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The effect of auditory stimulation on pet dogs' reactions to owner separation

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ABSTRACT

The domestic dog has attracted notable attention in relation to the welfare benefits of auditory stimulation. Studies carried out in rescue kennels, an environment in which dogs are prone to chronic stress, have pointed to a calming influence of both classical music and audiobooks. The benefits of auditory stimulation for dogs experiencing more immediate types of stress, however, are still unknown. This investigation thus examined the effect of classical music and the spoken voice in the form of an audiobook on the behaviour of pet dogs in response to separation from their owners, a known short-term stressor. Three conditions of auditory stimulation were employed: (1) a control (the normal environment of the university research room), (2) classical music (*Mozart's Sonata K.448*) and (3) an audiobook (*Harry Potter and the Philosopher's Stone*). The effect of these conditions was explored using two approaches. Study 1 explored the effects of auditory stimulation using a between-subjects design. Sixty dogs were assigned to one of the 3 conditions and exposed to the relevant auditory stimulus for 1-hour. Each dog's behaviour was recorded every 10 s using a purpose-designed ethogram. Latency data were recorded by video. Results revealed a significant effect of auditory condition on latency to lie down, latency to settle (i.e., lie down for >30 s) and speaker-directed gaze. Dogs exposed to classical music were significantly faster to lie down than animals in the audiobook condition and quicker to settle than animals in the audiobook and control conditions. Subjects in the audiobook condition spent significantly more time gazing at the speaker than animals in the classical music and control conditions. Dogs in the classical music condition also spent significantly more time looking towards the speaker than control animals. Study 2 examined the effects of auditory stimulation using a repeated measures design. Twenty-two dogs were exposed to each condition of auditory stimulation for 30 min, with a period of 10 min between conditions. Each animal's behaviour was recorded as per Study 1. Only speaker-directed gaze differed significantly between conditions, with animals spending more time looking at the speaker in the audiobook and classical music conditions than the control. Overall, findings point to only a moderately calming effect of classical music, and no apparent welfare benefits of an audiobook, on dogs separated from their owners. The research points to auditory stimulation having little value to dogs in situations of short-term acute stress. Further research is recommended in this field, ideally in a wider variety of contexts than studied thus far.

1. Introduction

Recent years have witnessed increasing interest in the benefits of auditory stimulation for animal welfare (for reviews see Alworth and Buerkle, 2013; Lindig et al., 2020; Kriengwatana et al., 2022; Wells, 2009). Studies have pointed to certain types of auditory cue resulting in behavioural and/or physiological changes suggestive of enhanced well-being in a variety of species, including horses (Huo et al., 2021), sheep (Meshabaz et al., 2017), gorillas (Wells et al., 2006) and elephants (Wells and Irwin, 2008).

The domestic dog, *Canis familiaris*, has attracted notable attention in relation to the welfare benefits of auditory stimulation (for reviews see Lindig et al., 2020; Wells, 2009). Most of this work has been conducted in kennels, an environment recognised to be stressful for dogs (Hiby et al., 2006; Rooney et al., 2007). In the first study of its kind, Wells et al. (2002) reported that dogs housed in a rescue shelter showed behaviours associated with improved welfare (decreased barking, increased resting) upon exposure to a mixed soundtrack of classical compositions. Similar

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behavioural benefits of classical music have been reported by others, again, in populations of kennelled dogs (Bowman et al., 2015; Kogan et al., 2012), although the relative short-lived nature of these benefits has been highlighted (Bowman et al., 2015). Research exploring the physiological effects of classical music on captive dogs, albeit limited, has largely confirmed the behavioural work in showing advantageous outcomes. For example, Bowman et al. (2015) reported increased heart rate variability in kennelled dogs exposed to classical music, which, when considered alongside their behavioural data, suggested a move from sympathetic to parasympathetic dominance.

Whilst most of the welfare benefits to captive dogs seem to arise from classical music, Brayley and Montrose (2016) discovered advantages to canine well-being from the spoken word. In this study, 31 dogs housed in a rescue kennel were exposed to five different types of auditory condition (audiobook, classical music, pop music, music designed specifically for dogs and a no auditory stimulation control). Each condition lasted for 2 h, during which the animals' behaviour was recorded using a scan-sampling technique. Dogs were found to spend more time resting and less time sitting or standing in the audiobook, than other conditions, leading the authors to conclude that exposure to this stimulus can be calming for captive-housed dogs.

Outside the confines of the rescue shelter environment, studies exploring the effect of auditory stimulation on canine welfare are less positive in their findings. Engler and Bain (2017), for instance, exposed dogs visiting a veterinary hospital for a wellness check to one of 3 types of auditory stimulation (modified classical music, the same music in its original format and no music [control]) in the examination room. Both owners and clinicians completed standardised surveys designed to explore the effect of the auditory environment on their perceptions of the animals' behaviour. Findings showed no difference in perceptions of canine aggression, anxiety or physiology (heart rate, respiratory rate, body temperature) between the three conditions; classical music, however, had a positive influence upon employee and owner satisfaction. In a similar vein, Albright et al. (2017) found that classical music designed to have a calming effect on dogs ('*Through a Dog's Ear*') did not improve depth of canine sedation in a veterinary hospital in a population of 10 animals, as assessed by behaviour, accelerometery and restraint tests.

The literature highlighted above hints at certain types of auditory stimulation having welfare benefits for dogs in the captive environment, a situation in which animals are likely to be chronically stressed. It appears to have less of a welfare advantage, however, to animals outside the confines of captivity, although thus far only a scant amount of data have been collected to explore this. This is surprising, considering the widespread recommendation of auditory stimulation as an enrichment tool and therapeutic intervention, regardless of the context (for discussion of this issue see Wells, 2009). In an effort to address the dearth of information in this area, the following study examined the effect of auditory stimulation on the behaviour of pet dogs separated from their owners, a known short-term stressor (Topal et al., 1998; Prato-Previde et al., 2003). Dogs are frequently required to be apart from their owners for short periods of time (e.g., during visits to groomers, pet sitters, etc.), a situation they may find stressful; exploring the value of auditory stimulation for animals in the type of context where they are separated from their owners would therefore prove informative from an applied animal welfare perspective.

Dogs in the present investigation were studied, for the first time, in a controlled room in a university setting in an effort to reduce the influence of extraneous variables. Animals were studied in response to two types of auditory stimulation known to have benefits in the kennel environment (classical music and an audiobook). For comparative purposes, dogs were also studied in response to the same environment minus the addition of any auditory cues (control). Given the role that individual differences can play in shaping canine behaviour (see Wells, in press), two studies were undertaken, one using a between-subjects design, in which dogs were studied in one of the three conditions of auditory stimulation (Study 1), and one involving a smaller number of subjects studied repeatedly across the three conditions (Study 2). Together, it was hoped that the studies would shed light on the welfare benefits of auditory stimulation in situations where dogs are separated from their owners.

2. Study 1

Study 1 explored the effect of auditory stimulation on dogs' reactions to owner separation using a between-subjects design methodology.

2.1. Methods

2.1.1. Subjects

The study population consisted of 60 pet dogs (26 [43.3 %] males, 34 [56.7 %] females), recruited through social media advertisements and posters (Table 1). Subject animals were aged between 10 months and 12 years (mean age = 4.38 +/- 0.37 years) and the vast majority (n = 48, 80 %) were neutered. A wide variety of breeds were recruited; animals were considered to be either a pure breed (a dog comprising 1 breed) or mixed breed (a dog comprising 2 or more breeds). All of the subject animals met the inclusion criteria for the study, i.e., dogs must: (1) be healthy with no indicators of poor physical or psychological welfare, (2) not be on any medication, and, (3) be over 7 months of age. All of the owners provided consent for their pets to take part in the research and, having read the Participant Information Sheet (which highlighted the fact that animals would be studied in a different room), indicated that they were comfortable for their dogs to be separated from them for the duration of testing. None of the dogs were reported to suffer from any behaviour problems that might cause distress during testing, and animals were used to being apart from their owners for short periods of time for various reasons, e.g., visits to groomers, pet-sitters, left alone at home. All animals were routinely exposed to a wide variety of auditory cues (e.g., radio, TV) as part of their daily lives.

2.1.2. Study site

Data collection was conducted in a testing room (6 m x 3.5 m) in the Animal Behaviour Centre (ABC), a research facility in the School of Psychology, Queen's University Belfast. The testing room set up was identical for every dog, with a water dish, table and two chairs. The room was installed with 4 cameras (Axis M1065-L) to allow for recording of the animals' behaviour.

2.1.3. Auditory stimuli

Three conditions of auditory stimulation were developed for use in this study:

1) Classical music - Mozart's *Sonata K.448 was used as the stimulus material for the classical music condition. This composition has attracted considerable scientific attention in relation to its effects on spatial*

Table 1
The number (and percentage) of dogs in each condition of auditory stimulation in Study 1 according to canine sex, castration status, age and breed.

Demographic	Control n (%)	Classical Music n (%)	Audiobook n (%)	Total n (%)
Sex	10 (38.0)	8 (31.0)	8 (31.0)	26 (100.0)
Male	10 (29.4)	12 (35.3)	12 (35.3)	34 (100.0)
Female				
Castration Status	15 (31.2)	16 (33.3)	17 (35.4)	48 (100.0)
Neutered	5 (41.7)	4 (33.3)	3 (25.0)	12 (100.0)
Intact				
Age	7 (33.3)	8 (38.1)	6 (28.6)	21 (100.0)
Juvenile (<2 years)	13 (33.3)	12 (30.8)	14 (35.9)	39 (100.0)
Adult (>2 years)				
Breed	11 (33.3)	10 (30.3)	12 (36.4)	33 (100.0)
Pure breed	9 (33.3)	10 (37.0)	8 (29.6)	27 (100.0)
Mixed breed				

reasoning (see Rauscher et al., 1993, 1995); its merits as an enrichment tool, however, has thus far escaped focus.

2) Audiobook - *Harry Potter and the Philosopher's Stone (J.K Rowling, read by Stephen Fry), was used for the audiobook condition. The audiobook presented a continuous recording of a male human voice, with no music or additional sound effects. Audiobook material has been used successfully as an enrichment tool in one study involving dogs (*Brayley and Montrose, 2016).
3) Control - The control condition comprised the normal background noise of the testing room, with no additional auditory stimulation.

Both the audiobook and classical music were played into the testing room using a Bluetooth speaker, located on a table in the middle of the room. During the control condition, the speaker was switched off, but remained in the room. Each stimulus was presented at what was considered a comfortable volume for humans (between 45 and 65 decibels, as loud as a typical human conversation).

2.1.4. C-BARQ

The Canine Behavioral Assessment & Research Questionnaire (C-BARQ, Hsu and Serpell, 2003) was completed by owners to allow for an exploration of differences in dog personality between the conditions. The C-BARQ is a psychometric tool designed to provide standardised evaluations of canine behaviour. The current test comprises 100 questions designed to collect information on how dogs respond to various situations, stimuli and events in their environment. Fourteen behavioural areas are assessed by the tool (e.g., stranger-directed aggression, dog-directed fear, separation-related problems, touch sensitivity, energy). The C-BARQ requires owners to respond to a series of statements pertaining to each of the subscale items (e.g., stranger-directed fear) using a 5-point Likert scale.

2.1.5. Procedure

Each subject animal was brought to the ABC for testing at a time suitable to their owner and, upon arrival assigned to one of the 3 conditions of auditory stimulation (classical music, audiobook, control). Assignment was systematic to achieve equal numbers of animals per condition. The dog was given 10 min to explore and acclimatise to the testing room with their owner present. Following this, the cameras were switched on and the owner was required to leave the room, whereupon they completed the C-BARQ; the experimenter, a 24-year-old female [RFK] remained seated on one of the chairs. The auditory stimulus relevant to the animal's condition was presented immediately following the owner's departure and was played on a loop for 1-hour. The behaviour of the dog was recorded in real time by the experimenter on a score sheet using a purpose-designed ethogram (based on Wells et al., 2002, see Table 2) every 10 s for 60 min using a scan-sampling technique. The dog's behaviour was also recorded continuously using the cameras in the testing room. The experimenter remained seated in the room throughout testing, but avoided interaction with the animal at any point. At the end of the testing period the auditory stimulus was turned off and the dog and owner were reunited.

2.1.6. Data analysis

A series of chi-squared tests were initially carried out to determine if there was any significant difference in the characteristics of the dogs (i.e., sex, castration status, age, breed) between the 3 conditions of auditory stimulation. The C-BARQ data were analysed according to the authors' guidelines, giving rise to 14 scores, one for each of the behavioural subscales (e.g., stranger-directed aggression, energy). Kruskal-Wallis tests were carried out for each subscale score to explore if there was any significant difference in the behavioural profile of the dogs between the 3 conditions.

Following this, the number of times a dog was recorded displaying each of the behaviours (activity, vocalisation, eye gaze) on the ethogram was determined by summing the number of observations. Frequency scores for each of these behaviours were converted to percentages (of the overall testing time) to control for the small number of observations where an animal was recorded as out of sight. Latency data (recorded in minutes) were calculated for three behaviours on the ethogram (length of time taken to first lie down, length of time taken to settle [i.e., lie down for >30 s] and length of time taken to start to vocalise). Since the data violated the assumptions for normality ($P < 0.05$, Shapiro test), a series of Kruskal Wallis tests were carried out for each of the behaviours on the ethogram to determine if the dogs' behaviour differed significantly between the three conditions (classical music, audiobook, control) of auditory stimulation. Mann Whitney U tests were also conducted to explore whether the occurrence of each behaviour recorded differed according to canine sex (male, female), castration status (neutered, intact), age (juvenile, adult) or breed (pure breed, mixed breed).

Ethical Approval: This study was given full ethical approval by the University's Faculty Research Ethics Committee (EPS 19_161).

Table 2
Ethogram of canine behaviours recorded in Studies 1 and 2.

Behaviour	Description
Latency	
Latency to lie	The time taken for the dog to initially lie down
Latency to settle	The time taken for the dog to remain lying down for >30 seconds
Latency to vocalise	The time taken for the dog to first start vocalising
Activity	
Sitting	Dog is resting on its hind haunches
Walking	Dog is upright moving around the room
Lying	Dog is lying on the floor with all paws and stomach touching the ground. Head is either on the paws or ground, with eyes open or closed
Standing	Dog is upright with all four paws touching the ground
Interaction	Dog is touching or attempting to gain the attention (e.g., nuzzling, pawing) of the experimenter
VOCALISATION	
Quiet	Dog is silent, making no vocalisations
Barking	Dog is barking
Whining	Dog is whining/whimpering
EYE GAZE	
Door	Dog is looking at the door
Person	Dog is looking at the researcher
Speaker	Dog is looking at the speaker

2.2. Results

Analysis revealed no significant difference in the sex ($\chi^2 = 0.54$, df = 2, P = 0.76), castration status ($\chi^2 = 0.62$, df=2, P = 0.73), age ($\chi^2 = 0.44$, df = 2, P = 0.80) or breed ($\chi^2 = 0.40$, df=2, P = 0.82) of the dogs between the 3 conditions of auditory stimulation. Out of the 14 behavioural areas assessed by the C-BARQ, only one (stranger-directed aggression) differed significantly between conditions ($H = 7.47$, df = 2, P = 0.02). Dogs in the audiobook condition showed significantly (U=98.0, P = 0.01) higher levels of this behavioural trait (mean score = 0.65 +/0.12) than animals in the control condition (mean score = 0.23 +/ 0.05).

Analysis revealed a significant effect of auditory condition on 3 of the behaviours recorded, specifically latency to lie down, latency to settle and speaker-directed gaze (Table 3). Post-hoc Mann-Whitney U tests showed that dogs in the classical music condition were significantly faster to lie down than animals in the audiobook condition (U = 84.00, P = 0.03). Likewise, dogs exposed to classical music settled more quickly than animals in both the audiobook (U = 87.00, P = 0.04) and control (U = 96.00, P = 0.02) conditions. Subjects in the audiobook condition spent significantly more time gazing towards the speaker than animals in both the classical (U = 121.00, P = 0.03) and control (U = 29.50, P < 0.001) conditions. Dogs in the classical music condition also spent significantly more time looking towards the speaker than control animals (U = 78.50, P < 0.001).

Table 3
The mean (+/-S.E.) duration (minutes) for latency behaviours and number of occurrences (percentage of time the dogs were observed) for activity, vocalisation and eye gaze behaviours, according to condition of auditory stimulation (Study 1). Results of Kruskal Wallis tests are presented.

Behaviour	Control Mean (+/-S.E.)	Audiobook Mean (+/-S.E.)	Classical Music Mean (+/-S.E.)	Kruskal Wallis (H)
Latency				
Latency to lie	8.35 (2.40)	10.12 (1.91)	5.16 (1.85)	5.69, P = 0.05
Latency to settle	9.54 (2.31)	11.65 (2.19)	5.60 (1.80)	6.42, P = 0.04
Latency to vocalise	2.50 (1.53)	2.75 (1.02)	1.86 (1.01)	2.73, P = 0.25
Activity				
Lying	54.06 (5.42)	42.24 (6.89)	54.41 (6.88)	2.05, P = 0.36
Sitting	7.25 (3.30)	9.81 (2.27)	6.27 (2.69)	3.65, P = 0.16
Standing	26.98 (4.57)	33.06 (5.71)	27.08 (6.12)	1.55, P = 0.46
Walking	7.65 (0.82)	10.14 (1.63)	7.57 (1.17)	2.11, P = 0.35
Interaction	2.66 (1.35)	2.36 (0.87)	2.84 (1.12)	2.25, P = 0.32
Vocalisation				
Quiet	84.34 (2.93)	83.39 (3.97)	77.58 (4.45)	0.47, P = 1.52
Barking	0.12 (0.07)	2.62 (1.75)	2.19 (1.49)	5.79, P = 0.06
Whining	15.53 (2.89)	13.98 (3.26)	20.22 (3.97)	1.85, P = 0.40
Eye gaze				
Person-directed	11.08 (2.29)	13.38 (2.30)	13.06 (1.92)	1.37, P = 0.50
Door-directed	21.1 (3.71)	19.40 (2.60)	17.26 (3.04)	1.03, P = 0.60
Speaker-directed	0.19 (0.06)	1.56 (0.26)	0.80 (0.15)	25.27, P < 0.001

None of the behaviours recorded differed significantly (P > 0.05 for all Mann Whitney U tests) according to canine sex, castration status or breed. Age of the dog was significantly related to both the amount of time spent walking (U = 268.50, P = 0.02) and interacting with the experimenter (U = 259.00, P = 0.02), with younger animals showing a higher occurrence of these behaviours (mean percentage of time spent walking=10.64 +/−1.45; mean percentage of time spent interacting with the experimenter = 4.52 +/- 1.55) than older animals (mean percentage of time spent walking=7.28 +/- 0.75; mean percentage of time spent interacting with the experimenter=1.60 +/−0.48).

3. Study 2

Study 2 explored the effect of auditory stimulation on dogs' reactions to owner separation using a repeated-measures design.

3.1. Methods

3.1.1. Subjects

Twenty-two pet dogs took part in this study, with all animals recruited via social media advertisements and posters. Information on the demographics of the sample can be seen in Table 4. Again, dogs were only recruited for participation if they met the inclusion criteria outlined earlier (e.g., animals did not suffer from any physical or psychological problems [including separation-related issues], see Section 2.1.1.) and if owners provided consent for their pet to take part. All animals were routinely exposed to a wide variety of auditory cues (e.g., radio, TV) as part of their daily lives.

3.1.2. Auditory stimuli

The 3 conditions of auditory stimulation used in Study 1 were used here (see Section 2.1.3. for full details).

Table 4
The number and percentage of dogs recruited for Study 2 according to canine sex, castration status, age and pedigree status.

Demographic	n (%)
Sex	
Male	12 (54.5)
Female	10 (45.5)
Castration Status	
Neutered	18 (81.8)
Intact	4 (18.2)
Age	
Juvenile (<2 years)	5 (22.7)
Adult (> 2 years)	17 (77.3)
Pedigree Status	
Pure breed	14 (63.6)
Mixed breed	8 (36.4)

3.1.3. Procedure

Testing for Study 2 was, again, carried out in the controlled environment of the Animal Behaviour Centre, Queen's University Belfast. Prior to the start of data collection, each dog was allowed 10 min in the testing room with their owner to habituate to their surroundings. After this, the owner left the room and the dog was immediately exposed to one of the three conditions of auditory stimuli (classical music, audiobook or control) for a period of 30 min. The behaviour of the dog was recorded throughout this timeframe by the experimenter (RFK, who remained seated in the room), using the same ethogram and sampling approach described in Study 1, i.e., scan-sampling every 10 s. The dog's behaviour was also recorded using video-cameras to allow for the analysis of the same latency data outlined earlier. Each dog was exposed to the remaining 2 conditions of auditory stimulation following a 10-minute interim period between conditions. During this time, the dog was reunited with its owner outside the testing room. Owners were required to keep this interim period as calm as possible; they were then instructed to bring their dog back into the testing room and depart; this routine ensured an identical dog-owner departure protocol for all 3 conditions. The sequence of auditory stimulus exposure was alternated between subjects to control for any potential order effects. The experimenter refrained from engaging with the animal during all testing trials. At the end of the testing period, the auditory stimulus was turned off and the dog and owner were reunited and allowed to leave.

3.1.4. Data analysis

The occurrence of each behaviour on the ethogram (with the exception of latencies) was summed, producing frequency data. As in Study 1, frequency scores for each of these behaviours were converted to percentage data to control for the small number of observations where an animal was recorded as out of sight. Latency data were presented in minutes. Since the data violated the assumptions for normality (P < 0.05, Shapiro test), a series of Friedman ANOVAs were carried out to explore for differences in behaviour between the 3 conditions of auditory stimulation. Since dogs in Study 2 were tested on 3 separate occasions, a series of Friedman tests were also carried out to explore for behavioural changes across the testing period (testing phase 1, phase 2, phase 3).

3.2. Results

Analysis revealed no significant difference in the behaviour of the dogs between the three conditions, with the exception of speaker-directed gaze (Table 5). Post-hoc Wilcoxon tests showed that dogs spent significantly more of their time gazing at the speaker in the audiobook (Z = −3.48, P < 0.001) and classical music (Z = −2.69, P = 0.007) conditions than in the control condition. The percentage of speaker-directed attention did not differ significantly between the audiobook and classical music conditions (P > 0.05).

Table 5
The mean (+/-S.E.) duration (minutes) for latency behaviours and number of occurrences (percentage of time the dogs were observed) for activity, vocalisation and eye gaze behaviours, according to condition of auditory stimulation (Study 2). Results of Friedman ANOVA tests are presented.

Behaviour	Control Mean (+/-S.E.)	Audiobook Mean (+/-S.E.)	Classical Music Mean (+/-S.E.)	Friedman Test (χ^2)
Latency				
Latency to lie	4.86 (1.06)	3.70 (1.16)	2.98 (0.62)	2.49, P = 0.28
Latency to settle	4.95 (1.05)	4.04 (1.15)	3.08 (0.62)	0.85, P = 0.65
Latency to vocalise	0.50 (0.11)	0.88 (0.31)	0.35 (0.06)	1.53, P = 0.46
Activity				
Lying	60.80 (6.08)	57.40 (6.72)	60.27 (5.64)	2.64, P = 0.27
Sitting	10.25 (3.19)	12.47 (3.77)	13.56 (3.56)	1.83, P = 0.40
Standing	14.06 (2.27)	18.43 (4.31)	15.98 (2.49)	0.63, P = 0.73
Walking	6.59 (1.34)	8.43 (1.70)	7.32 (1.19)	1.36, P = 0.51
Interaction	6.99 (4.22)	1.72 (2.45)	1.92 (0.70)	0.82, P = 0.66
Vocalisation				
Quiet	82.77 (3.43)	85.45 (3.98)	82.57 (3.50)	3.41, P = 0.81
Barking	0.40 (0.29)	0.15 (0.07)	0.25 (0.11)	1.37, P = 0.50
Whining	16.82 (3.27)	14.39 (3.67)	17.17 (3.49)	2.81, P = 0.25
Eye gaze				
Person-directed	11.99 (2.80)	12.17 (2.45)	10.15 (2.13)	2.61, P = 0.27
Door-directed	20.20 (4.24)	16.31 (2.74)	18.08 (3.43)	0.21, P = 0.90
Speaker-directed	0.25 (0.13)	1.28 (0.29)	1.16 (0.28)	13.94, P < 0.001

Table 6
The mean (+/-S.E.) duration (minutes) for latency behaviours and number of occurrences (percentage of time the dogs were observed) for activity, vocalisation and eye gaze behaviours, on phases 1, 2 and 3 of testing (Study 2). Results of Friedman ANOVA tests are presented.

Behaviour	Phase 1 Mean (+/-S.E.)	Phase 2 Mean (+/-S.E.)	Phase 3 Mean (+/-S.E.)	Friedman Test (χ^2)
Latency				
Latency to lie	5.16 (1.38)	3.67 (0.86)	3.15 (0.99)	6.91, P = 0.03
Latency to settle	5.44 (1.07)	3.76 (0.85)	3.68 (1.12)	13.58, P = 0.001
Latency to vocalise	0.53 (0.13)	1.87 (1.05)	0.65 (0.20)	1.34, P = 0.51
Activity				
Lying	47.93 (6.49)	63.33 (5.78)	67.22 (5.39)	16.17, P < 0.001
Sitting	16.62 (4.33)	12.50 (2.66)	7.17 (1.74)	8.41, P = 0.02
Standing	21.04 (3.58)	14.22 (0.68)	13.23 (2.96)	9.69, P = 0.01
Walking	9.87 (1.46)	6.31 (1.10)	6.16 (1.56)	9.50, P = 0.01
Interaction	3.08 (1.30)	2.12 (-/74)	5.43 (4.14)	2.39, P = 0.30
Vocalisation				
Quiet	81.11 (3.43)	82.27 (4.10)	87.42 (2.88)	5.74, P = 0.06
Barking	0.23 (0.12)	0.45 (0.29)	0.13 (0.06)	2.63, P = 0.27
Whining	18.66 (3.42)	17.27 (3.95)	12.45 (2.87)	4.67, P = 0.10
Eye gaze				
Person-directed	10.30 (1.76)	12.07 (2.93)	11.87 (2.71)	0.59, P = 0.75
Door-directed	26.92 (3.83)	16.09 (3.33)	11.59 (2.46)	22.92, P < 0.001
Speaker-directed	1.16 (0.31)	0.88 (0.30)	0.66 (0.15)	1.42, P = 0.49

Since dogs were tested on 3 separate occasions, Friedman tests were carried out to explore for behavioural changes across the testing period. Analysis revealed a significant change in both latency to lie down and latency to settle across the 3 testing phases. Animals were significantly slower to lie down ($Z = -2.94$, $P = 0.003$) and settle ($Z = -3.12$, $P = 0.002$) during the first phase of testing than the third (see Table 6). Dogs were also significantly slower to settle during the first, than second, phase of testing ($Z = -2.84$, $P = 0.004$).

Results also showed a significant difference in the occurrence of most of the dogs' activities across the 3 phases of testing. Dogs spent significantly more of their time sitting, standing and walking on phase 1 than phase 2 or 3 ($P < 0.05$ for all Wilcoxon tests). Dogs also spent significantly more time sitting during phase 2 than phase 3 ($Z = -2.26$, $P = 0.02$). By contrast, the animals devoted significantly less of their time to lying down during teir first phase of testing compared to their second ($Z = -3.38$, $P < 0.001$) or third ($Z = -3.01$, $P = 0.003$) phase of testing.

Door-directed gaze also differed significantly across the phases of testing, with animals showing a higher incidence of this behaviour during phase 1 than phases 2 ($Z = -3.13$, $P = 0.002$) or 3 ($Z = -4.11$, $P < 0.001$).

4. Discussion

This research explored the effect of two types of auditory stimulation known to have positive effects on captive canine welfare on the behavioural response of pet dogs to a known stressor, in this case short-term separation from their owners. Two studies were carried out to this end, both conducted, for the first time, in a controlled university research environment. Study 1 employed a between-subjects design, with the behaviour of dogs recorded in response to classical music, an audiobook or the control environment (no auditory stimulation), whilst Study 2 observed a smaller number of dogs in a repeated measures design across all 3 conditions of auditory stimulation.

The findings from this investigation pointed to only a marginal effect of classical music on the behaviour of pet dogs in response to separation from their owners. Analysis of latency data from Study 1 indicated that animals were both significantly faster to lie down and quicker to settle (i.e., remain resting for more than 30 s) than subjects in the control or audiobook conditions; a trend for lower latency for both of these behaviours was also observed in Study 2, although results did not reach the level of statistical significance. Studies carried out in rescue shelters have reported more obvious calming effects of classical music than found here, with less barking and higher frequencies of resting recorded in response to this specific type of auditory cue (Bowman et al., 2015, 2017; Kogan et al., 2012; Wells et al., 2002).

The audiobook employed in this study had no apparent welfare benefits for the dogs. Although subject to very little attention, one study has reported a more calming influence of an audiobook than classical music in kennelled dogs, with increased resting recorded in response to a reading of *'The Lion, the Witch and the Wardrobe'* (Brayley and Montrose, 2016). The present investigation actually reported a non-significant trend for higher activity levels (in both studies) and a greater frequency of barking (in Study 1) in response to the sounds of an audiobook than other types of auditory stimulation. In many respects, audiobooks serve a similar role to human conversation, and, given the social nature of dogs (e.g., Taylor and Mills, 2007; Tuber et al., 1996; Wells, 2004), might be expected to serve as an interesting, and perhaps even comforting, stimulus. That said, previous studies on kennelled dogs have reported little in the way of a welfare benefit from human conversation in the form of radio broadcasts (Albright et al., 2017; Wells et al., 2002). Animals in the audiobook condition in Study 1 did admittedly spend more of their time looking at the speaker than dogs exposed to classical music or those in the control condition. This may suggest more of an interest in the human conversation, although the possibility that dogs are simply unaccustomed to hearing a recorded human voice cannot be overlooked; drawing an inference from this behavioural difference from a welfare perspective is therefore challenging. Further work is recommended to explore the value of audiobooks for canine welfare and determine whether (and in what environments) they harbour any enrichment potential.

As to why the experimental stimuli in this study had so little effect on the dogs' behaviour is not entirely clear. One explanation might lie with the stimulus material employed, which was deliberately different to that used in studies reporting welfare advantages (largely in an effort to control for variations between auditory cues, e.g., pitch, timbre, etc.). These stimuli were repeated on a loop for the duration of the testing period. Most studies on kennelled dogs, however, have used a variety of classical compositions (Bowman et al., 2015, 2017; Wells et al., 2002). Perhaps the changing nature of the soundtracks is an important enrichment feature and would explain why so little effect on behaviour was reported in either the present study or in others that have used single, as opposed to multiple, pieces of classical/designer music (e.g., Albright et al., 2017). Indeed, Bowman et al. (2015) found resistance to music if the same playlist was used repeatedly, highlighting the importance of variety from an enrichment perspective. Interestingly, whilst Kogan et al. (2012) reported welfare benefits from classical music in the kennel environment, their data pointed to significant differences in the occurrence of certain canine behaviours (e.g., body shaking, vocalisation) in response to different classical compositions. Exploring what features of classical music exert the most enrichment potential might help us to establish the mechanisms underlying any welfare benefits.

One must consider not only differences in the nature of the auditory stimuli, but also in the environment of the present study and preceding investigations, notably in regards to the control conditions. The vast majority of work in this area has taken place in rescue kennels, in which the control condition has comprised the average background noise of the shelter. Animal shelters can regularly surpass 100 decibels in noise (Coppola et al., 2006). The control condition in the present investigation, by contrast, was a quiet and secluded area, with only low levels of background noise (<30 dB). Extreme levels of noise can be stressful for dogs, with studies recording detrimental effects on canine welfare (Sales et al., 1997; Scheifele et al., 2012). It is possible that relative silence has similar welfare advantages to classical music for dogs, which may potentially explain the conflicting results between this paper and prior research. Additionally, whilst there has been limited research on animal preferences for auditory enrichment, there is some evidence to suggest that silence may be the preferred choice over musical stimuli. For example, cotton-top tamarins (*Saguinus oedipus*) and common marmosets (*Callithrix jacchus*) have been found to prefer silence over music when given the choice (McDermott and Hauser, 2007). A more recent study examining the benefits of classical music on degus (*Octodon degus*) found that while individuals preferred Chilean classical music to silence, silence was preferred over western classical music (Watanabe et al., 2018).

Differences in the stress levels of the animals recruited for the present investigation and those employed in previous studies must be acknowledged. Research on dogs in rescue shelters has involved animals that have been resident for several days, in some cases even weeks. Such animals may not have been acutely stressed. Indeed, plasma and salivary levels of cortisol have been shown to be highest in the first 3 days of residence in a shelter environment, with a gradual decrease thereafter (for review see Hennessy, 2013). The dogs in the present study were in a novel setting and were separated from their owners for the duration of testing. Moreover, animals in Study 2 were deliberately reunited with their owners for a short period of time between conditions in an effort to standardise the pre-testing environment. It is possible that animals in this type of context are simply too stressed for therapeutic intervention in the form of auditory stimulation to have any welfare benefits; indeed, this might explain the lack of any welfare advantages arising from previous studies focused on dogs in the veterinary hospital environment (Albright et al., 2017; Engler and Bain, 2017), where dogs are more likely to be displaying acute, as opposed to chronic, stress. The effect of environmental context in relation to auditory stimulation is worthy of further exploration, in an effort to determine what types of enrichment are useful in what situations.

As expected, (and deliberately controlled for), this study unearthed an order effect across the 3 30-min phases of testing in Study 2. The behavioural changes recorded were strongly suggestive of habituation to the research environment over time, with animals showing calmer behaviour (e.g., a higher occurrence of resting, a lower occurrence of walking, door-directed gaze) during their second and third phases of testing than their first phase of testing. There was little in the way of any significant difference in the dogs' behaviour between testing periods 2 and 3. Future research should take this into consideration, perhaps introducing a longer period of environmental familiarisation prior to the collection of any data than employed here (10 mins).

4.1. Limitations

There are a number of limitations to this research that must be acknowledged. Study 1, which employed a between-subjects design, attempted to control for a wide variety of dog-related individual differences that might shape behaviour, e.g., canine sex, age, etc. It did not, however, control for the myriad of owner- or environment-related variables that have the potential to impact on how dogs behave (see Wells, in press). For example, the degree to which the subject animals were familiar with the types of auditory cue employed was unknown. Likewise, the type of owner separation that individual dogs were used to was unclear. Whilst this lack of information is common to all studies of this nature, these details would be useful (if somewhat challenging) to collect in future research to determine the extent to which they exert any influence on outcome measures. Habituating animals to the various auditory cues (and testing environments, see above) prior to testing may also be a worthwhile exercise.

Although unlikely, given that everyone except the experimenter was required to remain outside the testing room, one must consider the possibility that owners might have been influenced by the auditory stimulation (in either a positive or negative manner) which, in turn, might have had an effect on their animals' behaviour. Research points to a correlation (and in some cases a degree of synchrony) between owner and pet behaviour (e.g., Duranton et al., 2018; Merola et al., 2012) and a possible spill-over effect in this investigation cannot be entirely ruled out.

This investigation only collected behavioural measures of canine welfare, largely in an effort to reduce contact with animals at a time when COVID-19-related social distancing was still advised. Going forwards, there would be merit to recording additional measures of welfare. Indeed, a small body of research in this area has successfully included indicators including heart-rate variability (Bowman et al., 2015, 2017; Köster et al., 2019) and accelerometers (Albright et al., 2017).

5. Conclusions

Overall, the findings from this study point to only a moderately calming effect of classical music on pet dogs studied in response to separation from their owners, with this particular auditory stimulus encouraging animals to settle more quickly than either an audiobook or no added sound. There was nothing to suggest that human conversation in the form of an audiobook led to any welfare advantages, although this type of stimulation attracted slightly more attention from dogs in Study 1 (but not Study 2) than the sound of classical music. On a positive note, neither the classical music nor audiobook had any detrimental effect on canine welfare; other studies, however, have reported negative effects arising from heavy metal (Kogan et al., 2012; Wells et al., 2002) and rock (Bowman et al., 2017) music. Given that classical music is relatively easy to add to the captive environment, where it does seem to harbour enrichment potential, it should still be considered a useful therapeutic tool, particularly taking habituation issues into consideration. It must be remembered that some animals may benefit more from a lack of auditory stimulation (McDermott and Hauser, 2007), or having the ability to turn music off for themselves (see Novak and Drewsen, 1989); indeed, findings from Study 1 pointed to less barking in dogs denied additional auditory stimulation. There is also some suggestion that tailoring music to the sensory systems of the species concerned may be more advantageous from a welfare perspective than simply using a specific genre of music designed exclusively for humans (for review see Snowdon, 2021).

Further research is needed in this field, ideally in a wider variety of contexts than studied thus far. Auditory stimulation certainly holds potential as a tool for improving canine welfare, if used appropriately, and in the right environments. The findings from the present investigation, however, suggest that auditory enrichment harbours little value in situations where animals are likely to be experiencing acute stress. From a more applied perspective, the welfare merits of acoustic stimulation in situations where dogs are temporarily separated from their owners (e.g., groomers, pet sitters) are therefore questionable. Future empirical work will hopefully determine exactly what types of auditory cue hold the greatest advantage to animal well-being, the conditions under which these benefits can be observed, and the mechanisms by which any welfare benefits are exerted.

CRediT authorship contribution statement

RFK – data collection and analysis, help with paper write-up. DLW – conception of study, help with data analysis, paper write-up.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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