Testing the long-term memory in *Nyctalus noctula*

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Introduction

Learning and memory in bats are poorly studied subjects, however, the natural history of these volant mammals may predict considerable cognitive abilities. All the complexity of the natural history of flying echolocating mammals requires high abilities for memory and learning, and possible considerable cognitive abilities.

Hypothesis

- We examined the ability to remember how to eat in captivity by individually marked eight *Nyctalus noctula* recaptured after 10-11 months of living in nature.

We have noticed that bats got to the winter rehabilitation started eating quickly than new ones.

Result

- We found a statistically significant difference in speed of eating (seconds) of the first larva between *N. noctula* that had already eaten in captivity (average 70 s) and individuals without such experience (average 189 s) (Fig 2).
- There was no statistically significant difference in speed of first eating between adult and this-year-born bats, however, young *N. noctula* started eating faster (146 s) towards adults (221 s) (Fig 2).
- Our study suggests that *N. noctula*, which has experienced how to eat in captivity during winter rehabilitation (unnatural environment), can remember this for a year at a minimum.

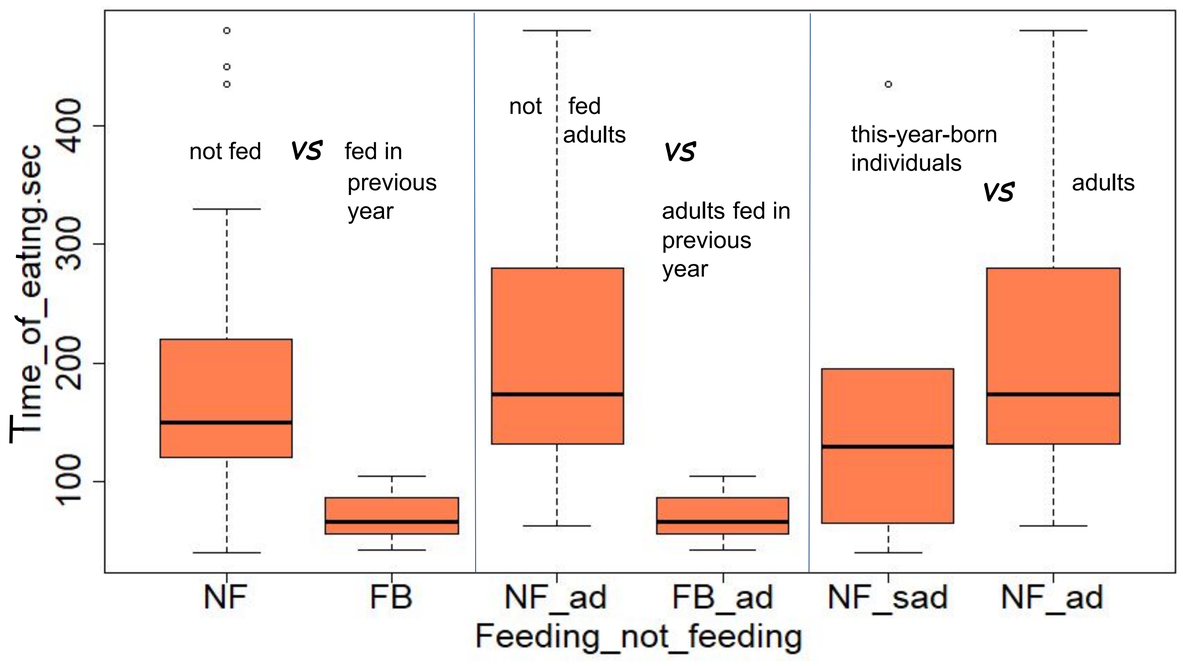

Fig. 2. NF - not feeding before, FB - feeding before, ad - adult individuals, sad - this-year-born individuals.

Conclusions

- To the best of our knowledge, this is the first study presenting a case of long-term memory in *N. noctula*.

Materials and methods

- Our study was conducted in the Ukrainian Bat Rehabilitation Center during winter rehabilitation work 2021-2022.
- For the reason of this study, **29 individuals of *N. noctula*** were selected from all the number of bats kept on winter rehabilitation.
- Among these 29 bats, **8** (4 adult females and 4 adult males) **were recaptured** after the previous winter rehabilitation circle (winter 2020-2021), (called - fed bats before **FB**). The other 21 *N. noctula* (adult females - 10, this-year-born females - 4; adult males - 2, this-year-born males - 5) were randomly selected from all the number of *N. noctula* from winter rehabilitation (called - not fed before **NF**).

General experiment design

- *N. noctula* from both groups were fed in the same conditions with measurement of time. The size of larvas of super mealworm *(Zophobas morio)* used in the experiment was similar in body mass (0.7 g) and length (4 cm).
- The experiment included 5 stages (Fig. 1). First, bats were taken from room-temperature condition, weighted, and warmed up until euthermy.
- In the stage Zero (“0”) a bat was watered *ad libitum* (Fig. 1A). Further, a decapitated larva was brought to the lips of the bat (Fig. 1B), immediately after a stopwatch was turned on, stage One (“1”).
- The Second (“2”) stage was the moment when the bat started to eat by itself, the first bit (Fig. 1C).
- Thereby, the Third (“3”) stage was being consisted the period of time when the bat continues eating the larva by itself (Fig. 1D).
- The last stage (“4”) was the moment when the larva was completely eaten (Fig. 1E), and at that moment the stopwatch was turned off.
- **The time from beginning of stage 1 till the end of stage 4 (time of fully eating of the larva) was estimated in seconds, and was considered as the time of learning of self-eating in captivity.**

Fig. 1 Illustration of the experiment stages:
A - stage 0 - watering,
B - stage 1 - a larva contact with bat’s lips,
C - stage 2 - the moment when the bat started to eat by itself,
D - stage 3 - the bat continues eating the larva by itself,
E - stage 4 - the moment when the larva was completely eaten.

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