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Social behavior and spatial memory in tame and aggressive mammals

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Motivation and Aim: Social behavior in mammals has a wide polymorphism from strictly social animals through facultative social to non-social animals. It is believed that a high sociality of their wild ancestors is one of the prerequisites for domestication. However, it should be noted that not all domesticated animals are subject to this rule; in addition, a destruction of the social structure of the group is observed in a number of cases (in particular, as seen in dogs) [1, 2]. The same applies to monogamous relationships of wild foxes that turned into promiscuity when bred in the captivity, and the selection of rats for tame behavior led to a deterioration in maternal behavior. However, it is likely that domestic and tame animals acquired the ability to socialize easier with a human showing an affiliative behavior towards him, which was the main hereditary change. However, the mechanisms of these changes are still poorly understood. Apparently, neurogenesis in the hippocampus in the juvenile period is one of the mechanisms of the formation of affiliative behavior [3]. It is known that neurogenesis in the hippocampus is higher in tame foxes as compared with foxes unselected for behavior (and, perhaps, in tame rats compared with aggressive ones) [4]. A high level of neurogenesis can be also associated with a high activity of oxytocin system, which, in addition, is associated with affiliative behavior in a number of cases. A change in the level of neurogenesis in the hippocampus can be also associated with spatial learning.

Methods and Algorithms: In this work, the expression of genes related to neurogenesis (particularly, to retinoic acid (RA) system playing an important role in initiating stress) was studied using qPCR in foxes and rats (models of domestication) in the juvenile and adult state. To change the activity of RA system and, accordingly, neurogenesis in the hippocampus (and possibly social behavior), the experiments were carried out with keeping rats and foxes on a diet with different amount of vitamin A in the juvenile period. In adulthood, tests for behavior towards conspecifics (three-chamber social test) and human (in the new enclosure) and a test for spatial learning (Barns test) were conducted. In addition, the behavior was tested after a nasal administration of oxytocin.

Results: It was demonstrated that tame rats and foxes exhibit the affiliative behavior to a greater extent than aggressive ones. At the same time, the expression of genes associated with neurogenesis is increased in tame animals. The administration of vitamin A in the juvenile period or oxytocin before the tests changes the behavior, reinforcing or, on the contrary, weakening the affiliative behavior. In addition, the administration of vitamin A improved the spatial learning in aggressive rats, apparently, through an increase in the levels of neurogenesis.

Conclusion: Vitamin A and oxytocin systems, associated with neurogenesis, stress, and other processes in CNS, seem to be involved in the formation of differences in social and cognitive behavior in the aggressive and tame animals (models of domestication). However, these effects are non-linear, a high dosage of vitamin A appears to have the opposite effect (increasing the aggression), while oxytocin can increase the anxiety and aggression under stressful conditions of the test.

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