

EFFECT OF ENVIRONMENTAL RICHNESS ON RESPONSIVENESS OF RATS TO SPECIES-SPECIFIC EMOTIONAL CALLS

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Language and speech communication are closely intertwined, and a comprehensive understanding of the evolution and origin of language cannot be achieved without the study of sound communication in a variety of animal species. Rats produce two types of ultrasonic vocalization (USV) in response to emotional and social contexts. Previous studies have suggested that 50 kHz “pleasant” USV increases heart rate with a significant tendency, while 22 kHz “unpleasant” USV decreases heart rate (Saito, 2019). However, the environment in which laboratory rats are raised is quite different from the environment in which wild rats live. Brydges *et al.* (2011) suggested that rats raised in rich environments tend to judge intermediate stimuli as positive stimuli. It has also been shown that environmental enrichment stimulates progenitor cell proliferation in the amygdala (Okuda *et al.*, 2009). Based on these studies, because the laboratory rearing environment may alter the innate response to USVs, it is necessary to conduct further studies with more wild-like enrichment environments. Therefore, in this study, we made a hypothesis that rats reared in a rich environment respond less to 22 kHz USV or more to 50 kHz USV and examined whether the environmental richness affects the responsiveness to USV.

In this study, rats raised in an enriched environment were exposed to USV, and their responses to USV were examined in comparison with those of rats raised in a standard environment. Following Saito's study (2019), the responses to USV were indexed by increases or decreases in heart rate. If the rats raised in the enriched environment are more optimistic and the decrease in heart rate when listening to 22 kHz USV is not significant, or if the heart rate of rats listening to 50 kHz USV is significantly increased, it is assumed that the enrichment altered the rats' responsiveness to USV.

Of the 12 weaned male rats, 6 were pair-reared in cages (approximately 25 × 40 × 20 cm) lined with recycled paper bedding. The others were kept in large cages (approximately 40 × 65 × 30 cm) with a thick layer of pepa-kurin (JapanSLC, Shizuoka, Japan) and several enrichment supplies, three animals per cage. Two months later, 50 kHz and 22 kHz USV were presented, and heartbeats were measured during listening.

MATLAB was used for the following analysis. The baseline was defined as the time up to 7 seconds before the start of voice presentation, and the test was defined as 7 seconds after. The RRI, the interval between R waves, was calculated, and the mean of the RRI (mean RRI) was calculated as the heart rate interval. Prolongation of the RRI indicates a falling heart rate and shortening of the RRI indicates a rising heart rate (Jose, 1966). For these indices, baseline values were subtracted from the tests in the block. For example, if the difference is significantly greater than zero, we can say that listening to the USV decreased heart rate.

The following analysis was then conducted using R. To examine whether each index changed from baseline due to the presentation of USV, we tested the median values by one-sample Wilcoxon signed rank test and found no significant changes in any of the conditions. The test results were shown in Fig. 1.

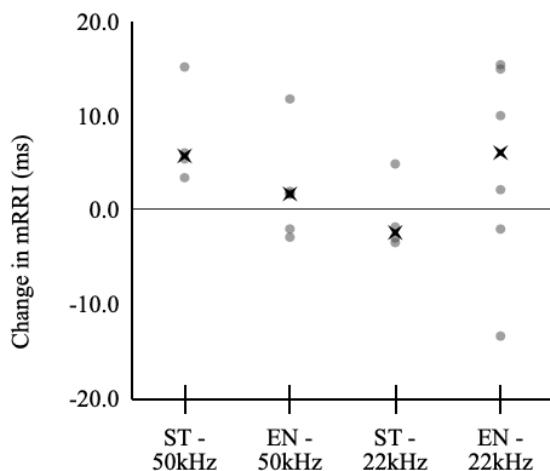


Figure 1. Change in mRRI from baseline. ST: standard group ($N = 4$), EN: enriched group ($N = 6$), \times : the median.

In conclusion, both the environmental richness and the category of USV did not affect the response of the autonomic nervous system in rats. However, some individuals did not return their heart rate to baseline after listening to the USV, which may have prolonged the effect of the preceding stimulus. Thus, we need to review whether the baseline and interstimulus interval settings were appropriate. Moreover, we would like to investigate whether the enriched environment operation was appropriate through further experiments.

References

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