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Effects of Two Types and Two Genre of Music on Social Behavior in Captive Chimpanzees (*Pan troglodytes*)

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Is music just noise, and thus potentially harmful to laboratory animals, or can it have a beneficial effect? Research addressing this question has generated mixed results, perhaps because of the different types and styles of music used across various studies. The purpose of this study was to test the effects of 2 different types (vocal versus instrumental) and 2 genres (classical vocal versus 'easy-listening' vocal) of music on social behavior in 31 female and 26 male chimpanzees (*Pan troglodytes*). Results indicated that instrumental music was more effective at increasing affiliative behavior in both male and female chimpanzees, whereas vocal music was more effective at decreasing agonistic behavior. A comparison of 2 genre of vocal music indicated that easy-listening (slower tempo) vocal music was more effective at decreasing agonistic behavior in male chimpanzees than classical (faster tempo) vocal music. Agonistic behavior in females remained low (<0.5%) throughout the study and was unaffected by music. These results indicate that, like humans, captive chimpanzees react differently to various types and genres of music. The reactions varied depending on both the sex of the subject and the type of social behavior examined. Management programs should consider both type and genre when implementing a musical enrichment program for nonhuman primates.

Abbreviations: MANOVA, multivariate analysis of variance

A sizeable literature suggests that music has positive effects on humans in institutional settings.[7,31] In particular, music has been used to lower patient anxiety and stress and to reduce pain.[1,18,19] Studies of the effects of music on laboratory animals have yielded conflicting results and lead to the questions of whether music in laboratories simply adds noise and stress or is beneficial. Studies involving monkeys found some behavioral benefits but no physiologic evidence of reduced stress.[6,29] Some studies of rodents have indicated that music may increase physiologic stress.[23,28] However, still other studies have shown that music has positive behavioral[6] and physiologic benefits[22] in nonhuman primates and other animals (rodents,[30,36] dogs[37]). Species differences aside, comparisons of these studies are difficult because of differences in levels of echo and sound reverberation at different institutions and because of variations in the type of musical stimuli used. Music in these studies ranged from radio music that included commercials[6] to rock and pop music[22,23] to classical compositions.[30,36]

Type of music has important effects on a wide range of human behaviors and may have implications for the use of music with laboratory primates. In humans, soft slow-tempo music has been shown to increase relaxation, when compared with fast-tempo music.[21,26,27] On the basis of these results, music that is softer and has a slower tempo has been hypothesized to increase affiliation between individuals and interactions between individuals and their environment.[27] In addition to tempo, some research has suggested that vocal music affects human behavior differently than does instrumental music.[3] Among college students, vocal background music disturbs both visual and spatial memory tasks, compared with instrumental background music.[8,11,17] Instrumental music is more effective than vocal music at calming anxiety in human patients, decreasing heart rate and increasing immune function.[9,24]

Previously, we showed that music has a significant effect on the social behavior of captive chimpanzees.[16] Wounding aggression in this colony[33] is comparable to that reported for other captive chimpanzee populations.[2,20] However, managing aggression and increasing group compatibility (through increased affiliation) continues to be a high priority for captive chimpanzee management.[4] The purpose of the current study was to refine the use of music as enrichment for chimpanzees by testing the effects of 2 different types (vocal and instrumental) and 2 genre (classical vocal and 'easy-listening' vocal) of music on social behavior in captive chimpanzees. These types and genre of music were chosen in an attempt to mirror research done in humans. In humans, instrumental music has proven more effective at decreasing anxiety and increasing relaxation, when compared with vocal music.[9,24] Therefore, we predicted that instrumental music would significantly decrease agonism and increase affiliation, compared with vocal music. In terms of musical characteristics, music that is soft and slow is more effective at decreasing anxiety and increasing relaxation in humans, when compared with fast-tempo music.[21,26,27] When examining vocal music by genre, we predicted that slow-tempo music (that is, easy-listening vocal) would significantly decrease agonism and increase affiliation in chimpanzees, compared with fast-tempo music (that is, opera).

Materials and Methods

Subjects included 31 female and 26 male chimpanzees (*Pan troglodytes*) housed at the Primate Foundation of Arizona, which is accredited by the Association for Assessment and Accreditation of Laboratory Animal Care, International.[10] All subjects were housed in 10 stable social groups of 3 to 7 animals each, with group composition consisting of 4 all-male groups, 3 all-

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Table 1. Results of within-subjects repeated-measures MANOVA of affiliative behavior during instrumental versus vocal music

			Mean (standard error)		
Factors	F (df)	*P*	Pretest	Test	Post-test
Phase[a,b]	47.96 (2)	0.0001	0.024 (0.003)	0.052 (0.004)	0.065 (0.005)
Phase × Type	3.27 (2)	0.04			
Instrumental[a,b]			0.022 (0.004)	0.046 (0.004)	0.069 (0.006)
Vocal[a,b]			0.027 (0.005)	0.056 (0.006)	0.061 (0.007)
Phase × Sex × Type	1.49 (2)	0.23			
Female Instrumental[a,b]			0.024 (0.006)	0.048 (0.005)	0.077 (0.008)
Female Vocal[a,b]			0.025 (0.006)	0.065 (0.010)	0.066 (0.009)
Male Instrumental[a,b]			0.019 (0.005)	0.045 (0.007)	0.060 (0.010)
Male Vocal [b]			0.029 (0.009)	0.048 (0.008)	0.056 (0.010)

[a]Test > pretest ($P < 0.01$).
[b]Post-test > pretest ($P < 0.01$).

female groups, and 3 harem groups. Female chimps ranged in age from 3.8 to 47.8 y of age at study onset (mean, 20.5 y); male chimps were 5.7 to 34.8 y of age at study onset (mean, 14.5 y).

Housing and care met and exceeded all current guidelines from the United States Department of Agriculture. Chimpanzees were housed indoors in built-in cages with access to outdoor play cages on a rotating basis. All observations were conducted in the indoor enclosures. Indoor cages included 3 interconnected cages with access to outdoor cages through hydraulic doors. Indoor cages provided each social group with 57 to 68 m^2 of floor space and 2.7 m of vertical space. Cages were furnished with elevated benches, vertical and horizontal poles, and firehose ropes. Chimpanzees also were provided with paper or straw bedding, manipulable enrichment items, and forage and browse material on a daily basis. The data collection protocol was reviewed and approved by the Primate Foundation of Arizona Institutional Animal Care and Use Committee.

Music for this study was chosen from a collection of compact discs that were familiar to the chimpanzees. Using familiar music controlled for any effect novelty might have on chimpanzee behavior; therefore any differences are more likely due to the different characteristics of the music rather than their novelty. Each disc chosen was played in its entirety, and only 1 disc was played at a time. Music was broadcast over an intercom system and could be heard by all subjects through the intercom speakers. The intercom speakers were 45 ohm 'talkback' horns (model V-1048C, Valcom, Roanoke, VA).[16] Selection of music was made by animal care staff without input from research staff. Volume on the stereo system was held at a consistent level during this study.

Data were collected by 3 observers and showed 85% reliability as calculated by use of the index of concordance.[15] Observations using scan sampling methods, with 3-min intervals, were conducted during both mornings and afternoons between June and November 2001. Behavior was recorded for 1 h before music was turned on (pretest), while music was playing (test), and for 1 h after the music was turned off (post-test). The test phase varied due to the length of music selections and ranged from 10 min 59 s to 81 min 6 s. The median length of the test phase was 51 min 29 s, although classical music selections were slightly longer, making the average length 67 min 33 s. We recorded the type of music played, and the behavior of each animal in the social group. Music was categorized first as vocal or instrumental, and then vocal music was assigned to musical genre (classical or easy-listening). Classical vocal music consisted primarily of opera (for example, Pavarotti) with tempos ranging from 95 to 170 beats per min, whereas easy-listening vocal music (for example, Enya, Doris Day) had tempos ranging from 50 to 90 beats per min. Behaviors recorded included agonistic (that is, charging display, attack, vocal display, hand-raise), affiliative (that is, social groom, social play, inspect or present, pant and grunt), and nonsocial other. A total of 48,635 recordings of behavior were collected for a total of 2431.8 h of data (853.2 scans and 42.7 h per subject), resulting in 27,736 recordings (1386.8 h) for instrumental music data and 20,899 scans (1045.0 h) for vocal music data (7,561 recordings [378.1 h] for classical vocal and 13,338 scans [666.9 h] for easy-listening vocal).

Data were summarized as the proportion of scores for each behavior by phase (pretest, test, post-test) and type and genre of music. Repeated-measures multivariate analysis of variance (MANOVA) was used to consider the effect of the experimental phase (pretest, test, post-test) on social behavior (agonistic, affiliative). The first repeated-measures MANOVA used sex (male, female) and type of music (vocal, instrumental) as independent variables. Post-hoc comparisons were conducted for all significant effects and compared levels of social behavior during and after music with those before music. The second repeated-measures MANOVA used sex and genre of music (instrumental, classical vocal, easy-listening vocal) as independent variables. All analyses were conducted with individual subjects as the experimental unit in order to directly compare the data with those from a previous study.[15] Two MANOVA models were created because of the small sample size. Significance was set at the 0.05-level, post-hoc comparisons were considered significant at the 0.01-level, and all tests were run using JMP 6.0 (SAS Institute, Cary, NC).

Results

Effects of vocal versus instrumental music. There was a significant interaction between phase and music type for affiliative behavior ($F = 3.27$, $P = 0.04$), with both vocal and instrumental music increasing affiliative behavior (Table 1). In female chimps, both vocal and instrumental music increased affiliative behavior during both test ($P = 0.0003$) and post-test phases ($P < 0.0001$), compared with pretest levels (see Table 1). In male chimps, affiliative behavior significantly increased during both test ($P = 0.003$) and post-test ($P = 0.0001$) phases of instrumental music, compared to pre-music levels. However, during vocal music males exhibited increased affiliative behavior only during the post-test phase ($P = 0.0007$; Table 1).

There was a significant phase, sex, and music type interaction for agonistic behavior ($F = 6.61$, $P = 0.005$). Levels of agonistic behavior throughout the study were particularly low for female chimps (Table 2). Male chimps exhibited a significant decrease in agonism during the test ($P = 0.004$) and post-test ($P = 0.0004$) phases of vocal music, when compared with pretest behavior. There was no effect of instrumental music on agonistic behavior in male chimps (test, $P = 0.62$; post-test, $P = 0.72$).

Effects of classical vocal versus easy-listening vocal. There was a significant phase and musical genre interaction for affiliative

Table 2. Results of within-subjects repeated-measures MANOVA for agonistic behavior during instrumental versus vocal music

			Mean (standard error)		
Factors	F (df)	*P*	Pretest	Test	Post-test
Phase[a,b]	11.98 (2)	0.0001	0.010 (0.002)	0.006 (0.001)	0.005 (0.001)
Phase × Type	7.51 (2)	0.003			
Instrumental			0.007 (0.002)	0.006 (0.001)	0.006 (0.001)
Vocal[a,b]			0.015 (0.003)	0.007 (0.001)	0.004 (0.001)
Phase × Sex × Type	6.61 (2)	0.005			
Female Instrumental			0.004 (0.002)	0.003 (0.001)	0.003 (0.001)
Female Vocal			0.005 (0.002)	0.002 (0.001)	0.003 (0.002)
Male Instrumental			0.010 (0.003)	0.009 (0.002)	0.009 (0.002)
Male Vocal[a,b]			0.025 (0.005)	0.011 (0.003)	0.005 (0.002)

[a]Test < pretest ($P < 0.01$).
[b]Post-test < pretest ($P < 0.01$).

Table 3. Results of within-subjects repeated-measures MANOVA for affiliative behavior during instrumental versus classical vocal versus easy-listening vocal music

			Mean (standard error)		
Factors	F (df)	*P*	Pretest	Test	Post-test
Phase	37.43 (2)	0.0001	0.024 (0.003)	0.052 (0.004)	0.065 (0.005)
Phase × Genre	6.09 (4)	0.0001			
Instrumental[a,b]			0.022 (0.004)	0.046 (0.004)	0.069 (0.006)
Classical Vocal[a,b]			0.023 (0.010)	0.071 (0.009)	0.063 (0.011)
Easy-listening Vocal[b]			0.034 (0.009)	0.054 (0.008)	0.064 (0.010)
Phase × Sex × Genre	1.30 (4)	0.26			
Female Instrumental[a,b]			0.024 (0.006)	0.048 (0.006)	0.077 (0.009)
Female Classical Vocal[a,b]			0.012 (0.006)	0.090 (0.014)	0.062 (0.012)
Female Easy-listening Vocal[b,c]			0.028 (0.009)	0.056 (0.010)	0.072 (0.012)
Male Instrumental[a,b]			0.019 (0.003)	0.045 (0.004)	0.060 (0.015)
Male Classical Vocal			0.035 (0.019)	0.052 (0.012)	0.064 (0.019)
Male Easy-listening Vocal			0.040 (0.016)	0.052 (0.013)	0.057 (0.011)

[a]Test < pretest ($P > 0.01$).
[b]Post-test < pretest ($P > 0.01$).
[c]Post-test < pretest ($P > 0.05$).

behavior (F = 6.09, $P = 0.001$; Table 3). Both instrumental and classical vocal music increased affiliative behavior while music was played (instrumental, $P = 0.0003$; classical vocal, $P = 0.0001$) and afterwards (instrumental, $P = 0.0001$; classical vocal, $P = 0.006$) as compared with pretest levels. Female chimps showed significantly more affiliative behavior both during ($P < 0.0001$) and after ($P = 0.002$) exposure to classical vocal music, compared with pretest levels. For easy-listening vocal music, there was a trend towards increased affiliative behavior while the music was playing ($P = 0.04$) and a significant increase during the post-test phase ($P = 0.013$), compared with pretest levels. For male chimps, there was no effect of either classical (during, $P = 0.30$; post-test, $P = 0.22$) or easy-listening (during, $P = 0.45$; post-test, $P = 0.32$) vocal music on affiliative behavior (see Table 3).

There was a significant phase, sex, and musical genre interaction for agonistic behavior (F = 7.48, $P = 0.0001$). With exposure to easy-listening vocal music, male chimps showed significantly less agonistic behavior both while the music was playing ($P = 0.005$) and during the post-test phase ($P = 0.0006$), compared to pretest agonism levels (see Table 4). There was a trend towards less agonistic behavior during the post-test phase of classical vocal music sessions ($P = 0.020$) but no effect of instrumental music. In female monkeys, neither classical (during, $P = 0.17$; post-test, $P = 0.11$) nor easy-listening (during, $P = 0.62$; post-test, $P = 0.37$) vocal music affected agonistic behavior (Table 4).

Discussion

In humans, soft instrumental music has been used to increase relaxation and affiliation and decrease stress (that is, heart rate and cortisol level) and anxiety.[3] A number of studies involving laboratory animals equate music with 'noise stress,' regardless of the characteristics of the music.[23,28] The current results show that when provided appropriately, music can benefit captive chimpanzees. Instrumental music had both immediate and residual effects on affiliative behavior in male and female chimpanzees. Although vocal music was also associated with behavioral change, the greater magnitude of response to instrumental music supports the hypothesis that instrumental music is most useful in increasing affiliation in chimpanzees. This finding has important implications not only for the management of captive chimpanzees but also potentially for that of other laboratory primates. Affiliative interactions (that is, submissive greetings and social grooming) have been demonstrated to actively reduce stress in macaques, as indicated by a decrease in heart rate.[5] In addition, affiliative social behavior has positive effects on immune responses in nonhuman primates[13,34] and both speeds healing time and slows disease progression in rodents.[12,25] On the basis of the current study, instrumental music might be implemented in a variety of laboratory primate settings to increase affiliative behavior and thus potentially decrease physiologic stress.

Controlling and managing aggression is a high priority in the management of captive chimpanzees[4] and other laboratory primates.[14] In the current study, both vocal and instrumental music increased affiliative behavior, and agonistic behavior decreased significantly during exposure to vocal music. Vocal music increases distraction during visual and spatial memory tasks,[8,17] so perhaps chimpanzees require 'distraction' to quiet aggressive displays and interactions and enable relaxation to

Table 4. Results of within-subjects repeated-measures MANOVA for agonistic behavior during instrumental versus classical vocal versus easy-listening vocal music

			Mean (standard error)		
Factors	F (df)	*P*	Pretest	Test	Post-test
Phase[a,b]	14.18 (2)	0.0001	0.012 (0.002)	0.006 (0.001)	0.005 (0.001)
Phase × Genre	3.15 (4)	0.03			
Instrumental			0.007 (0.002)	0.006 (0.001)	0.006 (0.001)
Classical Vocal[b]			0.011 (0.004)	0.004 (0.002)	0.003 (0.002)
Easy-listening Vocal[a,b]			0.019 (0.004)	0.009 (0.002)	0.005 (0.002)
Phase × Sex × Genera	7.48 (4)	0.0001			
Female Instrumental			0.004 (0.002)	0.003 (0.001)	0.003 (0.001)
Female Classical Vocal			0.007 (0.004)	0.001 (0.001)	0.000 (0.000)
Female Easy-listening Vocal			0.002 (0.001)	0.003 (0.002)	0.006 (0.003)
Male Instrumental			0.010 (0.003)	0.009 (0.002)	0.009 (0.002)
Male Classical Vocal [c]			0.016 (0.006)	0.008 (0.003)	0.006 (0.003)
Male Easy-listening Vocal [a,b]			0.036 (0.005)	0.014 (0.004)	0.004 (0.003)

[a]Test < pretest ($P < 0.01$).
[b]Post-test < pretest ($P < 0.01$).
[c]Post-test < pretest ($P < 0.05$).

occur. In terms of genre, easy-listening vocal music (with its slow tempos) was most effective at reducing aggression. Slow-tempo (or soothing) music is thought to increase relaxation, decrease anxiety, and improve mood in humans, compared with fast-tempo (or stimulating) music.[27,35] However, in our study, pretest agonism levels were greater for vocal music than for instrumental music (Table 2). In addition, pretest agonism levels were greater for easy-listening vocal music than for classical vocal music (Table 4). Because observations for all tests were balanced for time of day and order, the basis for these discrepancies is unclear. Perhaps variation in the music selected by different members of the animal care staff or on different days of the week accounts for this variation in levels of agonism. Additional research, with more controlled selection of music, is needed to clarify this effect.

The introduction of music has been suggested as a method of decreasing stress and agitation in nonhuman primates.[6,16] However, in human studies, both the presence of music and the type of music are important in reducing tension and anxiety.[9,24,26,27] Recent studies involving dogs[37] and horses[15] further indicate that animals react differently to different types of music. The results of our current study demonstrate that music should not be regarded as simply noise; music can be used to improve psychologic and (potentially) physiologic well-being of captive chimpanzees and other laboratory primates. The effects of music on chimpanzees in our study varied depending on the gender of the subject and the type of social behavior being examined. For nonhuman primates, for which managing aggressive behavior is a key concern,[4,14] our study provides additional support for the use of vocal music. Agonistic behavior in captive chimpanzees occurs more frequently during morning hours,[16] therefore vocal music may reduce stress in the mornings. In particular, the use of slow-tempo vocal music during periods of high activity or stress (that is, feedings, cleanings) followed by a combination of slow-tempo vocal and instrumental music likely would be most effective at decreasing aggression and increasing affiliation in chimpanzees. In the current study, musical enrichment, when tailored appropriately, increased psychologic well-being (by increasing affiliation) and decreased agitation (by decreasing agonism) in captive chimpanzees. Use of soft, slow-tempo vocal and instrumental music likely will be beneficial in other laboratory species. In addition, control has been proposed to be a crucial factor of enrichment, even more so than complexity, for nonhuman primates.[33] Providing chimpanzees the opportunity to control the type of music played likely will further increase the psychologic and physiologic benefits of musical enrichment. Future research will explore this issue in depth.

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