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Behavioral effects of auditory stimulation on kenneled dogs

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Abstract Dogs are kenneled in professional facilities for a variety of reasons; however, the kennel environment, even for short periods, is a potential psychogenic stressor for most dogs. Continual stress and the resultant anxiety are undesirable for both ethical and physiological reasons. One growing area of research pertaining to the welfare of kenneled dogs is environmental enrichment, including auditory stimulation. The current study investigated the impact of music (classical, heavy metal, and specifically designed/altered classical) on activity level, vocalization, and body shaking of 117 kenneled dogs. Results suggest that classical music leads to kenneled dogs spending more time sleeping ($F_{8,354}$ = 12.24, $P > 0.0001$) and less time vocalizing ($F_{8,354} = 3.61$, $P > 0.0005$) than when exposed to other music types or no music. Heavy metal music, compared with other music types, appears to increase body shaking ($F_{8,354} = 96.97$, $P > 0.0001$), a behavior suggestive of nervousness. It is suggested that playing classical music in a shelter environment may help mitigate some of the stress inherent for many kenneled dogs.

Introduction

Countless dogs are kenneled, either short term or long term, for a variety of reasons (Hubrecht and Turner, 1998). Some dogs are kenneled for short-term boarding, whereas others, including strays or those relinquished by owners, are kenneled in a rescue setting for varying amounts of time, some indefinitely. Other dogs are bred as laboratory animals and spend their entire lives in a kennel environment (Wells, 2004).

The kennel environment, even for short periods, is a potential psychogenic stressor for most dogs owing to its novel surroundings and separation from social attachment figures (Beerda et al., 2000; Hennessy et al., 2002; Pullen et al., 2010). A kennel is spatially and socially restrictive, and as a result, many dogs show signs of acute stress when housed in kennels (Hiby et al., 2006; Rooney et al., 2007). Social isolation or restriction, a major stressor for many dogs, can lead to the development of both physiological and behavioral problems (Bergamasco et al., 2010; Hubrecht and Turner, 1998).

Continual stress, and resultant anxiety, is undesirable for both ethical and physiological reasons. Stress in animals has both short-term and long-term effects on health and life span (McEwen, 2005). A recent study (Dreschel, 2010) found that increased stress in dogs is correlated with shorter life spans and increased skin disorders. Anxiety, demonstrated through physical and behavioral manifestations, is a growing welfare concern in veterinary medicine (Overall and Dyer, 2005), and as a result, there

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has been increasing awareness and concern for the welfare of kenneled dogs and the development of potential strategies to improve their environment (Bergamasco et al., 2010).

The primary means that have been used to assess stress are physiological measures and behavioral observations (Bergamasco et al., 2010). Physiological measures to assess stress include immune functions, heart rate, sympathetic nervous system activation monitoring, and hormonal indicators (Bergamasco et al., 2010; Rooney et al., 2007). Behavioral observations include lowered body posture, panting, vocalizing, paw-lifting, body shaking, and repetitive or stereotypic behaviors (pp. 49-62, Beerda et al., 2000, 1997; Hetts et al., 1992).

One growing area of research pertaining to the welfare of kenneled dogs is the idea of environmental enrichment. Environmental enrichment can be defined as any technique designed to improve the functioning of an animal through modifications to the environment (Newberry, 1995). The goals of environmental enrichment for kenneled animals include helping these animals to handle the inherent challenges in kennel environments (i.e., lack of control and unpredictability), encouraging more species-specific behaviors, and reducing abnormal or stereotypic behaviors (Wells, 2009; Young, 2003). One area of environmental enrichment that has started to receive more attention is that of sensory stimulation. This stimulus type is presented to trigger one or more senses (i.e., vision, smell, and/or hearing) as a method of environmental enrichment. This line of inquiry, however, is still new and sporadic (Wells, 2009), and conclusive evidence on effectiveness is still unclear.

Auditory stimulation

Auditory stimulation is one aspect of sensory stimulation that has received increased attention in current years with a variety of species. Listening to music has been found to be a mood-regulatory behavior (Saarikallio and Erkkilä, 2007), and several studies involving humans have found mood regulation and emotional management to be among the most important reasons for music consumption (North et al., 2000; Saarikallio and Erkkila, 2007; Sloboda, 1992; Wells and Hakanen, 1991).

Numerous studies on humans have found listening to relaxing or classical music to be beneficial in a variety of areas (Bechtold et al., 2009), including a decrease in anxiety (Dubois et al., 1995), increase in prosocial behaviors (Gueguen et al., 2010), improvement in satisfaction with medical procedures, decrease in blood pressure and heart rate (Chlan et al., 2000), increased tolerance for uncomfortable procedures, reduction in pain perception (Bampton and Draper, 1997; Nelson et al., 2008), and decreased need for sedative medications (Nelson et al., 2008; Schiemann et al., 2002).

Within other nonmedical settings, music has been found to positively affect various behaviors (Magnini and Parker, 2009), including the amount of time spent by customers in an establishment (Milliman, 1982, 1986) and how much money people spend (Areni and Kim, 1993).

The recognition of the effect music can have on humans has generated interest in investigating the effect of music on other species. A limited number of studies have explored the effects of music on nonhuman animals. For example, classical music has been suggested to enhance the well-being of chickens (Gvaryahu et al., 1989), carp (Papoutsoglou et al., 2007), Asian elephants (Wells and Irwin, 2008), western lowland gorillas (Wells et al., 2006), and domestic dogs (Wells et al., 2002). Other types of auditory stimulation that have been studied include the effects of country music on cattle (Uetake et al., 1997; Wisniewski et al., 1977) and ponies (Houpt et al., 2000).

Exactly why music affects animal stress and behavior is not thoroughly understood.

Despite the uncertainty regarding what causes the positive effects seen with music, the fact that some studies have found that music can positively affect animal stress and behavior has stimulated the development of a growing number of music selections, created and marketed specifically to enhance companion animal well-being. Despite the growing popularity of music tailored toward dogs, there remains a dearth of studies to investigate these claims. The only study published in a peer-reviewed scientific journal to date that has investigated the effect of music on dogs was done by Wells et al. (2002). Given that the study by Wells et al. (2002) involved only 1 exposure to each type of auditory stimulation, further exploration of the effect of music on dogs was thought to be important. Therefore, the current study investigated the effect of auditory stimulation on activity, vocalization, and body shaking—a behavior suggestive of anxiety or nervousness.

Material and method

The study was conducted within a building, in Northern Colorado, that housed both a dog shelter and boarding facility (a place where dogs are temporarily housed for a fee). The shelter had space for approximately 160 dogs. It consisted of 2 long runs, with kennels on each side of the concrete walkways. The kennels were rectangular concrete enclosures with a wire mesh front gate. The dogs were housed either singly or in pairs. Two populations of dogs were studied: dachshund rescue dogs and dogs of all breeds housed for short-term boarding. The boarding dogs and rescue dogs were placed randomly in kennels in both long lines of runs. The dogs were let outside twice a day and fed once daily in the late afternoon. The kennels were cleaned in the morning and then again as necessary throughout the day.

Table 1 Type of music, artist, and BPM

	Artist	Songs	BPM
Classical (average BPM = 121)			
C1	Beethoven	Für Elise	111
C2	Beethoven	Moonlight Sonata	143
C3	Strauss	Blue Danube Waltz	130
C4	Bach	Air on a G String	100
Heavy metal (average BPM = 131)			
HM1	Motorhead	Ace of Spades	140
HM2	Slayer	Angel of Death	102
HM3	Judas Priest	Turbo Lover	151
Psychoacoustically designed (BPM = 95)			
Psych	Through a dog's ear	Song 1	95

BPM, beats per minute.

Subjects

The sample consisted of 117 dogs. There were 34 rescue dogs with a mean age of 5.27 years (SD: 3.65) and a mean time of 155.97 days (SD: 84.72) in the shelter before the study. The rescue dog group included 12 spayed/altered females, 1 intact/unaltered female, 21 neutered/altered males, and 0 intact/unaltered males. The boarding dog group consisted of 83 dogs with a mean age of 5.92 years (SD: 3.34) and a mean time of 4.27 days (SD: 2.96) in the shelter before the study. This group included 38 spayed/altered females, 4 intact/unaltered females, 31 neutered/altered males, and 10 intact/unaltered males. The rescue dogs were either pure breed dachshund or mixed dachshund, whereas the boarding dogs were a variety of pure and mixed breeds. All dogs were healthy with no identifiable hearing impairments. Owing to the fact that some dogs were boarded for short periods, not all dogs were exposed to all music selections. Boarded dogs were exposed to the auditory stimulation presented on the day(s) they were present in the facility.

Auditory variable

The dogs were exposed to 3 general types of music: classical (4 selections), heavy metal (3 selections), and a modification of classical music designed specifically for dog relaxation (1 selection), as well as a control period, in which no music was played. The specific classical and heavy metal songs were chosen based on most popular songs within each genre (Table 1). The modified dog relaxation track was one created and marketed for the purpose of calming and soothing dogs in shelter and home conditions. The creators of the modified music explained that the music has been psychoacoustically designed with the specific goal of creating soothing music for dogs (Leeds and Wagner, 2008). The music is selected and arranged to create a simple sound, defined by Leeds and Wagner (2008) as music that minimizes the amount of auditory information (Leeds and Wagner, 2008). Volume 1, *Music to Calm Your Canine Companion* was used in the current study. Multiple selections from the classical and heavy metal genres were used to help determine whether any potential differences in dog behavior were due to the specific song or the music genre. Additionally, beats per minute (BPM) for each song was noted to assess whether any differences in dog behavior were due to music genre or BPM. Therefore, a variety of songs with different BPM were used within each genre. In addition to BPM, it is possible that other elements of music might affect psychological and physiological states of dogs, including rhythm, melody, pitch, harmony, and interval (Murrock, 2005). Because of the exploratory nature of this study, however, these elements were not assessed. Follow-up studies to assess these other elements of music are seen as important next steps.

Procedure

The 9 experimental conditions of auditory stimulation (4 tracks of classical, 3 tracks of heavy metal, 1 track of psychoacoustically designed music, and no music (used as a control) were presented using an iPod (Apple Store) music player and Eos wireless speakers (Eos Wireless, San Diego, CA). The speakers are rated at 15 W total root mean square @ 4_(3 $\times$ % W) >0.01% total harmonic distortion. Each speaker had 2 $\times$ 1” neodymium tweeters and a 3” ported subwoofer. The long kennel runs were divided into half, and speakers were placed in the center of each half of each run to ensure even distribution of sound to all sheltered dogs. A total of 4 speakers were used for the 2 runs. The sound level was gauged by 2 experimenters and a shelter worker who agreed that the sound seemed equal in each kennel.

Dogs were exposed to each of the 9 conditions of auditory stimulation over the course of 4 months (July-October). Exposure consisted of 45 minutes for each condition, followed by 15 minutes of no music/silence. Three conditions (including the control condition) were tested each day between 9 AM and 12 PM on Tuesday,

Table 2 Percentage of time spent sleeping for each music selection

Music	Percent	SE
C2	4.8	1.5
C3	4.7	1.9
C4	6.0	1.3
C1	3.7	0.9
Control	1.1	0.3
Psych	1.4	0.6
HM2	1.2	0.4
HM3	1.2	0.4
HM1	0.8	0.2

C1, Beethoven, Für Elise; C2, Beethoven, Moonlight Sonata; C3, Strauss, Blue Danube Waltz; C4, Air on a G String; HM1, Motorhead, Ace of Spades; HM2, Slayer, Angel of Death; HM3, Judas Priest, Turbo Lover; Psych, Through a Dog's Ear, Song 1; SE, standard error.

Wednesday, and Thursday. Monday, Friday, Saturday, and Sunday were not used as research days owing to the fact that these days involved more activity within the shelter, as boarding dogs were more frequently dropped off or picked up by owners on these days. The time frame between 9 AM and 12 PM was used to eliminate confounds associated with cleaning, feeding, and outdoor times. The presentation order of auditory conditions was randomly assigned each day to eliminate any potential order effects.

The dogs' behaviors were recorded by 1 observer (used throughout the study) every 5 minutes over the course of the exposure to auditory stimulation using instantaneous time sampling. After the first 5 minutes of each exposure period, the experimenter would begin observing each dog's behavior every 5 minutes. Therefore, each 45-minute exposure led to 9 behavior recordings. The observer began the music exposure in one run (separated by concrete walls and 2 separate heavy metal doors from the second run), waited 5 minutes to record behaviors, and then began music exposure in the second run. It took approximately 2 minutes for the observer to complete the behavior assessments in each run.

Three aspects of behavior were recorded at each observation. These included activity, vocalization, and body shaking. For each of these behaviors, the number of times the dog was observed performing the behavior in each category was recorded (e.g., silent, barking, other). A checklist was used by the observer for each behavior.

Table 3 Percentage of time spent silent for each music selection

Music	Percent	SE
C2	95.1	1.6
C3	88.4	4.2
C4	92.7	1.8
C1	91.7	2.1
Control	85.9	2.7
Psych	88.8	3.0
HM2	93.5	1.9
HM3	89.5	2.6
HM1	88.6	2.7

Table 4 Percentage of time spent shaking for each music selection

Music	Percent	SE
C2	0.5	0.3
C3	2.8	1.2
C4	0.7	0.2
C1	0.9	0.3
Control	1.2	0.3
Psych	0.5	0.3
HM2	71.2	5.3
HM3	49.9	5.8
HM1	37.8	5.1

The 3 categories of behavior measured included the following:

Activity
a. Sleeping
b. Other (i.e., moving standing, sitting, lying down)
Vocalization
c. Silent
d. Barking
e. Other (i.e., whining or yipping)
Body movement
f. Shaking
g. Not shaking

Results

A mixed model analysis of variance was used to control for multiple readings from the same dog and the fact that some dogs received more exposures to the auditory stimulus than other dogs, based on how long they were kenneled. The statistical significance level was accepted at $P < 0.05$. Because there was no significant interaction between auditory stimulus type and type of dog (i.e., rescue or boarding) or type of housing (singly or housed with other dogs) for any of the 3 categories of assessed behavior, data from all dogs were analyzed together. Two-tailed *t* tests were used for post hoc analysis, with significance level accepted at $P < 0.05$. The percentage of time dogs were seen displaying each of the behaviors analyzed (sleeping vs. not sleeping, vocalizing vs. silent, and shaking vs. not shaking) is presented in Tables 2-4.

Activity

A significant difference was found in the number of observations of sleeping behavior versus other activity behavior based on auditory stimulus ($F_{8,354} = 12.24$, $P > 0.0001$). Although there was a significant difference

Table 5 Post hoc *t* tests for music selections and activity (sleeping or not sleeping)

Music	Music	Estimate	SE	*df*	*t* value	*P* value
C2	C3	0.02	0.48	354	0.03	0.9744
C2	C4	−0.23	0.34	354	−0.68	0.4946
C2	C1	0.27	0.36	354	0.74	0.4591
C2	Psych	1.30	0.48	354	2.68	**0.0076**
C2	HM2	1.46	0.41	354	3.59	**0.0004**
C2	HM3	1.39	0.40	354	3.51	**0.0005**
C2	HM1	1.89	0.42	354	4.54	<**0.0001**
C3	C4	−0.25	0.44	354	−0.56	0.5791
C3	C1	0.25	0.46	354	0.55	0.5851
C3	Control	1.46	0.44	354	3.29	**0.0011**
C3	Psych	1.28	0.57	354	2.27	**0.0240**
C3	HM2	1.45	0.49	354	2.97	**0.0032**
C3	HM3	1.38	0.49	354	2.81	**0.0052**
C3	HM1	1.88	0.51	354	3.71	**0.0002**
C4	C1	0.50	0.29	354	1.74	0.0826
C4	Control	1.70	0.25	354	6.79	<**0.0001**
C4	Psych	1.53	0.42	354	3.67	**0.0003**
C4	HM2	1.69	0.36	354	4.67	<**0.0001**
C4	HM3	1.62	0.31	354	5.18	<**0.0001**
C4	HM1	2.12	0.35	354	6.03	<**0.0001**
C1	Control	1.21	0.27	354	4.44	<**0.0001**
C1	Psych	1.03	0.45	354	2.28	**0.0232**
C1	HM2	1.19	0.39	354	3.09	**0.0021**
C1	HM3	1.12	0.36	354	3.13	**0.0019**
C1	HM1	1.62	0.33	354	4.87	<**0.0001**
Control	Psych	−0.17	0.43	354	−0.41	0.6853
Control	HM2	−0.01	0.36	354	−0.03	0.9766
Control	HM3	−0.08	0.33	354	−0.25	0.8054
Control	HM1	0.42	0.33	354	1.25	0.2128
Psych	HM2	0.16	0.50	354	0.33	0.7448
Psych	HM3	0.09	0.47	354	0.20	0.8439
Psych	HM1	0.59	0.40	354	1.19	0.2338
HM2	HM3	0.07	0.42	354	−0.17	0.8662
HM2	HM1	0.42	0.44	354	0.98	0.3281
HM3	HM1	0.50	0.41	354	1.21	0.2281

df, degrees of freedom; <, less than.
P values in boldface are statistically significant at $P < 0.05$.

in the number of observations of sleeping behavior for rescue dogs versus boarding dogs ($F_{1,115} = 8.58$, $P > 0.004$), where rescue dogs slept more than boarding dogs, there was no interaction between type of dog (rescue vs. boarding) and music type for sleeping behavior.

Post hoc *t* tests indicated that both groups of dogs spent the most time sleeping during classical music selections compared with heavy metal, psychoacoustically designed, or the control. There was no significant difference in the number of observations of sleep time between any of the classical selections, but all classical selections resulted in more sleep time than any heavy metal selections, dog relaxation track, or control. There were no significant differences between the control, psychoacoustically designed, and any heavy metal selections in the number of observations of sleep time (Table 5).

Vocalization

Although data collection included 3 potential aspects of vocalization (silent, barking, and other), a decision was made to combine "barking" with "other" because of the difficulty in clearly identifying what constituted a "bark" versus other vocalizations that approximated a bark. Therefore, assessment was completed with 2 levels of vocalization: barking/other and silent. A significant difference was found in vocalization (silent or not silent) based on auditory stimulus ($F_{8,354} = 3.61$, $P > 0.0005$). Although there was a significant difference in the number of observations of silent time between rescue dogs and boarding dogs ($F_{1,115} = 12.17$, $P > 0.0007$), where rescue dogs spent more time silent than boarding dogs, there was no interaction between type of dog (rescue vs. boarding) and music type for vocalization. Post hoc *t* tests indicated that the dogs spent the most time silent during the classical 2 (Moonlight Sonata) selection and least time silent during the control periods. There was a significant difference between classical 2 and classical 3, control, psychoacoustically designed, and heavy metal 1 and 3. Classical 2 was not significantly different from classical 1 and 4 or heavy metal 2. Classical 1 and 4 were only significantly different from control (more silent time than control). Control was also different from heavy metal 2 (with less silent time for control). There were no differences between psychoacoustically designed and other auditory stimuli, with the exception of classical 2 (Table 6).

Body movement–shaking

There was no significant difference between rescue and boarding dogs in the number of observations of observed body shaking. There was a significant difference in the number of observations of shaking and type of auditory stimulation ($F_{8,354} = 96.97$, $P > 0.0001$). Post hoc *t* tests indicated that the dogs were observed shaking more with all heavy metal selections. Two selections were significantly different from most others. There was a statistical difference between classical selection 3 and all other stimuli, excluding the control. There was also a statistical difference observed between heavy metal selection 2 and all other stimuli (Table 7).

Discussion

Both boarded and rescue dogs responded to all the classical music selections by sleeping more than during exposure to any other auditory stimulation type. The number of observations of silence was greatest during 1 classical selection (classical 2) and least during the control period (no music). These results are consistent with human studies, which have suggested that music can reduce agitation (Sung et al., 2008), promote sleep (de Niet et al., 2009), improve mood, and lower stress and anxiety (Cooper and Foster, 2008).

Table 6 Post hoc *t* tests for music selections and vocalization (silent or not silent)

Music	Music	Estimate	SE	*df*	*t* value	*P* value
C2	C3	0.93	0.46	354	2.04	**0.0416**
C2	C4	0.43	0.34	354	1.27	0.2048
C2	C1	0.57	0.35	354	1.62	0.1051
C2	Control	1.16	0.31	354	3.74	**0.0002**
C2	Psych	0.89	0.37	354	2.39	**0.0176**
C2	HM2	0.30	0.35	354	0.87	0.3864
C2	HM3	0.82	0.35	354	2.38	**0.0178**
C2	HM1	0.91	0.35	354	2.64	**0.0087**
C3	Classical 4	−0.50	0.40	354	−1.24	0.2152
C3	C1	−0.37	0.41	354	−0.88	0.3792
C3	Control	0.23	0.38	354	0.60	0.5512
C3	Psych	−0.04	0.44	354	−0.09	0.9290
C3	HM2	−0.63	0.41	354	−1.51	0.1314
C3	HM3	−0.11	0.41	354	−0.26	0.7953
C3	HM1	−0.02	0.41	354	−0.05	0.9624
C4	C1	0.14	0.26	354	0.52	0.6051
C4	Control	0.73	0.21	354	3.54	**0.0004**
C4	Psych	0.46	0.28	354	1.62	0.0959
C4	HM2	−0.12	0.30	354	−0.42	0.6763
C4	HM3	0.40	0.24	354	1.63	0.1041
C4	HM1	0.48	0.26	354	1.85	0.0658
C1	Control	0.59	0.22	354	2.72	**0.0069**
C1	Psych	0.33	0.30	354	1.07	0.2840
C1	HM2	−0.26	0.31	354	−0.84	0.4012
C1	HM3	0.26	0.28	354	0.93	0.3534
C1	HM1	0.35	0.24	354	1.47	0.1438
Control	Psych	−0.27	0.26	354	−1.04	0.3002
Control	HM2	−0.86	0.27	354	−3.19	**0.0015**
Control	HM3	−0.34	0.22	354	−1.51	0.1319
Control	HM1	−0.25	0.21	354	−1.16	0.2473
Psych	HM2	−0.59	0.34	354	−1.73	0.0838
Psych	HM3	−0.07	0.30	354	−0.23	0.8198
Psych	HM1	0.02	0.30	354	0.06	0.9488
HM2	HM3	0.52	0.31	354	1.69	0.0928
HM2	HM1	0.61	0.31	354	1.97	0.0500
HM3	HM1	0.09	0.27	354	0.32	0.7511

<, less than.
P values in boldface are statistically significant at $P < 0.05$.

Table 7 Post hoc *t* tests for music selections and body movement (shaking or not shaking)

Music	Music	Estimate	SE	*df*	*t* value	*P* value
C2	C3	−1.79	0.78	354	−2.30	**0.0218**
C2	C4	−0.42	0.72	354	−0.58	0.5644
C2	C1	−0.70	0.71	354	−0.99	0.3235
C2	Control	−0.93	0.68	354	−1.37	0.1721
C2	Psych	−0.12	0.86	354	−0.14	0.8862
C2	HM2	−6.26	0.68	354	−9.18	<**0.0001**
C2	HM3	−5.35	0.68	354	−7.83	<**0.0001**
C2	HM1	−7.86	0.68	354	−7.14	<**0.0001**
C3	C4	1.37	0.53	354	2.57	**0.0107**
C3	C1	1.09	0.53	354	2.06	**0.0398**
C3	Control	0.86	0.48	354	1.81	0.0705
C3	Psych	1.66	0.71	354	2.33	**0.0202**
C3	HM2	−4.47	0.48	354	−9.28	<**0.0001**
C3	HM3	−3.56	0.48	354	−7.37	<**0.0001**
C3	HM1	−3.07	0.48	354	−6.36	<**0.0001**
C4	C1	−0.29	0.42	354	−0.68	0.4989
C4	Control	−0.51	0.36	354	−1.43	0.1530
C4	Psych	0.29	0.63	354	0.46	0.6428
C4	HM2	−5.84	0.39	354	−15.14	<**0.0001**
C4	HM3	−4.93	0.35	354	−13.92	< **0.0001**
C4	HM1	−4.44	0.37	354	−12.12	< **0.0001**
C1	Control	−0.22	0.33	354	−0.67	**0.5027**
C1	Psych	0.58	0.63	354	0.91	0.3613
C1	HM2	−5.55	0.37	354	−14.87	<**0.0001**
C1	HM3	−4.64	0.36	354	−13.00	<**0.0001**
C1	HM1	−4.15	0.32	354	−12.83	<**0.0001**
Control	Psych	0.80	0.59	354	1.36	0.1751
Control	HM2	−5.33	0.30	354	−17.94	<**0.0001**
Control	HM3	−4.42	0.27	354	−16.18	<**0.0001**
Control	HM1	−3.93	0.26	354	−15.31	<**0.0001**
Psych	HM2	−6.13	0.61	354	−10.03	<**0.0001**
Psych	HM3	−5.22	0.60	354	−8.77	<**0.0001**
Psych	HM1	−4.73	0.60	354	−7.93	<**0.0001**
HM2	HM3	0.91	0.31	354	2.95	**0.0033**
HM2	HM1	1.40	0.31	354	4.58	<**0.0001**
HM3	HM1	0.49	0.29	354	1.73	0.08

<, less than.
P values in boldface are statistically significant at $P < 0.05$.

Both boarded and rescue dogs exhibited more body shaking behavior during all heavy metal selections when compared with any other auditory stimulus. Therefore, while we found that classical music has a relaxing effect on kenneled dogs, heavy metal music, in contrast, appears to have the opposite effect, resulting in increased behaviors that could be a result of stress and/or add to their stress level at the same time (i.e., barking, body shaking, and less sleep time). Research pertaining to the effects of heavy metal music on humans has shown similar trends (Becknell et al., 2008).

The psychoacoustically arranged selection, a piece of classical music that was designed specifically to promote dog relaxation, was found to have minimal effect on the dogs' behaviors. The reason for this is unknown. Certainly more research into psychoacoustically altered music selections designed to affect animals' behaviors is warranted.

Our findings replicate some of the findings by Wells et al. (2002) in their study of the effect of auditory stimulation on shelter dogs. We found that classical music promoted more restful behaviors that might be associated with a reduced stress level. Heavy metal music was found to have the opposite effect, leading to behaviors that suggest increased agitation.

Shelters are inherently stressful environments for most dogs, and results of this study suggest that playing classical music might help ameliorate some of these negative aspects. It is also possible that the positive effects that classical music has been found to have on humans may also affect both shelter employees and potential adopters. In addition to creating a more positive work environment for employees, playing classical music might help potential adopters feel more comfortable at the shelter, thereby increasing the likelihood of them finding a suitable animal to adopt. This would be consistent with research that has demonstrated that slower-paced music can increase the amount of time people spend shopping (Milliman, 1982). Additionally, research conducted on humans suggests that uplifting music can positively affect helping behaviors (North et al., 2004), and adopting from a shelter is often viewed and marketed as a type of helping behavior. For example, the Humane Society of the United States lists the top reason to adopt as "to save a life" (HSUS, 2009), and American Humane indicates that "one way to start putting an end to pet overpopulation is to adopt your next pet from your local shelter or breed rescue group" (American Humane, n.d.). Perhaps, therefore, uplifting music in this context could positively affect adoption rates.

In contrast, it is suggested that playing heavy metal music might negatively affect dogs' welfare as well as the general experience of shelter employees and potential adopters. Human studies have found that listening to grunge or heavy metal rock is correlated with increased hostility, sadness, tension, and fatigue, as well as inappropriate behaviors, in addition to significant reductions in behaviors related to caring, relaxation, mental clarity, and vigor (Harris et al., 1992; McCraty et al., 1998).

Conclusion

Results from this study suggest that auditory stimulation can affect kenneled dogs' behaviors and stress levels, and therefore, auditory stimulation can be used to enhance the welfare of shelter dogs. The findings from this study have potential welfare implications for shelter dogs. As outlined in the American Veterinary Medical Association Animal Welfare Principles, "Procedures related to animal housing, management, care, and use should be continuously evaluated, and when indicated, refined or replaced" (AVMA, 2006). The fact that kenneled dogs can be effected either positively or negatively by the music played within a facility offers the opportunity to create a more positive environment for dogs for relatively minimal cost and effort. The potential benefits of music on shelter dogs, however, are likely to be altered by shelters' level of ambient noise.

In conclusion, it is suggested that shelters refrain from playing heavy metal music owing to the detrimental effect it may have on dogs' stress and anxiety levels. Instead, it is suggested that shelters play classical music as a cost-efficient, practical way to enhance the environment and, therefore, the welfare of shelter dogs. Classical music can reduce dogs' stress levels and potentially increase the likelihood of adoption. Limitations to the current study include the fact that only 1 kennel was used for assessment and other kennels might show different results. The kennel selected for this study had a minimal amount of ambient or background noise. Dogs at shelters with higher levels of background noise might respond differently to auditory stimulation. Future studies involving settings with varying levels of background noise will be important to further determine the effects of auditory stimulation in shelters. Additionally, although sound level (of stimulus or background) was not measured in this preliminary study, further research should include this information for more complete understanding of the outcomes of auditory simulation.

It should also be noted that only 1 type of rescue breed (dachshund) was used for this study and other rescue breeds or other types of boarded dogs might respond differently. It is also possible that age and sex of dogs might affect how they react to different types of auditory stimulation. More research to determine what aspects of classical music help reduce stress the most (i.e., BPM or tone) would be helpful in determining which classical music to play. Additionally, further research investigating effects of classical music in other stressful environments (e.g., veterinary clinics) would help advance the field of knowledge pertaining to the use of sensory stimulation to improve animal welfare.

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