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**Research Paper**

# Identification behavior changes of mice (*Mus musculus*) as effect of noise exposure

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***ABSTRACT:*** *Background: Noise is an unwanted sound that affects health and the environment. Objectives: This study aims to identify the effect of noise exposure on the behavior changing of mice (Mus musculus).Method: A study was a true experimental with a post-test only control group design. Subjects are 32 of mice with a bodyweight of 20-40 grams and aged 8-12 weeks. They were divided into two groups; a control (C) and a treatment (T). The noise exposure intensity was 100 dB for four hours/days for 15 days. Behavior changes were identified indirectly by calculating the behavior change of each mouse based on ethogram behavior observed from closed-circuit television (CCTV) recordings. T-test and Mann-Whitney U tests were used to analyze the data. Results: The results showed that increasing locomotion, grooming, resting, social, foraging, exploration, drinking, and nesting behaviors. An increase of locomotion, resting, exploration, and foraging behaviors significantly in the treatment group ($p<0.05$) compare to the control. Feeding behavior means decreased in the treatment group compared to the control group ($p>0.05$). We found an increase in locomotion, resting, foraging, drinking, nesting building behaviors in female mice, and increasing grooming, social, and exploration in male mice ($p>0.05$). A decreasing of feeding behavior on both male and female, and grooming behaviors only on female ($p>0.05$). We identified the changing of mice's behavior as an effect of noise exposure. Conclusion: Noise induces the changing of the mice's behavior, and foraging responses between females and males are different.*

***KEYWORDS:*** *Grooming, resting, feeding, foraging, exploration.*

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## I. INTRODUCTION

Noise is an unwanted sound that affects the health and comfort of the environment [1,2]. Health problems appear because of exposure to noise for a long time. High-intensity noise from the short distance will produce aggravated [3]. Un-disciplined use of personal protective equipment such as earplug and earmuff for workers in the industrial sector or someone who is often exposed to noise accidentally [4]. Tree planting on the roadside can reduce noise due to traffic [5]. Hearing loss will be an effect of noise exposure. A study of 13 respondents exposed to laundry noise ≥ 8 hours/day showed seven respondents (53,8%) were suffering from hearing loss on the right ear and six respondents (46,2%) on the left ear [6].

Psychological disorders or behavior is another effect of noise exposure. The behavior includes everything that is said and done by someone who can be observed directly or indirectly by others [7]. Some examples are lack of concentration, sleep disorder, unstable emotion, and depression [8]. Based on the study the noise impact of grinding machine on psychology showed a significant effect, 57% feel uncomfortable, 53% lack of concentration and emotional every 14 students, 38% had a sleep disorder, 19% feeling annoyed and 3% had an experience of stress when near the grinding machine [9].

Social behavior can also be affected by noise. According to a study, that male mice exposed to noise with intensity 90 dB and 110 dB for 2 hours in 3 months decreased social interaction with other mice. Another study stated that the level of student learning comfort was lower in schools exposed to noise than schools that were less exposed to noise [10]. Noise at night can disturb the quality of sleep [11]. A sound intensity between

60 to 65 dB can consistently affect sleep patterns. Then, intermittent noise with intensity 80 dB has more impact on sleep quality, mood, and performance than noise with the same intensity that is continuously exposed [12].

Noise during the night will induce a stress response that causes cortisol hormone secretion when the exposure exceeds 90 dB [11,13]. It will lead to body homeostasis that causes physical and non-physical symptoms such as behavior changes [14].

Response to the noise appeared different by gender, where women more sensitive compare to men. A study reported a higher increase in stress in women than men [15]. The difference in the increase in stress level is because the coping mechanism of the stress is different between men and women. Men tend to use ego-oriented coping, which makes them more relaxed in facing stress, while women tend to be task-oriented [16]. However, another study states that there was no significant relationship between gender and stress because of the same stress trigger factor [17]. In this study, we observed the changing behavior of mice (*Mus musculus*) on noise exposure.

## II. MATERIALS AND METHOD

This study was an experimental study with a post-test control-group design. It was conducted from September 2018 to July 2019 at Medical Physics Laboratory Faculty of Medicine Universitas Andalas. Subjects were 32 healthy mice (*Mus musculus*) consisting of 16 males and 16 females, aged 8-12 weeks, with a bodyweight of 20-40 grams, without any anatomic defect. They were divided into two groups (treatment (T) and control (C)).

The treatment group received a noise with an intensity of 100 dB for 4 hours/days for 15 days in the evening (4-8 pm)[18]. The type of noise exposure was intermittent from recording sound. Behavior was observed indirectly based using ethogram behavior, and calculating the activity was carried out from recording closed-circuit television (CCTV)/cameras, which was placed on the top of the cages of each group. Data were analyzed using independent sample T-test and Mann-Whitney U test, $p<0.05$ was considered significant.

## III. RESULTS

Mice behavior was observed in this study by calculated frequency of changing behavior frequency of each mouse every day, as shown in table 1.

**Table 1.** Observation behavior changing frequency

| Behavior | Behavior changes (Mean±SD) | | Δ | P value |
|---|---|---|---|---|
| | Treatment group | Control group | | |
| Locomotion | 28,94±4,43 | 25,13±5,89 | 3,81 | 0,047* |
| Grooming | 17,13±2,03 | 15,81±1,91 | 1,32 | 0,069 |
| Resting | 31,06±4,65 | 26,88±5,73 | 4,18 | 0,031* |
| Feeding | 2,88±1,46 | 3,81±2,11 | 0,93 | 0,224 |
| Social | 6,63±4,15 | 4,69±2,70 | 1,94 | 0,113 |
| Foraging | 13,06±2,24 | 9,69±2,55 | 3,37 | 0,001* |
| Exploration | 4,00±1,41 | 2,94±1,12 | 1,06 | 0,021* |
| Drinking | 5,50±1,21 | 5,06±2,14 | 0,44 | 0,483 |
| Nest building | 2,69±1,45 | 2,06±1,24 | 0,63 | 0,191 |

*significantly different

The treatment group demonstrated an increasing behavior-changing significantly of locomotion, resting, foraging, exploring, 3.81, 4.18, 3.37, 1.06 times, respectively $p<0.05$. Noise response between male and female mice is different, as shown in table 2, foraging females' responses higher than males (2.51 times, $p<0.05$). Besides, other behaviors changing were no significant differences.

**Table 2.** Behavior observation based on gender

| Behavior | Changes behavior | | Δ | P value |
|---|---|---|---|---|
| | Male | Female | | |
| Locomotion | 3,75 | 3,88 | 0,13 | 0,973 |
| Grooming | 2,88 | -0,25 | 3,13 | 0,076 |
| Resting | 3,62 | 4,75 | 1,13 | 0,707 |
| Feeding | -1,5 | -0,37 | 1,13 | 0,182 |
| Social | 2,12 | 1,75 | 0,37 | 0,863 |
| Foraging | 2,12 | 4,63 | 2,51 | 0,048* |
| Exploration | 1,38 | 0,75 | 0,63 | 0,547 |

| | | | | |
|---|---|---|---|---|
| Drinking | 0,25 | 0,63 | 0,38 | 0,454 |
| Nest building | 0,62 | 0,63 | 0,01 | 1,000 |

*significantly different

## IV. DISCUSSION

Our study results show, changing the behavior of locomotion, resting, foraging, and exploration increased significantly in the treatment group compared to the control group during noise exposure. The noise causes stress reactions and alerts the sympathetic nervous system activation and hormonal centers in the brain. It will lead to the body's balance disturbance, which will cause physical and behavioral symptoms [14]. In line with Ravindran et al. 's study, a stress-induced by noise could alter brain biogenic amines, and it leads to an increase in norepinephrine, epinephrine, dopamine, and serotonin in the discrete area of the mouse brain. The condition will happen after noise exposure 4 hours a day for 15 days with an intensity of 100 dB that can affect these mice's behavior [18].

Our study showed that locomotion behavior, resting, exploration, and foraging behavior increase $p < 0.05$ significantly. The study in line with Mancera et al. study, which found a significant difference in behavior change between the treatment group and the control group, which was exposed to high-intensity noise (range 70-75 dB) for three weeks [19]. Changing locomotion and exploration behaviors in the treatment group were caused by dopamine, which is the primary neurotransmitter in terms of locomotion and exploration has increased. This increase arises through glucocorticoids' effects and their effects on striatal neuropeptides, which have an impact on locomotion and exploration [19]. Decreasing dopamine concentrations in the brain will also influence locomotion and exploration behavior. It is in line with Naqvi et al. study, which states that there is a significant decrease in movement in rats exposed to noise 4 hours/day for 15 days compared to control [20].

In this study's resting behavior was in the form of sleeping mice or not doing other activities and curled up or hiding their heads under the body. Increased resting behavior is a response to avoid a threatening (coping mechanism) such as noise exposure. So, the stress that arises from noise can be reduced. Mancera Study also reported that there was an increase in resting behavior in the treatment group, which was exposed to high-intensity noise [19]. Grooming, eating, socializing, drinking, and making nests behaviors no significant difference between treatment and control group. It might be caused the noise exposure was not long enough to influence the behaviors. Our study accordance with Mancera et al. study [19]. Changes in eating behavior, even though there were no significant differences between the treatment group and the control group, a decrease in behavior change that occurred in the treatment group was influenced by stress response due to noise exposure. Maniam et al study reported the relationship between stress and eating behavior, and it stated that stress responses influence the decrease or increase in eating behavior because the system that controls both responses in the brain has the same anatomy [21].

The study results showed that no significant differences in social behavior between the treatment and control groups were in line with the study by Salehpouret al. The study stated that mice received acute noise exposure for 2 hours in 1 day with an intensity of 90 dB, and 110 dB did not show changes in social behavior. However, chronic exposure with the same intensity for three months showed a change in behavior. A social behavior changing in the treatment group was associated with an increase in stress hormones stimulated by noise exposure [13].

Gender response to stress reactions due to noise is different. In this study results, we found that changing behavior was more experienced by females in locomotion, resting, foraging, drinking, and making nests. Whereas in males, grooming, social and exploration behavior are most affected. Furthermore, there was a decrease in grooming behavior in female mice and eating behavior in both genders with more in male mice than females. Other behaviors had an increase in each gender (table 2). This study's results are in line with the Mancera study in 2018, which states that behavior changes are more common in female mice than males [19]. The condition might be influenced by estrogen produced in the estrus cycle, which increases the response to female mice's behavior [22].

In this study, only in foraging behavior, there were significant differences between male and female mice, whereas, in other behaviors, there were no significant differences (Table 2). It can be allegedly due to the placement of male and female mice combined into one cage, thus affecting mice's behavior changes. Besides that, noise exposure, which is only 4 hours/day for 15 days, is thought to be still tolerated by mice, so there is no significant difference in mice's behavior. In other words, different types, intensities, and duration of noise will give different responses. The study in line with a study that states intermittent noise with intensity 80 dB has more impact on sleep quality, mood, and performance compared to noise with the same intensity that is continuously exposed [12].

## V. CONCLUSION

Noise induces the changing of the mice's behavior. The responses of mice between males and females are almost similar, except for foraging. Further studies need to elaborate on the effect of noise toward behavior and quality of life and the different responses between males and, females which may be related to coping mechanisms.

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