

Summary of the Ph. D. thesis

Effect of acoustic stimuli on the behaviour, physiology and learning performance of laboratory rodents and domestic fowl

dr. Gabriella Korsós

Supervisors: dr. Sándor György Fekete
and dr. András Gáspárdy



UNIVERSITY OF VETERINARY MEDICINE
Veterinary Doctoral School

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Supervisors:

.....
dr. Sándor György Fekete
University of Veterinary Medicine
Animal Breeding, Nutrition and Laboratory Animal
Science Department
Supervisor

.....
dr. András Gáspárdy
University of Veterinary Medicine
Animal Breeding, Nutrition and Laboratory Animal
Science Department
Supervisor

Made in 1 copy.

.....
dr. Gabriella Korsós
assistant research fellow
University of Veterinary Medicine
Animal Breeding, Nutrition and Laboratory Animal
Science Department

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1. History and objectives

Ensuring proper animal welfare in animal husbandry is not only a moral obligation, but also a legal requirement and an economic interest. This is particularly true in the keeping, breeding and use of laboratory animals in animal experiments, where the 3Rs (Reduction, Replacement, Refinement) are the guiding principles. These three principles are closely linked, as the more refined the methods and the better the welfare of the animals, the more accurate the results, thus significantly reducing the number of animals used. Standardisation of environmental factors is essential if we are to achieve more valid results by excluding confounding variables.

There is growing evidence that the acoustic environment has a significant physiological impact on certain animal species. In some cases this impact is negative, for example, the adverse physiological effects of different types of noise have been demonstrated in both farm and laboratory animals (Burrow et al., 2005; Escribano, 2014). However, acoustic signals can also be used to positively influence animal behaviour and well-being. The laboratory environment must meet the

physiological and ethological needs of the animals, but replicating natural living conditions is not always feasible in practice. In order to ensure that captive animals have the physiological needs, the living conditions necessary for their well-being and the opportunity to express their natural behavioural patterns, species-specific environmental enrichment is necessary (Baumans, 2000). The modified environment affects the behaviour, physiology and brain anatomy of the animals. Hebb (1947) showed that rats kept in enriched environments performed better in the Hebb-Williams maze, with improved learning abilities, increased cortical thickness and weight, and increased size, number and complexity of their synapses (Widman et al., 1992). Sensory environmental enrichment includes visual, auditory, olfactory, tactile and gustatory senses. Already in the first half of the 20th century, Yerkes (1925) and Hediger (1950), and more recently Maegele et al. (2005), demonstrated in animal models that after brain trauma, the recovery of brain function after exposure to a richer environment and multimodal early stimulation (e.g. music) is faster than in rats kept in conventional conditions.

In addition to their relevance for basic and applied research in veterinary medicine, the changes induced by

acoustic stimuli also provide an opportunity for human psychological modelling. Furthermore, positive effects on learning abilities and memory seem to be confirmed, which may improve the training of certain animals (dogs, horses) and the observed effects may also serve as a basis for human studies. In addition, acoustic environmental management can be used as a stimulus to promote animal welfare by masking harmful environmental noises, thereby contributing to the reduction of distress, which can have a significant impact on the outcome of experiments and reduce their reliability.

However, the use of music composed by humans for humans for this purpose still raises many questions. Since music has many positive effects on humans, we tend to assume that it has a similar positive effect on stress in different animal species and can therefore be used to enhance animal welfare. But can we really extrapolate from human to animal so easily?

The aim of this paper is primarily to answer this question. To this end, several studies have been carried out on different animal species: domestic chickens, mice and rats. We used different strains of mice, both inbred and outbred, and tested whether the two sexes of the same strain respond differently to the same stimuli.

2. New scientific results

1) We found that human music and noise have the same effect on the pathophysiological and physiological indicators of stress (weight gain, fluctuating asymmetry) in Ross-308 meat hybrid domestic fowl.

2) We have found that in CD1 mice, the activity is reduced by exposure to Bach's original and rodentised compositions, and in BALB/c mice, the activity is reduced by exposure to Mozart and Bach's original and rodentised versions of their compositions during the openfield tests.

3) We have found that in CD1 mice, less free radicals are formed in the brains of males than females when exposed to acute noise.

4) We have found that noise habituation reduces free radical formation in the brains of female CD1 mice, but no such effect is observed in males.

5) We have found that listening to classical music at normal pitch before the maze test improves reference

memory, memory return following a 2-week period, and long-term 4-hour working memory retention in rats.

6) We found that rodentised classical music improves 2-hour working memory and retention and reference memory, but only when listened to before and during the maze test.

3. Publications based on the results of the doctoral study

Publications in peer-reviewed scientific journals with impact factors

Fekete, S. Gy., Korsós, G.: **Különböző emberi környezethatások (szocializáció, zene, zajzene, zaj) befolyása a patkányok viselkedésére: 1. rész**, Magyar Állatorvosok Lapja, 135. 117-122, 2013.

Fekete S. Gy., Sukikara C, Korsós, G.: **Különböző emberi környezethatások (szocializáció, zene, zajzene, zaj) befolyása a patkányok viselkedésére: 3. rész. Különböző típusú zajok hatása a patkányok porondteszt-viselkedésére**. Magyar Állatorvosok Lapja, 135. 692-698, 2013.

Fekete, S. Gy., Lukács, A., Horváth, K., Korsós, G., Vezér, T.: **Mozart-szonáta hatása patkányok tanulási és emlékezési teljesítményére.** Magyar Állatorvosok Lapja, 136. 167-176, 2014.

Korsós, G., Brown, D. L., Rühlicke, T., Fekete, S. Gy.: **Egéretológia: különböző emberi és rodentizált zene hatása az egerek társas és egyéni viselkedésére, közérzetére és a genetika-környezet kölcsönhatásra I. Irodalmi összefoglaló.** Magyar Állatorvosok Lapja, 138. 695-704, 2016.

Korsós, G., Brown, D. L., Windig-Zavadil, C., Rühlicke T., Fekete S. Gy.: **Egéretológia: különböző emberi és rodentizált zene hatása az egerek társas és egyéni viselkedésére, közérzetére és a genetika-környezet kölcsönhatásra: II. Eredeti és öt oktávval megemelt Bach- és Mozart-zene hatása különböző genotípusú egerek viselkedésére.** Magyar Állatorvosok Lapja, 138. 743-752, 2016.

Korsós, G., Horváth, K., Lukács, A., Vezér, T., Glávits, R., Fodor, K., Fekete, S. Gy.: **Effects of accelerated human music on learning and memory performance of rats.** Appl Anim Behav Sci, 202. 94-99, 2018.

Korsós, G., Kulcsár, M., Szabóné Benyeda, Zs., Glávits, R., Bersényi, A., Gáspárdy, A., Fekete, S. Gy.: **The effect of noise and music on young meat chickens' behaviour and stress state.** J Dairy Vet Anim Res, 8. 146-151, 2019.

Conference presentations

Fekete, S Gy., Korsós, G., Vezér, T., Lukács, A; Brown, D L: **Effects of Mozart-Music on the Rat's Learning Capacity and Short-Term Action Catalogue - Preliminary Study.** (*poszter*) Acoustic Communication By Animals” 3rd Intern. Conf. Aug.1-5, Cornell. 2011. p. 41-42.

Korsós., G., Brown, D. L., Williams, W. O., Winding, C., Rüllicke, T., Falkenhorst, O., Rácz, N., Fekete, S. Gy.: **Effects of rodentized Mozart- and Bach-music on mice openfield behaviour** (*poszter*) IV. Central and Eastern European Laboratory Animal (CEELA-2015) Triannual Conference, 2015. 11. 28.

Korsós, G., Benedek, T., Benyeda, Zs., Kulcsár, M., Glávits, R., Fekete, S. Gy.: **A zaj és a zene hatása az 1-21 napos csirkék viselkedésére, stresszállapotára és kortikoszteron-vérszintjére** (*poszter*) IV. Central and

Eastern European Laboratory Animal (CEELA-2015) Triannual Conference, 2015. 11. 28.

Korsós, G., Benedek, T., Benyeda, J., Kulcsár, M., Glávits, R., Fekete, S. Gy.: **A zaj és zene hatása az 1-21 napos csirkék viselkedésére és stresszállapotára (szóbeli prezentáció).** In Memoriam Kovács Ferenc Nemzetközi Állatorvos és Állattenyésztő Kongresszus. 2016. 10. 9-12. Magyar Állatorvosok Lapja. 138. Suppl. I. 2016.

Korsós, G., Glávits, R., Bózi, Sz., Fekete, S. Gy.: **Lehetséges-e patkányokat környezeti zajokhoz szoktatni? (poszter)** Magyar Laborállat-tudományi Egyesület Nemzetközi Tudományos Ülése. 2017. május 25.

Korsós., G., Dudás, K. D., Fodor, K., Fekete, S. Gy.: **Emberi zene hatása menhelyi kutyák viselkedésére (szóbeli prezentáció).** 6th Scientific Day of Animal Breeding in Gödöllő. 2017. 11. 24. Book of Abstracts of presentations and posters. Szerk.: Bényi, E. et al. Gödöllő: University Publisher

Korsós, G., Blázovics, A., Fekete, S. Gy.: **A heveny és ismétlődő zajterhelés hatása hím és nőstény egerek**

agyszövetének lipidperoxidációs folyamataira.

(*poszter*) Iv. Central And Eastern European Laboratory Animal (Ceela-2018) Triannual Conference 2018. 06. 02.

Korsós, G., Dudás, K. D., Fodor, K., Fekete, S. Gy.: **Zene hatása menhelyi kutyák viselkedésére.** (*poszter*) IV.

Central and Eastern European Laboratory Animal (CEELA-2018) Triannual Conference, 2018. 06. 02.

Korsós, G., Fodor, K., Fekete, S. Gy.: **The effect of music upon the behaviour of shelter dogs.** (*poszter*)

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Korsós, G., Blázovics, A., Fekete, S. Gy.: **Effect of noise exposure on the lipidperoxidation in the brain of mice.**

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Korsós, G., Bozi, Sz., Glávits, R., Fekete, S. Gy.: **Patkányok hozzászoktatása zajokhoz.** 2016. január 25.

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Correction

3. Publications based on the results of the doctoral study

Publications in peer-reviewed scientific journals with impact factors

Deleted:

Korsós, G., Kulcsár, M., Szabóné Benyeda, Zs., Glávits, R., Bersényi, A., Gáspárdy, A., Fekete, S. Gy.: **The effect of noise and music on young meat chickens' behaviour and stress state.** J Dairy Vet Anim Res, 8. 146-151, 2019.

Correction:

Korsós, G., Fodor, K., Kiss, A., Blázovics, A., Fekete, S. Gy.: **Effect of acute and repeated noise exposure on the behaviour and lipid peroxidation in brain tissue of male and female mice.** Turk J Vet Anim Sci, 47. 127-137, 2023.