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Effect of Music Exposure on Sexual Behavior of Female Rats

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ABSTRACT

Background: The human limbic system is excited by music. The nervous system sends music signals converted into neural information by inner hair cells to the primary auditory area and limbic system. This activates genes that play a role in social and cognitive function. This study aims to prove the effect of music on physiological sexual behavior.

Methods: The study was conducted on adult female *Rattus norvegicus* rats aged 2-3 months with a body weight of about 200 grams. The rats were exposed to the sound of music which divided into soft (Javanese), medium (Balinese gamelan), and loud (Dangdut tekno) music categories. The duration of exposure for each type of music is two hours in a row for seven days. During music exposure, rats' behavior in cages was recorded using CCTV. The test carried out is a normality test using the T-test (student's t-test).

Results: A comparison test between treatment groups showed that all groups did not show differences in general behavior. For sexual behavior, the normality test showed that the Balinese group was the only abnormal group. The Piano group's sexual behavior was statistically the same as the control group.

Conclusion: Exposure to Balinese gamelan showed an increase in sexual activity in female rats. Balinese gamelan music shows a relationship between music and limbic system activity, which is indicated by increased activity in the estrous phase.

Keywords: emotion, limbic system, music, sexual activity

BACKGROUND

The limbic system consists of the thalamus, hypothalamus, amygdala, hippocampus, mammary bodies, and fornices. The limbic system is a part of the brain that controls autonomic and vegetative functions like appetite, breathing, body temperature, and mood. It is also part of the emotional anatomy of a person. [1] The ventromedial prefrontal cortex plays an essential role in processing various emotional responses. It regulates emotional responses such as adjusting heart rate, body temperature, and blood pressure. [2]

In the central nervous system, glutamate and GABA are pairs of excitatory and inhibitory neurotransmitters that play a role in all areas. In the hypothalamus, these two neurotransmitters play a role in the production and secretion of GnRH and the feedback from steroid hormones to the HPG axis. LH (luteinizing hormone) and FSH (follicle-stimulating hormone) are released from the pituitary gland, and steroid hormones are released from gonadal cells. LH and FSH are released by GnRH (gonadotropin-releasing hormone) from the hypothalamus.[3] The cell bodies of hypothalamic GnRH neurons are located in the basal area of the hypothalamus. These neurons are integrators of a complex series of input signals that carry information about circadian, seasonal, pheromone, behavioral, and emotional aspects.[4]

Clynes stated that the human limbic system is excited by music.[1] This is aligned with the study by Ukkola et al., who state that there is a relationship between music signals and the limbic system's activation. With the help of the neurotransmitter glutamate-GABA pair, the nervous system sends music signals converted into neural information by inner hair cells to the primary auditory area and limbic system. This activates polymorphisms of the 1A-arginine vasopressin receptor (A₈PR1A), serotonin transporter (SLC6A4), catechol-O-methyltransferase (COMT), dopamine D2 receptor (DRD2), and tyrosine hydroxylase 1 (TPH1), which are genes that play a role in social and cognitive function.[5] This study aims to prove the effect of music on physiological sexual behavior.

METHOD

The study was conducted on adult female *Rattus norvegicus* rats aged 2-3 months with a body weight of about 200 grams. The sound of music is playing at 20 dB and divided into soft, medium, and loud music categories. The soft music played was Javanese music, the medium music played was Balinese gamelan, and the loud music chosen was Dangdut Tekno music. Music exposure was carried out at night when the

rats were active. The duration of exposure for each type of music is the same, which is two hours in a row for seven days. During music exposure, rats' behavior in cages was recorded using CCTV. Female rats act sexually when arching their backs, jumping like frogs, and climbing on other rat's backs. These are all signs of the estrous phase. Rat behavior was observed for 4 hours every day, i.e., 1 hour before exposure, 2 hours during exposure, and 1 hour after exposure. The goal of the observations was to figure out the estrous and other dominant behaviors that started to show up. During music exposure, rats' behavior in cages was recorded using CCTV. The test carried out is a normality test using the T-test (student's t-test).

RESULTS

The recordings used as data sources were made for seven days. This was enough time to cover one estrous cycle, which ended on the day that blood serum samples and vaginal smears were taken. The results of the observations are shown in Table 1. Some examples of rat behavior that falls into the categories of sexual and general behavior are shown in Figure 1.

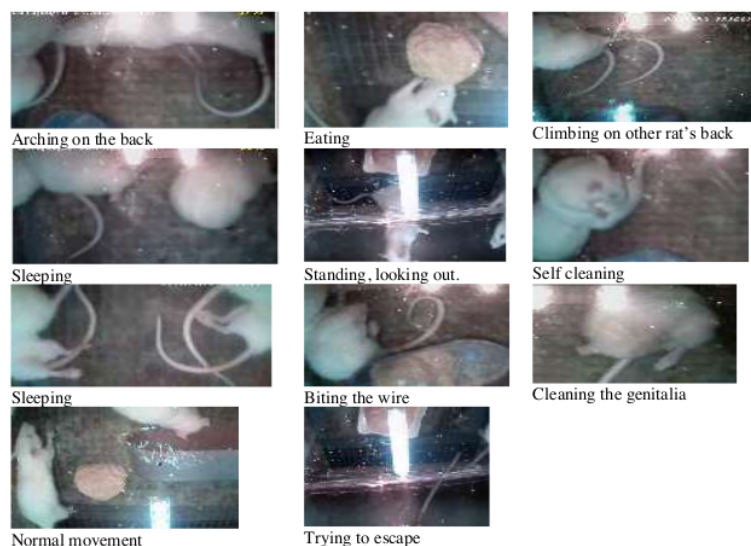


Figure 1. Rats' behaviour on CCTV.

The normality test results showed that all groups' general behavior tended to be as expected, except for the Mozart Piano exposure group. In this case, the Balinese Gamelan group showed the same behavior pattern as the control group. A comparison test between treatment groups showed that

all groups did not show differences in general behavior. For sexual behavior, the normality test showed that the Balinese group was the only abnormal group. The Piano group's sexual behavior was statistically the same as the control group.

Table1. Statistical analysis of the sexual activity after music exposure

Music Exposure	Sexual activity			Normal activity			p-value
	Arching	Jumping	Climbing	Sleeping	Walking	Eating	
Piano	3	2	2	50	35	15	0.322
Javanese	3	1	1	75	25	5	0.283
Balinese Gamelan	6	9	3	40	30	30	<0.001
Dangdut Tekno	1	2	1	90	8	2	0.122

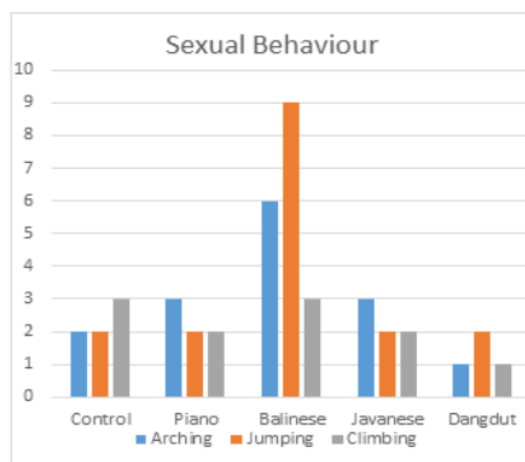


Figure 2. Changes in the sexual behavior of rats due to exposure to music. The estrous phase is characterized by arching the back, jumping up and down, and climbing on the backs of other mice. These three types of sexual behavior increased in rats exposed to Balinese Gamelan.

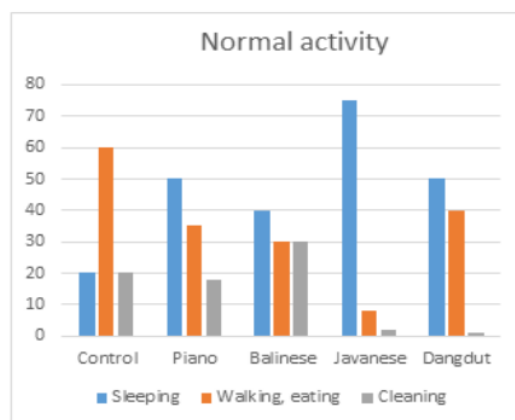


Figure 3. Changes in the general behavior of rats due to exposure to music. All rats showed increased sleep or silence. Rats exposed to Dangdut Tekno always sleep for almost the entire exposure period and barely eat.

DISCUSSION

The study's general results showed that the activity level of all groups exposed to music seemed to decrease drastically compared to the control group. During the exposure to music, the sleeping rats did not move at all. After being exposed to music, most rats looked stunned or alert. Occasionally, they chose to find a way out of the cage by biting the wire or standing and jumping on the cage's wall. The results of this observation follow the results of general behavioral statistical tests, where all groups do not show significant behavioral differences.

In the group of rats exposed to Balinese gamelan and piano in the monitoring, mostly sleep. In the group that was exposed to piano, there was an increase in eating activity. Groups of rats that were given piano music tended to spend their time playing games, touching each other's friends, or wandering around the cage. Rats that listen to Balinese music spend most of their time cleaning themselves well, especially around their genitalia.

Sleeping and cleaning the body only took up 20% of the total time spent on activity compared to the control group, and eating took up 60% of the time spent doing things. Thus, for the group exposed to classical piano, and Balinese gamelan music, their eating habits were still similar to the control group. In contrast, the Javanese music group decreased dramatically while the Dangdut group barely ate. For self-cleaning activities, the Balinese music group increased, while the classical piano was almost the same as the control group. Javanese music groups and Dangdut Tekno barely clean themselves at all.

Observations also showed that the Balinese musical group showed abnormal sexual activity, while the other exposure groups could be said to be as normal as the control group. In this case, classical Piano Group had sexual behavior that could be said to be the same as the Control group.

Considering the noise spectrum that is most dominant in the Javanese, the frequency range of Dangdut Tekno and Javanese

music has the most significant area on the temporal spectrum display during the whole exposure period if it is related to psychoacoustic characteristics.[6] Although some also raise high frequencies, single-tone music, Mozart's Piano, and Balinese Gamelan are not monotonous. This makes it more likely that the frequency of sounds significantly affects how rats act. Javanese and Dangdut Tekno seem to have almost the same percentage level of silence and eating. But different types of residence might be linked to the loudness of the sound or the presence of human voices in the music. The other three types of music are purely musical sounds. The human voice in Dangdut Tekno is almost obscured by the stomping sound of the music, while in Javanese music, it sounds very clear. So, the human voice element influences the alert condition and tendency to run away in Javanese music.[7]

The difference in the responses of the exposure groups showed agreement with the results of research by Jouhaneau & Bagady that rats can choose the type of music they like if, since infancy, they have been 'taught' different types of music. This suggests that rats may be able to perceive the music they hear.[8] Lin et al found that the different ways people react show how different brain parts work. Meanwhile, the type of music that each rats chooses is the result of limbic activity and the area of decision-making.[9] Considering that the limbic area is where emotions are controlled, how the rats act, whether scared, alert, or just walking around, shows how the music makes them feel. Thus, groups piano and Balinese emotionally showed a positive response, while groups Dangdut Tekno and Javanese Gamelan showed a negative response.

CONCLUSION

Exposure to Balinese gamelan showed an increase in sexual activity in female rats. Balinese gamelan music shows a relationship between music and limbic system activity, which is indicated by increased activity in the estrous phase.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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