Symposium 9: Ecology, brain and behaviour
Organized by H.P. Lipp

Symp 9/1

AGONISTIC ENCOUNTERS IN MICE HOUSED IN SEMINATURAL AND LABORATORY CONDITIONS: REFLECTIONS ON MEASURING SOCIAL RELATIONSHIPS IN MAMMALS

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Methods to score adequately male mouse aggressive behaviour will be shortly summarised. As an example of ethologically-grounded evaluation, twenty feralized male mice (of a strain characterised by large variability in hippocampal mossy fibers projections) were trapped from a colony living in outdoor large enclosure (300 m²) in western Russia. Twenty control male subjects (of the same origin but maintained in laboratory conditions for several generations) were housed in standard laboratory facilities at the university of Moscow. All mice were isolated for 9 days in standard mouse laboratory cages before being exposed to agonistic encounters in a large cage (53 x 23 x 30 cm) with a mixture of sawdust and sand as bedding material. Behaviour of the mice was video-recorded and analysed during 1st, 3rd and 5th of 5 agonistic encounters lasting 10 min. Feralized mice showed shorter latency to the first attack and a generalised increase of the offensive components of agonistic behaviour (attack, chase, display of offensive upright posture). Only half of the feralized mice, however, showed a steady dominant profile throughout the five sessions. A preliminary neuroanatomical analysis showed that mice with larger brain weight had significantly shorter attack latencies. On the other hand, the extent of the infrapyramidal mossy fiber projection was not correlated with initial attack latencies. In those animals (chiefly from the outdoor pens), which did not show a constant behavioral profile, larger IIP-FM were correlated with increasing attack latencies.

Symp 9/2

MICRO- AND MACROEVOLUTION OF THE INFRAPYRAMIDAL MOSSY FIBER PROJECTION IN MICE AND SMALL MAMMALS

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The intra/infrapyramidal mossy fiber projection (IIP-MF) of mice and rats shows strong genetic variation found to correlate positively with learning abilities in hippocampus-dependent tasks. However, negative correlations were also observed with non-learned tasks, for example with attack latencies in a male intruder paradigm. In order to elucidate the biological significance of the IIP-MF variation, a double strategy has been employed. For one, we have checked a variety of small mammals in western Russia for differences in the IIP-MF projections in order to discover adaptations to particular ecological profiles. In parallel, we have tested short-term natural selection in populations of laboratory mice kept outdoors in

large enclosures for several years. Systematic quantitative species comparisons included voles (*Microtus agrestis*, *Microtus oeconomus*, *Microtus arvalis*, *Terricola subterranea*, *Clethrionomys glareolus*), wood mice (*Apodemus sylvaticus* and *Apodemus microps*), shrews (*Sorex araneus*, *Sorex minutus*) and moles (*Talpa europea*). Individual specimens included small rodents (*Sicista betulina* and *Micromys minutus*), rare shrews (*Sorex isodon*) and the weasel (*Mustela nivalis*). The IIP-MF projection showed extreme variations between species, and also more subtle differences within a genus. The survey suggests that species having more IIP-MF can be classified according to three factors: they live in more complex environments, and/or are predators and/or show higher encephalization. For experimental natural selection of mouse IIP-MF projections, an F1 founder generation consisting of reciprocal crossings between four strains showing differential IIP-MF projections (C57BL/6J, C3H/HeJ, NZB/BINJ, DBA/2J) was released into two large outdoor pens, each one containing shelters of 2x2 m. Apart from being fed, they were left to survive avian predators, diseases and the harsh Russian climate. A third sample was moved to Moscow and kept there under standard conditions and bred randomly. Once per year, all animals were trapped and a sample of 20 mice was selected randomly for hippocampal morphometry. In the second year, an additional sample was taken from each pen, brought to Moscow and bred there randomly also. The IIP-MF projection showed an amazingly rapid adaptation: in one pen, it was reduced after one year already (about 3 generations), in the other pen in the second year (after 5 generations), to about 66% of that of the controls. In the third year it was slightly larger and remained stable in the fourth year. As the IIP-MF of the mice derived from the pens but bred in Moscow did not change over time, the changes in mossy fiber distribution imply very rapid natural selection of a brain trait for a specific environment requiring reduced exploration and increased aggressivity.

Supported by SNF 31-37497.93 and 31-46691.96.

Symp 9/3

COMPARING HIPPOCAMPUS-DEPENDENT LEARNING BEHAVIOR ACROSS MANY SPECIES: A GIANT OUTDOOR RADIAL MAZE FOR COMPARATIVE STUDIES IN BIRDS AND MAMMALS

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For a comparative neurobiological analysis of spatial learning and working memory, a large outdoor eight-arm radial maze was constructed which permits behavioral assessment of many avian and mammalian species both from the laboratory or the wild, using the same metric space and session schedules. It consists of a central part of 250 cm diameter, and has arms of 650 cm length, 170 cm height and 75 cm width. In order to determine appropriate training schedules for comparison of different species, we tested three avian and three mammalian species: 13 homing pigeons (*Columba livia*), 7 hooded crows (*Corvus corone cornix*), 5 chicken (*Gallus domesticus*), 6 guinea pigs (*Cavia cavia*), 6

rabbits (*Oryctolagus cuniculus*), and 9 albino rats (*Rattus norvegicus*). With the exception of guinea pigs which refused any within maze activity, successful learning within 5-10 sessions was observed for members of all species. Adult wild-caught crows, juvenile rabbits and adult rats showed good-to-excellent learning; homing pigeons performed moderately, while the adult chickens showed only two individuals with recognizable learning. Thus, in spite of species-specific demands for reward, adaptation and pretraining, this type of radial maze permits to compare directly a wide variety of species. Such comparability is essential for an analysis of underlying neurobiological mechanisms. For classical laboratory species such as rats and pigeons, it also provides the opportunity to test some of the theoretical assumptions underlying the design of small laboratory-based radial mazes or radial maze analogues.

Supported by SNF 31-37497.93 and 31-46691.96.

Symp 9/4

CAN MICE LEARN A RADIAL-MAZE-LIKE TASK IN SEMI-NATURAL CONDITIONS ?

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Laboratory mice were adapted to outdoor life in a large enclosure providing a semi-naturalistic environment. Following subcutaneous implantation of microchips with unique codes, they were tested for their ability to modify their feeding activity under a controlled food supply schedule. The computerised system used consisted of automatic units delivering portions of the daily quantity of seeds to each individual mouse. Eight of such units were placed into an outdoor pen to mimick a radial maze like task. Mice had to visit all units to gather the daily amount of food; they were individually recognized by an antenna detector, which revealed the code of the subcutaneous microchip. Feeding places visited, number of food rewards received and number of re-entries in already visited feeder boxes were automatically recorded during a 14-days period of a computer-controlled feeding schedule. Number of food rewards increased throughout the experiment, while number of re-entries decreased from day 8 onwards, thus suggesting that mice of the pen learn the task. At the same time, temporal feeding activity pattern, which previously had a bimodal profile, peaked around the beginning of each daily session. These data demonstrate that, despite presence of territorial constraints and some procedural differences from lab studies, spatial learning of a radial maze like task can be assessed also in mice living in semi-natural conditions.