in these cages for at least 5 years and were familiar with the environment.

The animals were fed twice daily with fruit and vegetables in the morning and vitamins and Purina monkey chow in the afternoon. Water was available to all animals ad libitum. Cages were cleaned twice daily, both times prior to feeding.

Apparatus

Lever box

The lever box to which the animals were exposed was made of wood covered with sheet aluminum. Two primate levers (BRS-LVE) protruded from the front of the box (see Figure 1), and two aluminum bars extended across the front at the top and the bottom of the box, with all wiring at the back.

During the time that music was available to the animals,
Figure 1. Lever box as seen from the monkeys' viewpoint. The left lever turned the music on and the right lever turned the music off, for the Music Control (MC) Group. The levers were deactivated when the box was presented to the No Music but Box (NMB) Group.
the left lever, as the monkeys faced the box, elicited music and the right lever turned off the music. There was a 10 second delay after turning on the music during which any other bar press would not affect the music, ensuring at least 10 seconds of uninterrupted sound.

The music produced through lever pressing was heard by the Yoked group via a speaker. The YC group members did not have levers available to them at any point in the experiment. This allowed the examination of the overall effects of music on the animals without the added contingency of lever pressing.

Music presentation

The frequency of the music to which the animals were exposed did not exceed their auditory range. The decibels were low enough that any vocalization could be heard above the music. The music was melodic but non-repetitive (George Winston, Autumn and Winter into Spring, jazz piano).

Primate levers in a console box were provided adjacent to the cages of the NMB and MC groups ensuring that all animals had access. In the NMB group music was not provided in any session of the experiment and lever pressing did not elicit music. Lever presses were recorded for both groups on BRS-LVE counters for totals
of ON, OFF and "ON" (number of actual activations of the music) and the total duration of music for each session. The levers were wired to a solid state rack of counters and clocks which recorded the monkeys' responses. A Sony reel to reel tape recorder was used to play the tapes and was wired to the lever box via the rack. In addition to the early A.M. baseline data collection (8:30-10:00 A.M.) behavioral data were also collected while the subjects were being tested. This Stimulation data was collected within a 4 hour period between 10:00 - 2:00 P.M. permitting comparison of the monkeys' behavior both with and without music.

A modified frequency check sheet, the monkey behavioral profile, was used for both the A.M. baseline and the stimulation data collections (see Appendix A). This system used a 5 minute focal animal technique with 20 15-second intervals. If a behavior occurred in an interval it was coded by number which reflected the sequence in which it occurred with the other behaviors in that interval. All animals were sampled 4 days a week. A randomization schedule for both individual and group observation was used to ensure that all animals were represented equally across all possible observational samples. A total of 7 observers collected some portion
of the behavioral data. Interobserver reliability, using a percent agreement score, was calculated at better than 90% for all phases across all behavioral categories.

**Procedure**

Behavioral data were collected over a total of 32 weeks. See Table 1 for a summary of the experimental design. A pretest-test-posttest design was used (ABA).

During the five week pretest phase, behavioral data were collected on all subjects using the monkey behavioral profile (A.M. baseline data). Cortisol levels were measured twice using urine samples collected from subjects at the conclusion of this phase of the experiment. Prior to the onset of the test phase the animals who were to manipulate the lever box (MC and NHB groups) were adapted to the presence of the box and were given training such that the "on" lever initially turned a red light on while the "off" lever turned it off. This was to provide the animals with experience manipulating the levers to ensure that when the music was presented the contingencies on the two levers would already be familiar.

During the 9 week test phase, A.M. baseline data collection continued. Later in the morning the lever box
Table 1
Summary of the Experimental Design

<table>
<thead>
<tr>
<th>Groups</th>
<th>Pretest Phase</th>
<th>Test Phase</th>
<th>Posttest Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Music Control Group (MC)</td>
<td>Nothing</td>
<td>Music controlled by levers and access to levers</td>
<td>Nothing</td>
</tr>
<tr>
<td>Yoked Control Group (YC)</td>
<td>Nothing</td>
<td>Music yoked to MC group; No levers</td>
<td>Nothing</td>
</tr>
<tr>
<td>No Music Box Group (NMB)</td>
<td>Nothing</td>
<td>Access to deactivated levers; No music</td>
<td>Nothing</td>
</tr>
</tbody>
</table>

**Measures**

<table>
<thead>
<tr>
<th>Behavior</th>
<th>A.M. Baseline data 4 times a week (A)</th>
<th>A.M. Baseline Data 4 Times a week (B)</th>
<th>A.M. Baseline Data; 4 times a week (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Stimulation Data 4 times a week (D)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D1 = music intervals</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D2 = non-music intervals</td>
<td></td>
</tr>
<tr>
<td>Level Pressing Response</td>
<td>---</td>
<td>Amount of lever pressing during music presentation. (E)</td>
<td>---</td>
</tr>
<tr>
<td>Adrenal Reactivity</td>
<td>Urine collection (2) after each phase (3 times) (F)</td>
<td>(G)</td>
<td>(H)</td>
</tr>
</tbody>
</table>

**Analysis**

Phase comparisons: (A) (B) (C) Music comparisons: (B) (D) (F) (G) (H) (D1) (D2) for YC and MC groups only
was placed adjacent to the cages of the MC and NMB groups. For the MC group the introduction of the lever console to the homecage indicated the period when the animals could elicit music through lever presses. As there was only one lever box console only one group could have access to the box at a time. Two time periods were used for the presentation of the box, an AM phase and a PM phase and this was equally distributed between the groups.

Stimulation behavioral data collection was taken during the two hours immediately following the introduction of the console box. Thirteen adults were scored from the three groups. Two observers collected data simultaneously on the MC and YC groups. The removal of the console after 2 hours indicated the end of the test session.

Urine collection

Urine was collected twice from each of 11 subjects after each phase and all aliquots were frozen at -10 °C, for assaying at a later date. The animals were removed from their homecage and placed into individual cages for approximately six hours. Infants remained with their mothers as separation is traumatic for both and Novak et al (submitted) found no significant effect on cortisol
levels due to the presence of the infant with the mother. Urine was collected from catch pans underneath individual cages once an hour and refrigerated at 4°C between collections. After six hours the animals were returned to their homecages, total urine volume recorded and samples frozen for assaying at a later time. As the animals were familiar with this removal procedure and as visual and auditory communication was still possible between the individual cages, this procedure constituted a mild stressor to these animals. The cortisol values yielded from this urine were therefore a measure of cortisol reactivity to a mild stressor. As two of the animals from the YC group had not yet been trained as to the removal technique the removal of these animals would have resulted in a more highly stressful situation than was true for any of the other subjects and they therefore were not included in the urine collections. During the hours of urine collection which followed the test phase music was presented by the experimenter without any control by the monkeys during the test session time, so as not to eliminate any effects that the music might have had on the animals. No access to the levers was available at this time.
Cortisol/Creatinine Assay

The technique used here for assaying monkey urine for cortisol concentration can be found in a paper by Clark, Rubin and Poland (1971) who describe it in much greater detail. Novak et al (submitted) used this technique with success when they used the urine collection method described above.

Cortisol Assay:
The frozen urine samples were thawed, mixed with B-glucuronidase/aryl sulfatase in acetate buffer and incubated for approximately 18 hours at 37° C, hydrolyzing the cortisol conjugates. To extract the free cortisol, CH2Cl2 was added. A centrifuge was then used to separate layers and the upper aqueous phase was aspirated off. The lower phase was dehydrated using anhydrous Na2SO4 and formamide and isoctane were added. The upper phase was again aspirated and 4% NaIO4 was added. All tubes were incubated at 37° C for one half hour, to ensure the oxidation of the cortisol to 17 B-carboxylic acid. To stop the oxidation 12% Na2SO4 was added and again CH2Cl2 was used to extract the cortisol derivative. The upper phase was transferred to tubes containing 2N H2SO4 and CH2Cl2. The upper phase was aspirated off and anhydrous Na2SO4 was added to dehydrate...
the lower phase. This extract (methylene chloride) was then transferred to test tubes containing H₂SO₄-ethanol, causing the development of fluorescence of the cortisol derivative. The CH₂Cl₂ phase was aspirated off and the remaining phase was incubated for approximately one hour.

The wavelengths used to read the fluorescence were; excitation=470nm and emission=530nm. Water blanks and cortisol standards were carried throughout the assay allowing a standard curve to be plotted so that the cortisol concentrations in the unknowns could be determined. The cortisol values were calculated by subtracting the average blank from all standards and unknowns and then; cortisol = corrected sample fluorescence/corrected standard fluorescence x 1 x total volume of urine excreted.

As urine is secreted in proportion to body weight (Schneeberg, NG 1970) bodyweight must be taken into consideration. Creatinine is another chemical in urine that is secreted in proportion to body weight. Using Sigma Chemical Company Kit #555, urinary creatinine was also assayed.

Creatinine Assay:
Mixing a thawed urine sample with an alkaline picrate solution caused a yellow colored acid complex to form.
Substances other than creatinine may bind to the picric acid causing part of the yellow coloration. A wavelength of 500nm on a spectrophotometer was used to read the absorbance of the complex. Acid was then added and the color due to the creatinine-picric acid complex was destroyed and the absorbance was read again. The difference in the absorbances before and after the addition of the acid is proportional to the creatinine in the sample. A cortisol/creatinine ratio was used for the corrected cortisol value, taking body weight and total urine volume secreted into consideration.

**Data Analysis**

Within phases (A.M. baseline data vs. stimulation data) and across phases comparisons were analyzed using an ANOVA (BMDP4V), with the within factor of phase and between factors of group, sex and age. For the across phase analysis the test phase was broken down into two 4 week periods, T₁ and T₂, such that T₁ represented the first 4 weeks of the test phase and T₂ represented the last 4 weeks.

Within the stimulation data collection behavior during the play of the music was compared to behavior without the music. To do this an average change score was
calculated for each behavior, for each individual. The nonmusic situation was used as the baseline and music scores were subtracted to show change.

Where:

\[ A_m \text{ or } nm = \text{total music or nonmusic intervals for behavior per week}, \]

\[ B = \text{total number of music intervals in each week}, \]

\[ C = \text{number of weeks in phase} \]

\[ \left( \frac{A_{nm}}{B} - \frac{A_m}{B} \right) / C \]

Lever pressing data was graphically analyzed. A µg cortisol/mg creatinine ratio was calculated for each individual and changes were graphically analyzed.
CHAPTER III

RESULTS

The results of this experiment were examined in two ways. First, behavioral differences (A.M. baseline vs stimulation data) and lever pressing activity during the test phase were evaluated. Second, behavioral differences (A.M. baseline only) and cortisol changes over the three phases were assessed. All behaviors were analysed in this manner and those with significant ANOVAs are contained within Tables 2 and 3.

Test Phase

Lever pressing and Behavioral Profile data during music presentation.

As can be seen from figure 2 both groups having access to the lever box acquired the lever pressing response. The MC group however, had much higher lever pressing rates even during the adaptation period than did the NMB group. Interestingly, lever pressing behavior in the MC group declined over the 9 week test phase even though the amount of music to which the MC and YC groups were exposed remained fairly constant (see figure 3). The decline in the lever pressing rate appeared to be caused
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Figure 2. This graph illustrates the rate of responding (responses per hour) to the lever box by the Music Control (MC) and the No Music but Box Groups (NMB). An adaptation phases wherein the levers controlled the onset and offset of a red light, for both groups, preceded the test phase. The test phase was followed by an extinction phase for the MC group during which the levers were deactivated.
Figure 3. This graph illustrates the amount of music (minutes per hour) to which the Music Control (MC) and the Yoked Control (YC) groups were exposed.
by a drop in extraneous responses to the lever (e.g. during the 10 second timeout in which the levers were deactivated). The two music groups were exposed to an average of 19 minutes of music per activation of the system and about 50 minutes of music per 2 hour session (see figure 4).

Behavior within the stimulation data collection was also examined. I will focus first on the two music groups (MC and YC). In reporting changes in behavior in the presence or absence of music within the daily session it was important to note that the percentage of time music played during data collection differed for each subject. Due to the fact that the animals had control over the music, the observers were unable to ensure that each subject was observed for the same length of time under both conditions (music on, music off). As a result, all scores were converted to percentages. Table 4 shows the percentage of the intervals (out of 720) in which each animal was observed under the music condition. Each animal was observed for at least 25% of the time during which the music was playing.

Within the stimulation data collection, behavior with or without music was compared. Only the MC and YC groups who were exposed to the music were examined for these
Figure 4. This figure illustrates the minutes of music that were played, on the average, per activation of the system by a lever press of the Music Control (MC) Group.
Table 4
Percent of the Total Observation Intervals in which Music was Present

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<th>Subjects</th>
<th>Percent of Music Intervals (No. out of 720 intervals)</th>
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<td>MC Male 1</td>
<td>41% (298)</td>
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<td>30% (218)</td>
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<tr>
<td>MC Male 2</td>
<td>29% (210)</td>
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<tr>
<td>MC Female 2</td>
<td>39% (279)</td>
</tr>
<tr>
<td>MC Female 3</td>
<td>31% (220)</td>
</tr>
<tr>
<td>MC Female 4</td>
<td>35% (250)</td>
</tr>
<tr>
<td>YC Male 1</td>
<td>31% (222)</td>
</tr>
<tr>
<td>YC Female 1</td>
<td>29% (209)</td>
</tr>
<tr>
<td>YC Male 2</td>
<td>24% (175)</td>
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<tr>
<td>YC Female 2</td>
<td>34% (245)</td>
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MC = Music Control; YC = Yoked Control
changes. Figures 5a-j contain behavioral profiles of the animals under music and nonmusic conditions. Although no common pattern emerged when the individual profiles were compared, individual changes are interesting to note. Some of the animals tended to show more activity during music intervals and others were more active during the nonmusic intervals.

A.M. Baseline and Stimulation comparisons.

See Table 3 for a summary of the significant behavioral comparisons.

Interactions—Figure 6 shows interaction effects of group by stimulation vs A.M. baseline for tactile/oral exploration, agonistic behaviors, and for affiliative behaviors. The NMB group showed the most tactile/oral exploration during A.M. baseline whereas the two music groups showed comparable levels of tactile/oral exploration during both data collections. For agonistic behavior the nonmusic group showed the most agonistic behavior during both data collections. The YC group exhibited a decrease in agonistic behaviors from A.M. baseline levels during the stimulation data collection. The reverse trends were seen in affiliative behavioral levels where the nonmusic group showed the lowest level of affiliative behavior of the groups and showed a
Figure 5a-j. The following 10 figures are the individual behavioral profiles for each monkey who was observed in the presence of music, both the Music Control (MC) Group and the Yoked Control (YC) Group. The values that are graphed are percent difference scores of the number of intervals under a condition (music or nonmusic) in which a behavior was observed. Behavior labels are as follows: SOCGRM=social groom, SOCCON=social contact, SLFGRM=self groom, PAS/VIS=passive visual exploration, LOC=locomotion, TAC/ORL=tactile or oral exploration, SCRAT=scratch, STER=stereotypy, CRKTL=cocktail, YAWN=yawn, VOCAL=vocalization, THRT=threat, AGGRES=aggression.
BEHAVIORAL PROFILE OF MC MALE 1

DIFFERENCE SCORE
BEHAVIORAL PROFILE OF MC MALE 2

DIFFERENCE SCORE
BEHAVIORAL PROFILE OF MC FEMALE 2

DIFFERENCE SCORE
BEHAVIORAL PROFILE OF MC FEMALE 3

DIFFERENCE SCORE
BEHAVIORAL PROFILE OF MC FEMALE 4

DIFFERENCE SCORE
BEHAVIORAL PROFILE OF YC MALE 1

DIFFERENCE SCORE
BEHAVIORAL PROFILE OF YC FEMALE 2

DIFFERENCE SCORE
BEHAVIORAL PROFILE OF YC MALE 2

DIFFERENCE SCORE
BEHAVIORAL PROFILE OF YC FEMALE 2

AGGRES
THRT
VOCAL
YAWN
CRKTL
STER
SCRAT
TAC/ORL
LOCOM
PAS/VIS
SLFGRM
SOCCON
SOCGRM

DIFFERENCE SCORE
Figure 6. Bar graph of the behaviors that were significant for a Group by Time interaction in the A.M. Baseline vs. Stimulation Comparison. An ANOVA was done and all behaviors on this graph were significant at p<.01. MC=Music Control Group, YC=Yoked Control Group, and NMB=No Music but Box Group.
decrease in affiliative from A.M. baseline to stimulation data collection. Both music groups showed a slight increase in affiliative behavior during the stimulation data period.

Figure 7 illustrates the significant group by week interactions for tactile/oral exploration, active alone behaviors and affiliative behaviors. The MC group exhibited a decline in tactile/oral exploration while this behavior first increased and then decreased in the YC group. The non music group in general exhibited higher levels of this behavior than the other two groups. The music control group declined slightly in Active Alone behaviors over weeks while the YC showed the same inverted curve as tactile/oral exploration. The music groups increased their affiliative behaviors over weeks while both groups were higher overall in levels of affiliation than the NMB group.

Across all phases

Comparison of social behavior.

The significant sex differences found in the across phase comparison are the same as those found in the stimulation vs A.M. baseline comparison and are summarized in Table 3. Overall significant phase effects are shown in Figure 8. For tactile/oral exploration and
Figure 7. Bar graph of the behaviors that were significant, at \( p < .01 \), (ANOVA) for a Group by Week interaction in the A.M. Baseline vs. Stimulation Comparison. MC=Music Control Group, YC=Yoked Control Group, and NMB=No Music but Box Group.
Figure 8. Bar graph of the behaviors that were significant, p<.01, (ANOVA) for the main effect of Phase in the Cross Phase Comparison. MC=Music Control Group, YC=Yoked Control Group, and NMB=No Music but Box Group.
passive visual exploration a significant decrease to the posttest for all groups can be noted in Figure 8. Social contact showed an increase in the test phases and social grooming increased over all 4 phases to reach a peak in the posttest. Affiliative behaviors were higher in the test phases for all groups. Agonistic behaviors were shown to be the lowest in the posttest.

Significant group by phase interactions are shown in Figure 9. For threat, the music groups exhibited opposing effects, with the MC group having higher levels of threat during the test phases and the YC group showing the opposite pattern. The NMB group showed a decrease in threats over all 4 phases. Locomotion declined in the MC group over all phases while the YC group remained fairly stable. It should be noted that these threats did not involve the lever box, but they do indicate increased interaction among the animals. The NMB group showed an increase in locomotion from pretest to posttest although there was also a decrease from T₁ to T₂. Affiliative behaviors decreased from pre to posttest for the YC group while the MC group showed slightly higher levels during the test phases, as did the NMB group.

Cortisol/Creatinine.

The cortisol data revealed fairly similar levels of
Figure 9. Bar graph of the significant behaviors for the Group by Phase interaction in the Cross Phase Comparison. P<.05 for this analysis of variance. MC=Music Control Group, YC=Yoked Control Group, and NMB=No Music but Box Group.
cortisol/creatinine for all animals over all phases (see Figure 10 and Table 5 except that females as a group showed higher levels than males, as expected (Scallet, Suomi, and Bowman, 1981). Cortisol values did not vary in a predictable manner across treatment.
Figure 10. Line graph of the ug cortisol/mg creatinine ratios for all three experimental groups across the Pretest, Test, and Posttest phases. 
0---------0 = females.  X---------X = males.
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CHAPTER IV

DISCUSSION

This experiment attempted to investigate whether control over a musical stimulus would enhance the captive monkey environment in terms of promoting affiliative behaviors and reducing stress reactivity. Although the manipulation was rather limited as to total time of exposure to the stimulation and type of music involved, it was apparent from the data that the animals did respond to the music. From individual observational reports it appeared that the MC subjects were most active while the music was playing and turned it off to sleep or slept only when the music was off. Although this was reported by the majority of individual observers this was not obvious from the data. As single subjects were scored at a time, group behavior was difficult to extrapolate from the data itself. It was apparent however, that the MC group did not simply play with the levers, as indicated by the relatively moderate rates of bar pressing. The animals tended to turn the music on and leave it on or turn it off. It was also the case that in
each experimental session there was always some music played. Also noted by observers was the fact that the YC animals especially reacted to the music when it turned on. Most often they would exhibit vigorous cage shaking behavior and head flipping stereotypies. Since there was no possible way for these animals to predict the appearance of music, perhaps the predictability offered by control could be a factor in differences between groups.

Although the animals did respond to this manipulation both the behavioral and urinary cortisol data indicate that this response did not have deleterious effects nor especially beneficial effects. As expected, females had higher levels of cortisol than did males. Except for two females the cortisol data were fairly stable between treatment groups and across treatment phases. Both the outstanding females increased their levels dramatically to the posttest. The MC group female was at an advanced stage of pregnancy at the last urine collection and it is possible that the increase in her cortisol may have been due to complications associated with her pregnancy. It has been shown that the removal of control can be stressful to rhesus monkeys (Stroebel, 1969) as might have been the case in this group. However there was no
suggestion of this type of increase in any of the other animals. The other female (YC) also showed a similar increase to the posttest, although there was no logical explanation for this.

The effect that we were looking for was a differential reaction of the groups to the phases. The effects that are in the expected direction are those seen for threatening and affiliative behaviors in the group by phase comparisons. As the MC and YC groups showed opposing effects with the MC having the highest level of threats during the test phases and the YC having lower levels during test than pre or posttest, this might indicate that control was stressful, as suggested by Brady, Porter, Conrad and Mason (1958) in their Executive Monkey study, causing more tension among group members. One possible hypothesis for these differences is related to maternal threats to infants. The MC group had more infants than the YC group and as threats to infant change developmentally, it is possible that the increase in levels of threats were those threats of mothers to infants as this was a period of maternal rejection. This hypothesis was dismissed as the same percentage (~1/2) were addressed to the infants in all three phases. Another possible hypothesis to explain the increase in
levels of threats would be that the group's overall activity levels increased, increasing threats. The general activity levels of the MC group did not change in the same manner as threat behavior, with a continuous decline across all three phases. Locomotion, an indicator of activity, decreased steadily from pre to posttest. This would suggest that this change could not be attributed to changes in the activity levels of the animals and that this hypothesis too can be discarded.

What is interesting to note is the change in affiliative behavior in connection with the changes in levels of threat. Although we see opposing directionality for the MC and the YC groups for threat, the changes in affiliative behavior were in the same direction for both groups. So, for the MC group an increase in threats during the test phase was accompanied by an increase in affiliative behaviors. Although seemingly contradictory, it has been documented in rhesus monkeys that affiliation often follows agonistic encounters. In fact, affiliative behaviors are the most likely behaviors to follow directly after an agonistic encounter between two animals (De Waal and Yoshihara, 1983). An increase in social tension is often followed by an increase in social grooming in rhesus monkeys.
(Terry 1970). Therefore, in a situation with increased group tension we might expect to see an increase in affiliation correlated with an increase in threats. This was not so in the YC group, where threats decreased and affiliation increased. If music had a soothing effect, then a decrease in threats and an increase in affiliative behaviors might be expected. As the changes in the NMB group are not similar to the MC group it is possible that the control of the music, rather than the box itself, was responsible for the changes in the MC group. Stroebel (1969) found that the removal of control over aversive stimulation was stressful to rhesus monkeys. We would do well to wonder whether this should also be the case in this study of presumably neutral or positive stimulation. There are no significant increases in stress related behaviors in the MC groups, in fact threat levels declined to below pretest levels at posttest.

It was suggested that control allows for the prediction of upcoming events and that this predictive ability is responsible for the beneficial effect on behavior (Averill, 1973 and see Mineka and Henderson 1985 for a review). It was not apparent, however, whether the consequences of this study had beneficial effects on the subjects. Not all behavioral changes
observed were beneficial, but what is evident is that such changes in the environment of captive primates do have an effect on them. The question remains as to the nature of this effect.

The most apparent findings were that the study affected all three groups, as there were a number of overall phase effects. All three groups reacted similarly to the stimulation that they received. Increased observer interaction with the animals may have been in part responsible for the changes in behavior between phases, as the number of observational periods per day increased as did general movement in the laboratory. The other effects, although interesting and possibly important, may be more likely to indicate seasonal variation or possible age related changes.

The social atmosphere in which monkeys live cycles naturally with the time of year, breeding condition, weather conditions, availability of food, presence of predators, and the age of group members. Since much of the variation has been removed from the captive monkey's life, then it might be expected that they might become more reactive to smaller variations in their environment. Although social tension and aggression are not necessarily abnormal as they may be important in
maintaining heirarchical structures in the wild, wild animals can often flee and avoid each other more readily than captive monkeys. Therefore, changes in the environment of captive animals must be made with care in order that the stressful nature of the intervention be assessed.

**Conclusion**

Further hypotheses that might account for why little or no effect of music or control of music was seen in these animals might include:

1) the type of music that was played. Perhaps another type of music would elicit greater reactions to the music and control of its presence,

2) the amount of exposure. The animals were only allowed access to both music and the lever box for 2 hours a day 4 days a week for 9 weeks, and perhaps if music was available at all times during the day stronger reactions of the animals might have been noted,

3) music does not matter to the monkeys. Maybe there really are no reactions to this type of stimulation and music is not as important in the animal world as in the human world,

4) a still further possibility would be that these animals are so well adapted to their environment that any
effects that music and its control might have had on other rhesus monkeys were not readily apparent in this situation. Under more highly stressful conditions these animals might react more to the music or another less well adapted group might show any effects more clearly.

However, these are only some hypothesis to account for the findings of this study. What this study has shown is that musical stimulation and control of this stimulation does not have deleterious effects on captive monkey subjects. Therefore, the effects of more intense and continuous stimulation should be evaluated before a conclusion can be drawn as to the beneficial or negative effects of such intervention.
References


22. Lindsay, W.L., Mind in Animals, Vols I and II, 1871.


| Condition | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| Subject:  |   |   |   |   | Vocalization |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Yawn        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Aggression  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Displacement|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Rejection   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Cage Shake |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Crooktail  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Fear Grimace|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Body Spasm |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Moan-Lipsnack|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Locomotion |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Stereotypy |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Tac/Orol Explore |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Pass/Vis Explore |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Social Contact |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | V/V, D/K Contact |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Social Groom |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Scratch |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Present |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Neck/Shank/Belly |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Social Play |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Self Present |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Yount |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Masterbating |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|           |   |   |   |   | Sexual Direct |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
APPENDIX B

Categories and Definitions of Rhesus Monkey Behavior

Non-social

Passive/Visual exploration – motionless with eyes open, not in contact with other animals.
Tactile/Oral exploration – tactile or oral manipulation of environment not including other animals.
Locomotion – 2 directed steps in any direction.
Self play – repetitive activity involves toy or part of cage.
Self groom – picking, licking or stroking one's own body and hair.
*Scratch – vigorous stroking of hair with fingernails or toenails.
*Self mouth – placing part of one's own body in the mouth.
*Stereotypy – repetitive ritualized behavior that serves no obvious function.
Masterbate – tactile or oral manipulation of one's own genitals, not involving grooming.
*Vocalization – any sound emitted by the monkeys.

Social-Affiliative

Social groom – picking, licking or stroking of another animal's body hair.
Social play – chasing, bouncing, grabbing, wrestling and mock biting of another animal.
Neck present – lifting the chin, exposing the neck.
Social contact – passive physical contact with another animal, not involving sex, grooming, aggression or play.
*Mount – grabbing hind legs of another animal with the hind feet and placing the hands on the lower back of the other animal.
*Rump present – standing on all fours with hind quarters elevated and tail raised.

Social-Agonistic

+Threat – complex behavioral signal involving an open-mouthed stare, eyebrows lifted, ears flattened or flapping, piloerection of the hair, and rigid body; may be vocal elements.
+Hair pull – vigorous hair pulling not involving grooming.
Aggression - actual attack of another animal, chasing, biting, hair pulling.
Fear grimace - a grin-like facial expression.
*Displace - takeover of object, activity or position of another animal.
Cage shake - vigorous shaking of the cage.
Crook-tail - strutting locomotion with tail held high and curled at end.

**Grouped Behavioral Categories**

**Active Alone includes**
- locomotion
- tactile/oral exploration

**Affiliative includes**
- social contact
- ventral/ventral or dorso/ventral contact between mother-infant
- social groom
- moan-lipsmack
- social play
- presents
- rump present
- mount

**Agonistic includes**
- threat
- aggress
- displace
- cage shake
- fear grimace

*Possible measures of tension in the social group depending upon context.*
+Definite measures of tension in the social group.