Favourite swimming patterns in the Morris water maze: allothetic and idiothetic navigation in small rodents

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Introduction

Animals apply two navigation systems to reach their goal by the shortest way in familiar habitats: allothetic and idiothetic. The allothetic navigation system is based on the determination of direction and distance to the goal according to the relationships between used landmarks animals can find in their habitats [1]. On the other hand, in the idiothetic navigation system animals rely on the vestibular system, proprioreceptors and the muscle spindles as the sources of information [2]. Both of these systems can be investigated in the Morris water maze (MWM) [3]. The most of studies about navigation abilities in MWM are based on the experiments with laboratory rats and mice. Hence we chose three wild rodent species, *Microtus arvalis*, *Acomys dimidiatus*, *Mus musculus,* and one laboratory mouse (outbred CD-1 strain) that underwent classical MWM training. We wanted to make better sense of rodent searching strategies which could be one of reasons they are able to find their goal successfully, so we evaluated observed repetitious observed swimming patterns for the first, third and fifth day of testing.

Methods

Our MWM consists of a pool (95 cm in diameter, 50 cm in height) surrounded with a non-transparent and non-translucent tent. Every animal had to swim eight trials per day from four start positions to find a submerged escape platform which we placed in one fixed position in the pool. Their path length was recorded. We compared the allothetic navigation of the rodents, when three accentuated and contrast landmarks were placed inside the tent, and their idiothetic navigation, when no landmarks were present.

Evaluated strategies often occurred in all species or they were special for one species, more or less. During thigmotaxis, animals were swimming near the wall because lots of animals are afraid to swim far from the wall. When animals left the wall and made an arch to return, we denominated this swimming as arch near the wall. Animals explored more parts of the pool but they didn't swim to the centre. We found some individuals that swam across the whole area of the pool. Thus we also recorded swimming across. During floating, animals were lying still on the water surface. Sometimes animals were searching for the platform in one part of the pool and their path resembled big circles. On the other hand, small loops, whereby animals were searching through the whole pool, were typical for semicircular swimming. Some animals didn't regard the platform as a safe place and they abandoned it immediately, so the recording of their path didn't stop. When animals headed for the centre and they missed the platform but soon they returned to it, we described this pattern as return. We also noted the frequency of direct swimming: In the end we recorded the frequency of the following swimming patterns: thigmotaxis, arch near the wall, swimming across, floating, big circles, semicircular swimming, abandoning the platform, return, direct.

Results

All species were able to find the platform more accurately in the presence of visual landmarks than without them. All species preferred semicircular swimming for idiothetic navigation, whereas we didn't find any swimming patterns most preferred for allothetic navigation. The abilities of *Acomys dimidiatus* to find the platform were worse than of all the other species. This result is consistent with our presumption that the natural environment affects the navigation abilities of species. Moreover, *Acomys dimidiatus* also preferred swimming patterns such as thigmotaxis, arch near the wall and floating more than other species. These patterns might be interpreted as a bad searching strategy. We suggest that in addition to the relation between the natural environment of the species and their ability to orientate with or without landmarks, the preferred strategy for searching platform can affect the performance of small rodents in MWM.

References

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