THE INFLUENCE OF HOUSEHOLD NOISE ON ANIMAL BEHAVIOR. CASE STUDY ON THE LABORATORY RAT MODEL

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Abstract. Noise becomes a component part of the animal's living environment, with the expansion of anthropogenic activities. As a result, wildlife in human-impacted areas face new risks, which dictates the new adaptation tactics to stress factors, including behavioral changes. In order to establish how noise produced by human activities affects the behavior of laboratory animals, in process of adaptation to anthropogenic modifications, the laboratory animals - white Wistar rats, initially divided in morning and nigh feeding groups, were subjected to noise stress produced by vacuum cleaner of 70 dB intensity. As a consequence of noise action, the change in the rate of body mass gain in rats was established – an increase in the nocturnal subgroup and a reduction in the morning subgroup, which can be explained by the disorders of foraging behavior of stressed rats. The changes of rat behavioral parameters as reaction time (center square duration, blocking time), orientation behavior (rearing and line crossings), and parameters that characterize anxiety (grooming, urination, defecation, smelling holes) were established using "open field" method as a result of noise stress action. Stressed rats from both experimental subgroups have the same behavioral responses to noise which differ in the amplitude: experimental rats from night-feeding group had a higher level of behavioral response inhibition than experimental rats from morning-feeding group, that can most likely be explained by acclimation to sound, as 70 dB noise intensity used in the experiment does not cause functional disorders.

Keywords: laboratory animals, noise pollution, behavior.

Rezumat. Influența zgomotului menajer asupra comportamentului animalelor. Studiu de caz pe modelul șobolanilor de laborator. Zgomotul devine o parte componentă a mediului de viață al animalelor, odată cu extinderea activităților antropice. Ca urmare, animalele sălbatice din zonele afectate de activitățile umane se confruntă cu noi riscuri, ceea ce dictează noi tactici de adaptare la factorii stresogeni, inclusiv schimbări comportamentale. Pentru a stabili modul în care zgomotul produs de activitățile umane afectează comportamentul animalelor de laborator, în procesul de adaptare la modificările antropice, animalele de laborator (șobolanii albi linia Wistar), divizate inițial în loturi cu hrănire dimineața și seara, au fost supuse acțiunii zgomotului sonor produs de un aspirator cu intensitatea de 70 dB. Ca urmare a acțiunii zgomotului, a fost stabilită modificarea ratei de creștere a masei corporale la șobolani – majorarea în lotul nocturn și reducerea în lotul matinal, care poate fi explicată prin tulburări ale comportamentului alimentar al șobolanilor stresați. Modificările parametrilor comportamentali ai șobolanilor, cum ar fi timpul de reacție (perioada latentă de ieșire din centru, timpul de blocare), comportamentul de orientare (poziția verticală și traversarea liniilor) și parametrii care caracterizează anxietatea (spălarea, micțiunea, defecarea, mirosul găurilor) au fost stabilite prin metoda „câmp deschis” ca urmare a acțiunii stresului. Șobolanii stresați din ambele loturi experimentale au aceleași răspunsuri comportamentale la zgomot, care diferă în amplitudine: șobolanii experimentali din lotul hrănit noaptea au avut un nivel mai mare de inhibare a răspunsului comportamental în comparație cu șobolanii experimentali din lotul hrănit dimineața, ceea ce poate fi explicat, cel mai probabil, prin aclimatizarea la sunet, deoarece intensitatea zgomotului de 70 dB utilizată în experiment nu provoacă tulburări funcționale.

Cuvinte cheie: animale de laborator, poluare fonică, comportament.

INTRODUCTION

It is known that environmental change has negatively affected most biological systems on our planet and is becoming of increasing concern for the well-being and survival of many species (ACEVEDO-WHITEHOUSE & DUFFUS, 2009). Biodiversity currently experiencing anthropogenically driven environmental changes. Recent estimates have shown that „species extinctions are currently 10 to 100 times higher than the natural baseline” and is determined by ecosystem destroying and habitat fragmentation as a result of pollution caused by anthropogenic expansion, mainly, urban growth (WHO, 2025). As a result, wildlife in human-impacted areas face new risks, which dictates the need for adaptation tactics, including behavioral changes, especially in foraging (FEHLMANN et al., 2024).

Since the industrial revolution, human activities have become increasingly noisy, and currently, noise pollution has become one of the most dangerous forms of pollution caused by urbanization that is ubiquitous in aquatic and terrestrial ecosystems, leading to both acute and chronic disturbances in a wide variety of animals (SORDELLO et al., 2020; KOK et al., 2023). Sounds produced by human activities, such as traffic, ships and aircraft, industrial and household activities, represent an imminent danger to biodiversity, not only at the individual level but also at the population level for many biological groups of animals (SORDELLO et al., 2020; KOK et al., 2023).

The negative impacts of noise to organisms, have been documented in variety of studies in the last decades. Thus, taking into account the threats that noise pollution can have on wildlife, research on the effect of anthropogenic noise on biodiversity is increasing. Studies have shown that the types and severity of effects caused by noise pollution are related to a range of noise characteristics, including the level of noise received and the duration of exposure, but also depend on contextual factors such as proximity, familiarity and the behavioral state in which animals have been exposed, and the effects of anthropogenic noise on individual animals can escalate to the population level (ERBE et al. 2022). Finally, it is evident that species diversity, i.e., biodiversity in an ecosystem could be affected. In this case, it is necessary to delimit studies on the action of natural sounds that are characteristic of the animal world and serve for communication, from studies that investigate the negative impact of sounds, when its turn into “noise”, which depends on each species

(sensitivity threshold) and on the type of impact generated (e.g., disturbances, avoidance, damage). Noise pollution can be directly perceived by animals as a threat, causing changes in the animals' natural behavior, resulting in multiple problems for them (SORDELLO et al., 2020). For example, it has been shown that noise pollution can reduce birds' ability to gather information about their surroundings, increase their risk of predation (by masking predator sounds), and interfere with signals that are crucial for reproductive success and parental care (HALFWREK et al., 2011; SCHROEDER et al., 2012; FRANCIS & BARBER, 2013). Noise pollution greatly affects marine animals, especially mammals, as marine species are highly dependent on sound for their survival (ERBE et al., 2022). Noise has been shown to significantly influence feeding and predator avoidance behavior (ARCANGELI et al., 2022). At the same time, less attention has been paid to investigating the impact of noise on captive animals, even though captive environments are full of human activity and a wide range of sounds (STEINBRECHER et al., 2023). However, there are investigations carried out on laboratory animals that have aimed to elucidate the impact of noise or noise pollution on the behavior and physiological state of the animals (CASTELHANO-CARLOS & BAUMANS, 2009). Research on laboratory animals is also being carried out in order to highlight and extrapolate how noise pollution, which is one of the major environmental problems in many cities with rapid urbanization, acts on animal and human health (PATTERSON-KANE & FARNWORTH, 2006).

Thus, our study aimed to establish how noise produced by human activities affects the behavior of laboratory animals, in process of adaptation to anthropogenic modifications.

MATERIAL AND METHODS

The experiments were carried out on laboratory animals, white Wistar rats in the vivarium of the Institute of Physiology and Sanocreatology, Moldova State University. The laboratory rats, males, one month old, weight 73-86 g, maintained 6 in 4 cells with dimensions 40 x 50 x 20 cm in artificial light and temperature between: +10,5 °C - + 20 °C. The animals were divided into 2 groups of 6 each: the "morning" group (which fed during the day from 7^{30} to 19^{30}) and the "night" group (which fed during the night, in the absence of light from 19^{30} until at 7^{30}). The experiment lasted 35 days during the winter period (January - February, 2025).

Investigations on nocturnal and morning groups of animals were based on the fact that any change in the conditions of the natural environment could change the period of activity of the animals and their behavior.

In order to study the influence of household noise on behavior, the experimental 2 groups were divided into 2 subgroups of 3 animals each: control and rats subjected to noise action (stress). The laboratory rats were subjected to noise stress in an isolated room with the sound of a vacuum cleaner directed to the experimental animals (sound intensity of 70 dB). The sound level of 70 dB was chosen on the grounds that it is approximately the average of the physiological effect zone, so as not to cause functional disturbances. During 10 days, laboratory rats (3 from both groups) were subjected to noise stress for 5 min at a specified intensity of 70 dB. Changes in rat behavior were noted each day after the noise stressor.

Changes of animal behavior in experimental groups were recorded using the "open field" method, proposed by HALL (1936) for recording animal behavior in response to potentially dangerous new stimuli. Testing animals in the "open field" method is one of the most commonly used methods for studying the behavior and mental processes in small laboratory animals. A cylindrical open field device was used for this. The arena of the device was divided into 19 sections (squares), 12 of which were peripheral and 7 - central. Each rat was individually tested. The duration of the animal testing in the open field was 5 min. During this time, the following parameters were characterized that characterize the behavior: the number of line crossings; the number of vertical lifts – rearing; center square duration; blocking time; the number of smelling holes; the number of defecations and the number of urinations during testing (these two parameters are considered indicators of emotional anxiety; 5) grooming, its duration (VÕIKAR & STANFORD, 2023). At least, 60 minutes before testing in the open field, any handling of animals shall be excluded.

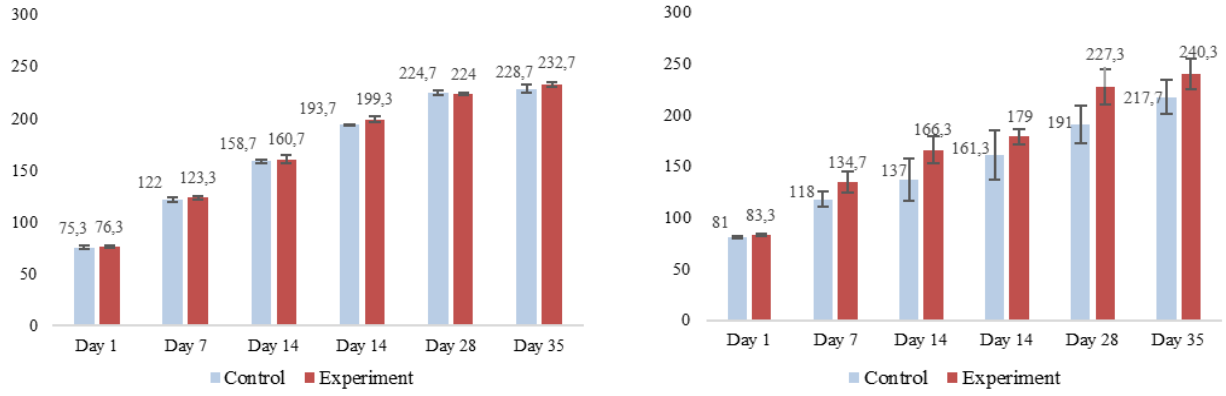
The data obtained were statistically processed using the Student’s t-test to determine probability and error.

The experiments were performed in accordance with Directive 86/609 / EEC of 24 November 1986 on the Protection of Animals Used for Experimental and Other Scientific Purposes and were approved by the Methodical and Ethics Committees of the Institute of Physiology and Sanocreatology, Moldova State University.

RESULTS

Initially, the influence of the environmental factor (noise) in combination with the nutrition time on body mass changes in white laboratory rats was studied. After being divided into "morning" and "night" subgroups, the rats were maintained for two weeks for adaptation to feeding regimes. It was established, that laboratory animals from the control and experimental groups in both "morning" and "night" subgroups during the adaptation period (1-14 days) underwent approximately similar changes in body mass, namely its increase (Fig. 1).

From day 14, the rats in the experimental group were subjected to sound (noise) stress of 70 dB. The stress factor (noise) differentially influenced the body mass gain in experimental animals. In the first week days of stress action, the morning experimental group of rats gained more weight (38 g) compared to the night experimental group (12,71 g). Over the next 14 days, it was observed an increase in body mass of the rats from the "night" groups and a decrease of body mass of "morning" animals, so that at the end of the experiment, the body mass of the rats from both groups did not show major differences (Fig. 1).

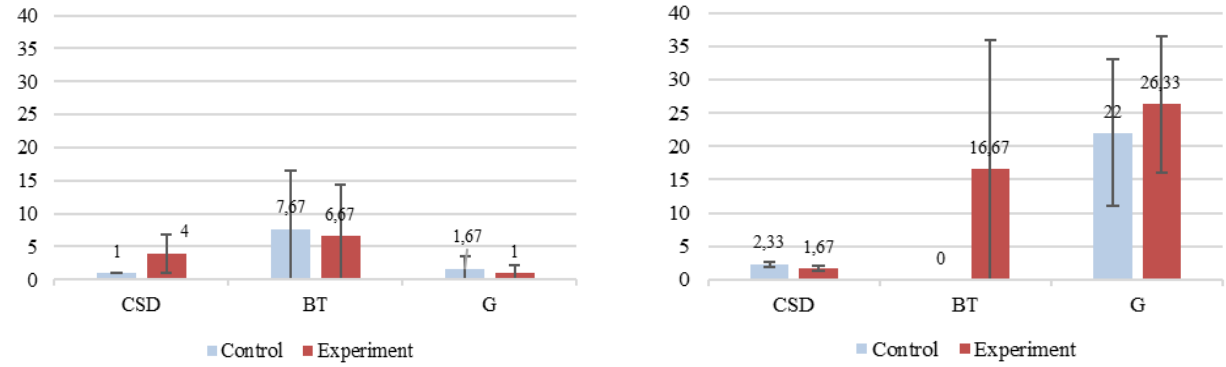


A **B**

Figure 1. Change in body mass of rats in "morning" (A) and "night" (B) subgroups during the experiment, (g).

Therefore, the noise produced by the vacuum cleaner in association with morning or night feeding of rats does not produce large differences at the end of the experiment (day 35 of the experiment). It was observed, however, that noise stress causes a change in the rate of body mass gain, i.e., an increase in the nocturnal group and a reduction in the morning group (day 28-35).

Simultaneously with the testing of body mass changes, the behavior of animals from the morning and night feeding groups in association with noise stress impact was studied. The behavior of rats was studied according to the "open field" method. It was established that the division itself of the feeding period – morning and evening, caused changes in the animals' behavior. Nocturnal feeding, in comparison with morning feeding, influenced the behavior of white laboratory rats by: intensifying (or increasing) of some indicators, such as – center square duration (2.33 times); duration of washing or grooming (13.17 times); number of defecation (1.9 times); number of urination (3.0 times); number of vertical lifts - rearing (1.2 times). Also, in this group of animals (nocturnal) the inhibition or reduction of such behavioral parameters as – blocking time (7.67 times), line crossings (1.3 times), number of smelled holes (1.7 times) was reported (Figs. 2 and 3).

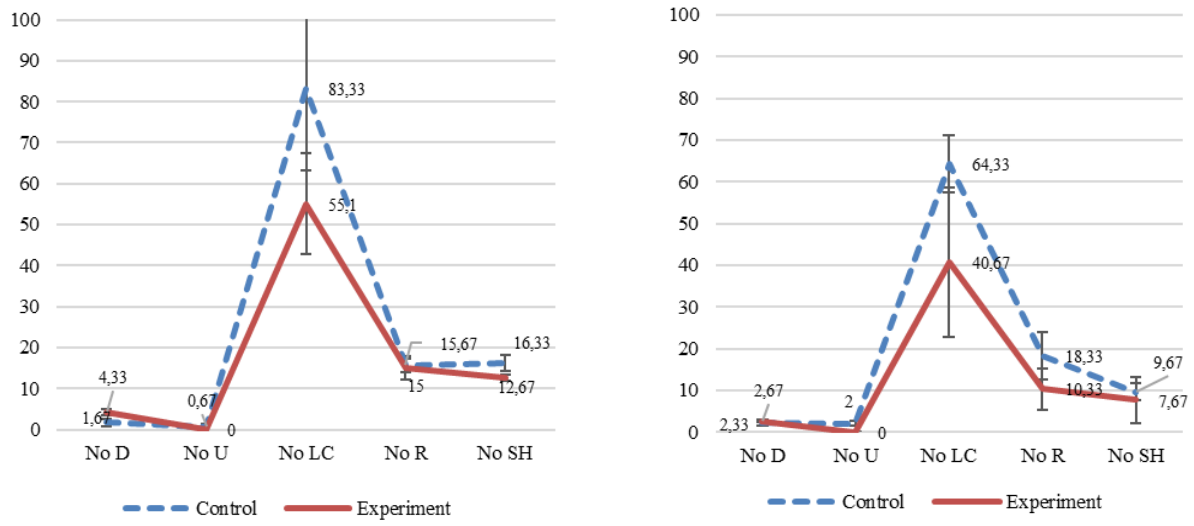


A **B**

Figure 2. Reaction time (s) of rats from "morning" (A) and at "night" (B) subgroups in association with noise stress
Legend: CSD - center square duration; BT – blocking time; G- grooming.

The stress factor, by applying the noise of 70 dB produced by the vacuum cleaner, caused changes of the rat's behavior. Noise stress had a greater effect on some behavioral reactions of the rats from "nocturnal" group, which is expressed by increasing the animals' blocking time and washing duration (grooming). If for "morning" group animals these indicators were 6.67 s ± 7.74 and 1.00 s ± 1.16, respectively, then for "night" group these indicators were 16.67 s ± 19.36 and 26.33 s ± 10.26 (Fig. 2.). Animal from "morning" group react to noise stress through increasing of center square duration (center time), parameter that in some cases is applied to determine anxiety.

At the same time the noise stress caused an inhibition of some behavioral indicators of animals from both the morning-fed and evening-fed groups (Fig. 2 and 3). Thus, behavioral indicators, such as: the number of urinations, the number of line crossings, the number of vertical lifts - rearing, the number of smelled holes were reduced at animals from both the "morning" experimental group (0 ± 0; 55.0 ± 12.20; 15.0 ± 2.90; 12.67 ± 0.77), and the "nocturnal" experimental group, subjected to stress (0 ± 0; 40.67 ± 17.81; 10.33 ± 5.03; 7.67 ± 5.42) compared to the control groups (0.67 ± 0.77; 83.33 ± 19.94; 15.67 ± 1.55; 16.33 ± 1.94, and 2.0 ± 0.58; 64.33 ± 6.78; 18.33 ± 5.61; 9.67 ± 1.94 respectively). At the same time, noise stress amplifies the defecation reaction in both experimental groups: from 1.67 ± 0.97 in the "morning control" group to 4.33 ± 0.77 in the "morning experimental" group, and from 2.33 ± 0.77 in the animals in the "night control" group to 2.67 ± 0.39 units in those in the "night experimental" group, respectively.



A **B**

Figure 3. Some indices of behavior activity of rats subjected to noise stress in the "morning" (A) and "night" (B) groups.

Legend: No Ds – number of defecations; No Us- number of urinations; No LCs – number of line crossings; No R – number of vertical lifts (rearing); No SHs – number of smelling holes.

Thus, according to the obtained data, it was established that the noise stress factor of 70 dB intensity affected the behavior of laboratory animals, in particular reaction time (center square duration, blocking time), orientation behavior (rearing and line crossings) as well as the parameters that characterize anxiety (grooming, urination, defecation, smelling holes)

Rats in the nocturnal group show a high level of behavior inhibition and "anxiety" in comparison with the morning group. This difference in the behavior/anxious reaction of rats with a different foraging time (as we established in previous experiment with high temperature stress) can be explained by the fact that the rats in the "morning" group were previously subjected to circadian stress (different feeding time) (VRABIE et al., 2022). Subsequent exposure to a limiting factor such as noise and testing in the open field (which in fact is still a stress factor) can cause a lesser reaction to stress.

DISCUSSIONS

Noise pollution is expanding with the growth of human population, the globalization of transportation networks, the expansion of resource extraction and urban and industrial development and causes essential changes in animal behavior depending on the intensity of noise.

Eating behavior disorders have been documented by KREBS et al. (1996) in laboratory rats exposed to noise levels of 60 and 95 dB. The authors established that the food intake of experimental rats was lower in stress group exposed to action of 60 dB noise and higher in stress sessions with 95 dB noise. The different rate of body weight gain in stressed experimental animals, from both morning and night feeding groups can be explained by changes in eating behavior. Thus, the enhanced rate of body mass gain in the night group may be associated with an increased metabolic rate. Moreover, the intensification of metabolic rate has been established in some predatory fish, which consumed more than twice as much prey when exposed to the noise of motorboat noise (SIMPSON et al. 2016). Noise at 75 dB increased the average daily weight gain of lambs and improved their feed efficiency compared to the control group and the group exposed to 100 dB noise, thus demonstrating sound acclimation (AMES, 1978, cited by BROUČEK, 2014). The differences in the rate of body weight gain in the nocturnal and morning groups can be explained by the fact that changing the feeding time, however, induces disorders of the normal behavior of rats under stress. Feeding the animals in the morning it is a supplementary stress factor, as feeding during the day is not characteristic of rats, which are nocturnal animals. Thus, the peculiarities of the behavior of rats in the nocturnal group represent a natural pattern of behavior, which can reproduce the reaction of animals to the action of stress factor (VRABIE et al., 2022).

Field studies and laboratory experiments have provided considerable evidence that noise exposure can cause a wide range of ecological impacts on wildlife. These include changes in the normal (natural) behavior of animals, such as modification of spatial distribution and deterrence of wildlife from important feeding and breeding areas, predator avoidance, prey detection and conspecific communication, i.e., changes associated with orientation and locomotion behavior reactions (KOK et al., 2023).

The obtained result in this study revealed an evident impact of noise stress on behavior of laboratory rats, including indices of orientation reaction, locomotion and anxiety. Differences were also found depending on feeding time. Experimental rats in the night-feeding group had a higher level of behavioral response inhibition. This may be due

to the fact that adaptation to nocturnal feeding of laboratory animals may contribute to increased vigilance, which in association with the stressor, in this case of noise, may amplify or inhibit some behavioral parameters. Often, animals showed increased vigilance in a noisy environment, potentially at the cost of other behaviors (RABIN et al., 2006, ERBE et al. 2022). However, the behavior of stressed rats in the morning and night feeding groups is approximately the same, with differences in the amplitude of the response. This can most likely be explained by the fact that the 70 dB noise intensity used in the experiment does not cause functional disorders. For example, some studies have established that continuous noise of 85 dB was shown to increase defecation and reduce sniffing, grooming or crawling of rats when compared with 50 dB, 65 dB or 75 dB. Pigs exposed to 90 dB prolonged or intermittent noise increased time lying down and decreased social interaction (CASTELHANO-CARLOS & BAUMANS, 2009). When rats were exposed to 95 dB at 0.5-5 kHz for two 5-minutes 'periods per day for 28 weeks, their behavior changed and above all they became aggressive (ALGERS et al., 1978, cited by BROUČEK, 2014).

In any cases, it is evident that noises of medium and even high intensity become permanent for the animals' natural living environments, causing the animals to adopt coping strategies, which primarily induce changes in their behavior.

CONCLUSIONS

Morning and night feeding in association with the stress produced by the vacuum cleaner noise influence the rate of body mass gain during the experiment: an increase in the nocturnal group and a reduction in the morning group (at the end of experiment). These differences can be can be explained by the disorders of foraging behavior of rats under stress.

The stress factor, by applying the noise of 70 dB produced by the vacuum cleaner, affected the rat reaction time (center square duration, blocking time), orientation behavior (rearing and line crossings) as well as the parameters that characterize anxiety (grooming, urination, defecation, smelling holes). A high level of behavior inhibition and "anxiety" has been documented in nocturnal animals compared to the morning group.

The same behavioral responses of noise stressed rats in the morning and night feeding groups which differ in the amplitude, can most likely be explained by acclimation to sound, as 70 dB noise intensity used in the experiment does not cause functional disorders.

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