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Original article

THE EFFECT OF THE NOISE STRESS AND MUSIC ON THE BEHAVIOUR OF FEMALE ALBINO RATS

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ABSTRACT

Noise is considered an important environmental factor that can affect animal behaviour and productivity. Its impact varies depending on the noise intensity, pattern, duration, and frequency. This research was undertaken to determine the effect of noise stress and playing music on improving the behaviour of female rats. Seventy-five female albino rats were divided into 3 groups, with 25 rats per group. The research groups were Control (no sound exposure), classical music, and noise stress. The sound level for the classic was 80 dB with a frequency of 1 kHz using an MP3 player. The sound level of stress exceeded 150 dB. The results revealed that using classical music led to a significant reduction in the frequency of aggressive behaviours (P<0.01) and an increase in vocalisations (P<0.01). In addition, music and noise stress significantly increased grooming (P<0.05) and climbing behaviour (P<0.05). Furthermore, exposure to the use of music caused increased drinking and feeding behaviours significantly (P<0.01), whereas lying and standing behaviours were decreased (P<0.01). In conclusion, playing music, especially classical music, benefits rats' welfare by improving their behaviour, as evidenced of decreased vocalization and increased feeding and drinking.

Keywords: Music, laboratory rats, noise, behavioural observation

1. INTRODUCTION

Unwanted sound, whether intermittent or persistent, is referred to as noise, an environmental stressor. It can be characterized by its intensity, frequency, frequency spectrum, and the form of sound pressure as time passes (Burn, 2008). The unit of measurement for sound intensity is decibels (dB) (Brouček, 2014).

The noise can affect animal behaviour and productivity, depending on its loudness or intensity, pattern, duration, and frequency (measured in hertz, Hz), as well as other factors, such as age, the animal's hearing ability, and the physiological state of the animal during exposure. Additionally, it is influenced by the animal's history of noise exposure and the obviousness of the auditory stimuli (Castelhano-Carlos and Baumans, 2009; Brouček, 2014; Meshabaz *et al*., 2017). Similarly, noise pollution can influence the quality of life for humans (Nerweyi and Al-Sulaivany, 2021).

Animals have different audible sounds within the spectrum, and their maximum hearing sensitivity frequencies differ from those of humans (Voipio, 1997). The highest sensitivity of rats' ranges from 8 to 50 kHz, while the lowest and highest frequencies reported are 0.25 and 80 kHz, which is lower than humans by between 10 and 20 dB. Different levels of background sound can affect rat behaviour and learning, leading to increased abnormal behaviours and impaired learning (Castelhano-Carlos and Baumans, 2009). Algers *et al*. (1978) found that when noise was turned off, general activity increased in both rats and mice. Initially, when exposed to the noise, the rats huddled in groups and froze. They experienced 95 dB at 0.5 to 5 kHz twice a day for five minutes each time. The noise altered their behaviour, making them antagonistic (Algers *et al*., 1978). Animals are less startled by gradual noises than by abrupt ones (Burn, 2008). On the other hand, pain, anxiety, sadness, and nausea have all benefited from the use of sound in therapies (Ezzone *et al*., 1998; Burns *et al*., 2002; Siedliecki and Good, 2006). Furthermore, music affects blood pressure, respiration, heart health, and behavior (Knight and Rickard, 2001; Meshabaz *et al*., 2017). Many diseases of the central nervous system, including dementia, schizophrenia, and Alzheimer's disease, are treated with it in humans (Brotons and Marti, 2003; Sung and Chang, 2005; Gold *et al*., 2005; Bleibel *et al*., 2023; Rossi *et al*., 2024).

Research indicates that exposure to classical musical compositions influences behavioral patterns, physiological responses, and overall well-being among captive animal populations (Chikahisa *et al*., 2006). Other research indicated that music led to physiological benefits and positive behaviours (Sutoo & Akiyama, 2004; Meshabaz *et al*., 2017). It was also found that classical music in an elevated maze reduced anxiety in mice (Chikahisa *et al*., 2006; Escribano *et al*., 2014) and lowered blood pressure in rats (Akiyama and Sutoo, 2011). However, there is little information about the effect of noise stress and

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classical music on rats' behaviour. Consequently, the present research was undertaken to evaluate the effect of classical music exposure and noise stress on the behavioural response of rats.

2. MATERIALS AND METHODS

The study site :

The study was undertaken in the animal houses of the Department of Biology, College of Science, University of Zakho, Kurdistan Region, Iraq. The experiment was undertaken in November and December 2024. Rats were provided with feed and water *ad libitum.*

Animal Housing and Breeding:

Seventy-five female albino rats, weighing about 200-250 g, were used in the current study. Rats were bred in the animal house, Department of Biology, College of Science, Zakho University, Zakho, Kurdistan Region, Iraq. They were kept in cages (30 × 25 × 17 cm) bedded with wooden chips, and under standard laboratory conditions. A photoperiod of 12 hours' light and 12 hours' dark, and at 23 ± 1ºC. Animals were fed on normal rat chow (67% wheat, 26.2% soya, 4.4% oil, 1.5% lime stone, 0.63% salt, 0.16% methionine, 0.06% choline chloride, and 0.05% trace elements) and tap water *ad libitum* (Habbib and Sulaivany, 2013).

Experimental Design:

Female rats were divided into 3 groups, 25 rats for each group. The experimental groups were: The Control (with no exposure to sound), Classic music, and Noise stress groups. The sound level for the classical music was 80 dB and 1 kHz frequency using an MP3 player. The sound level of stress was 150 dB. The volume of sound was measured using a digital sound meter (Voltcraft SL-200, Voltcraft®, Germany). Animals of all groups were placed in their cages 3 days before the beginning of the experiment to be adapted to the experimental environments.

Behavioural data collection:

Only the control group's data was gathered on the first day of the experiment; the music and noise stress groups' data were collected on the second and third days, respectively. For the remainder of the experimental days, the experiment was performed in the same method. Behavioral observation began at 9:00 am and lasted for one hour for each experimental group. Table (1) displays all of the behavioral data that were measured in this study along with their details. Two observers measured the behavioral data: one recorded the behaviors as frequency per unit of time, while the other recorded duration per unit of time.

Table 1: Ethogram: list of the observed behaviours recorded during this study with their descriptions.

Behaviours	Descriptions
Aggressiveness	All agonistic interactions, with and without physical contact, were observed in the feeding area, with and without displacement.
Vocalization	The occurrence of each vocal sound was recorded.
Climbing	The animal is suspended with all paws in contact with a vertical surface or the cage ceiling
Lying	Lying included resting and sleeping behaviour when animals were lying on all four legs.
Standing	Standing described the animals' standing, and moving, more precisely, when the feet had to carry the animal's body weight.
Feeding	When an animal had its head placed entirely through the feed barrier and over the feeding table.
Drinking	The muzzle is in contact with water and is ingesting water.
Grooming	Usually in a sitting position, the mouse will lick its fur, groom with its forepaws, or scratch with any limb. Often, the rat will mix all of these grooming behaviours.

(*Source*: adapted from Molony *et al*., 2012; Chapagain *et al*., 2014)

Data analysis:

All the measured data were stored in a new Microsoft Excel spreadsheet; thus, the data were arranged for statistical analysis. The collected data were analysed statistically using Genstat (17th edition, VSN International). The Shapiro-Wilk normality test showed that the behaviour data were non-parametric; thus, they were analyzed using the Kruskal-Wallis test followed by the Mann-Whitney U test for post hoc comparisons (Hussein, 2019). The differences were considered significantly different at the level (*P*<0.05).

3. RESULTS

The results indicated that treatment had a significant (p<0.01) effect on aggressiveness (*P*<0.01), vocalization (*P*<0.01), climbing, and Grooming (*P*<0.05) behaviour of rats (Figure 1). The noise-stress group showed higher aggressiveness (P<0.01), climbing (P<0.05), and grooming (P<0.05) frequencies per minute than the other experimental groups (Figure 1). In contrast, the music group exhibited a lower rate of aggressive behaviour than the control and noise stress groups. In the present study, the aggressiveness frequency per minute in noise, control, and music groups was (3.17 ± 0.09, 2.12 ± 0.39, and 1.20 ± 0.28), respectively.

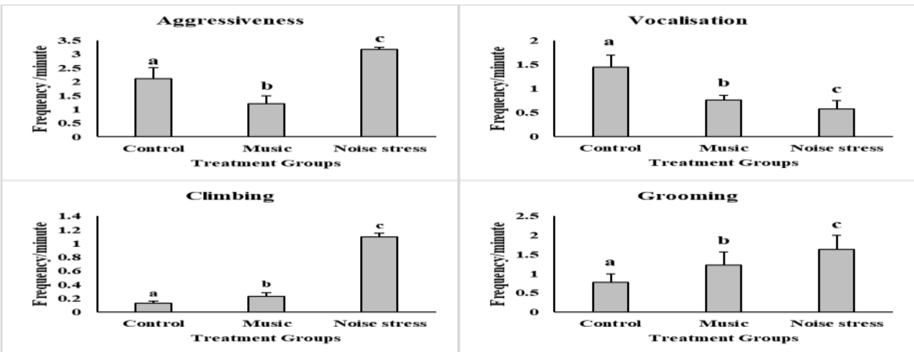

Figure 1: The effect of both music and noise stress on the behaviour of the rats. The behaviours are presented as frequency (mean ± SEM) per minute. **Note:** different letters mean a significant difference. Aggressiveness (P<0.01), vocalisation (P<0.01), climbing (P<0.05), and grooming (P<0.05).

The behaviours measured in frequency over a 60-minute period are shown in Figure 2. The study examined how different environmental conditions—control (no additional stimuli), music, and noise stress—affected the behaviour of rats over 60 minutes. The results showed statistically considerable differences in these behaviours through the 3 conditions.

Exposing rats to the music, with 80 dB sound levels and noise stress with150 dB in this study reduced lying (P<0.01), and standing (P<0.01) behaviours, in control group rats spent more time lying (1.80 ± 0.09) followed by noise stress (1.26 ± 0.09) and lowest in music group (1.06 ± 0.06). Standing behaviour was also higher in control than noise and music (1.83 ± 0.09, 1.53 ± 0.21, 1.23 ± 0.04), respectively (Table 2). In addition, feeding and drinking behaviours of experimental rats were higher in the music treated group (1.23 ± 0.03) and (0.43 ± 0.04) compared to other studied groups

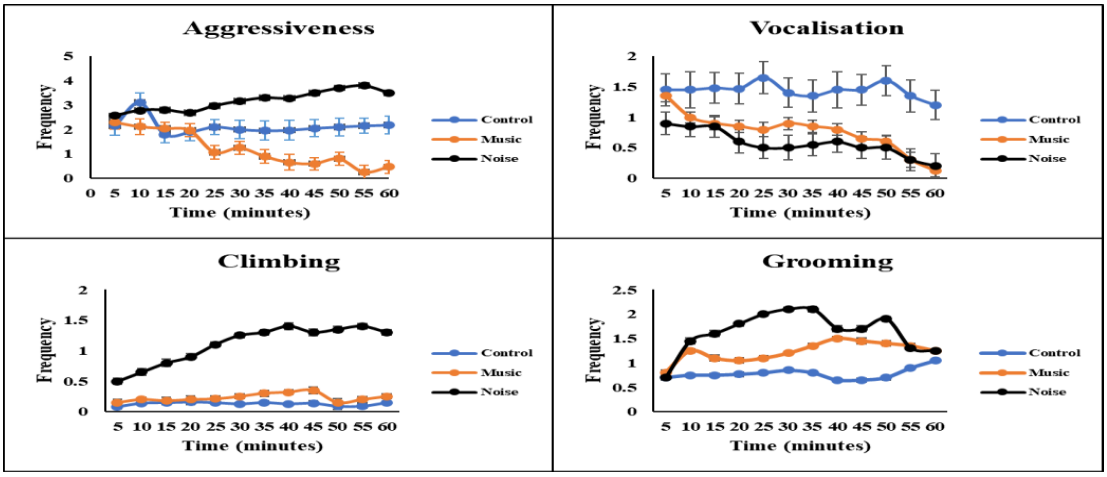

Figure 2: The mean of some behaviours of female rats over 60 minutes. Note: the significance was for Aggressiveness (P<0.01), vocalisation (P<0.01), climbing (P<0.05), and grooming (P<0.05).

Table 2: The effect of music and noise stress on rats' behaviour. The behaviours are presented as duration in seconds (mean ± SE) per minute per animal.

Behaviours	Groups			P value
	Control	Music	Noise Stress	
Lying	1.80 ± 0.09^a	1.06 ± 0.06^b	1.26 ± 0.09^c	0. 01
Feeding	1.83 ± 0.09^a	1.23 ± 0.04^b	1.53 ± 0.21^c	0.01
Standing	0.63 ± 0.08^a	1.23 ± 0.03^b	0.36 ± 0.06^c	0. 01
Drinking	0.16 ± 0.02^a	0.43 ± 0.04^b	0.13 ± 0.01^a	0.05

Note: Different letters in rows (a, b, and c) indicate significant differences.

4. DISCUSSION

The results indicated that treatment significantly influenced the aggressiveness, vocalization, climbing, and Grooming behaviour of female albino rats. This result agrees with the previous findings of Burn's (2008) previous findings. Furthermore, when rats were exposed to 95 dB at 0.5-5 kHz for two 5-minute periods per day for 28 weeks, their behaviour altered, and they became aggressive (Algers *et al.,* 1978). Recent studies indicate that music may improve social memory and sociability in both sexes of rats, with a more pronounced effect in females (Taheri *et al*., 2024).

In addition, the control group showed higher vocalization frequency per minute than the other groups studied (Figure 1). Similarly, playing music at 80 dB reduced vocalization and stress in different types of animals, such as horses (Wilson *et al*., 2011) and sheep (Quaranta *et al*., 2002; Meshabaz *et al*., 2017). However, contradictory results were found: when the noise level increased from 45 to 95 dB, cortisol hormone concentration in the blood also increased, leading to animal stress (Sevi *et al*., 2001). Moreover, Grooming and climbing were higher in the studied groups than in the control. The more frequent grooming behaviour in music (1.23 ± 0.33) and stress (1.63 ± 0.47) was found in the present study. It should be noted that the rats participating in the present experiment are likely to be more reactive to stressors. Grooming increases in stressful situations, as found in previous research of van Erp *et al*. (1994). Grooming in animals has been connected not only to stress but also to emotional reactivity by several authors (Kalueff and Tuohimaa, 2005; Rojas-Carvajal *et al*., 2023; Apukhtin *et al*., 2024; Goh *et al*., 2025). Different background noise levels were revealed to affect the general activity of mice and rats (Castelhano-Carlos and Baumans, 2009; Zhvania *et al*., 2020; Gogokhia *et al*., 2021).

Aggressiveness was significantly higher in the noise-stress condition than in both the control and music groups. The rats exposed to noise showed a notable increase in aggressive behavior over time, peaking around the 30-minute mark before declining slightly. In contrast, the music group showed lower levels of aggressiveness, similar to the control group, suggesting that music did not provoke aggressive behaviour. In addition, vocalization frequency differed significantly, with noise stress resulting in the highest frequency of vocalizations. This peaked early in the session (around 10–15 minutes) and remained elevated. The music group, while showing some vocalizations, stayed closer to the control levels, indicating that music was less disruptive than noise. Moreover, climbing behaviour presented moderate but significant differences. Rats in the noise-stress condition climbed more frequently, particularly during the first 20 minutes, possibly as an escape response. The music and control groups displayed similar, lower levels of climbing, suggesting that music did not significantly alter this behaviour. Lastly, grooming, another stress-sensitive behaviour, varied significantly. Noise stress led to reduced grooming, especially after the 20-minute mark, suggesting heightened stress or distraction. The music group's grooming frequency was intermediate, slightly higher than the noise group but lower than the control group, suggesting a mild calming effect.

The findings highlight that noise stress consistently increased negative behaviours, such as aggressiveness and vocalization, while reducing self-care activities, such as grooming. Music, on the other hand, had a neutral or mildly moderating effect, resembling the control condition more closely. These results suggest that environmental noise can significantly disrupt rats' behaviour, while music may not have the same adverse effects.

Previous studies found that rats consume more food and spend more time ingesting when exposed to classical music (Fizza *et al*., 2015). Similarly, exposing pup rats to music of 432 Hz for 3 and 6 days increased eating behaviour and weight gain (Russo *et al*., 2020). In contrast, higher sound exposure was found to decrease the food-consumption behaviour (0.36 ± 0.06). This result is in agreement with the findings of Krebs *et al*. (1996), who reported that the amount of food intake and duration of eating behaviour were lower in rats exposed to a 95 dB noise for 20 minutes daily. Recently, Bodhika and Jayakody (2018) found that the continuous noise of 70-80 dB decreases food-consuming behaviour.

CONCLUSION

To conclude, this research reveals that classical music is a promising environmental enrichment approach that significantly improves behaviors related to the welfare of female albino rats. This suggests that using classical music has significantly decreased both aggressive and vocalization behaviours while increasing feeding and drinking behaviours. Consequently, playing music, especially classical music, is advantageous for rats' welfare because of decreased vocalization and increased feeding and drinking. In addition, further research is needed to examine how other types of stressors, such as heat and cold, affect rats' behaviour. More research is required to investigate behavior, in addition to physiological parameters such as peripheral temperatures and cortisol levels, of rats under music and noise stress.

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Ethical Statement:

All the procedures were undertaken as they were not harmful to the rats. Therefore, the method of the current study was ethically approved by the Animal Ethics Committee at the University of Zakho under code AEC-034.

Author Contribution:

All authors have contributed equally in the working on this research.

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Conflict of interest :

The authors have no conflicts of interest to declare.

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