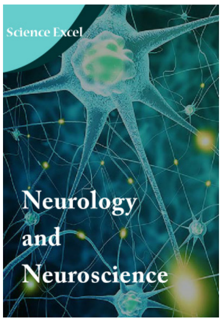
Neurology & Neuroscience

Original Article



Performance of food seeking behavior in rats of different age

Albertin SV*

Pavlov Institute of Physiology of the Russian Academy of Sciences, St.- Petersburg, Russia

*Correspondence
Albertin SV
Pavlov Institute of Physiology of the Russian Academy of Sciences, St.- Petersburg, Russia
Tel: 7(812) 328 07 01
E-mail: salber1@rambler.ru

- Received Date: 14 Oct 2020;
- Accepted Date: 11 Nov 2020;
- Publication Date: 19 Dec 2020.

Keywords

juvenile rats, radial maze, food seeking behavior, hippocampus, striatum

Abstract

The ability of juvenile rats to seek food behavior in radial maze with asymmetrical rein-forcement following injection of pharmacological drugs selectively affecting the hippocampal or striatal activity was investigated. It has been shown that the ability of animals to form selective attention on significant sensory signals and the animal efficiency to wait the delayed discrete reinforcement appeared in rats on the different phases of age where hippo-campus and striatum are in competition each to another.

Introduction

A number of neurobehavioral investigations published in recent years pay a much attention to study the role of the hippocampus and ventral striatum in the formation and performing of food seeking behavior in animals [1-4]. Studies with recording of synchronous neuronal activity of hippocampus and nucleus accumbens in rats performing seeking behavior in the radial maze [5,6], as well as the experiments with electrolytic lesion of the medial part of the nucleus accum-bens [1,2] selectively receiving afferent projections from hippocampal subiculum region [7,8], have demonstrated that these brain structures can be involved into synergistic relationships under searching for the preferred reinforcement in adult rats.

Taking into account an evidence that morphological and functional maturation of these brain structures take place in the different periods of postnatal ontogenesis of rats [9-11] our task was directed for studying the ability of animals of different ages to form food-seeking behavior in intact juvenile rats as well as under the application of pharmacological drugs having a selective effect on the activity of hippocampus and the striatum.

Method

Experiments were carried out on juvenile Long Evans rats performing seeking behavior in a radial maze with asymmetric food reinforcement [1]. The animals were taken into the experiment starting on the age of 3 weeks. The experimental animals were trained to enter that reinforced compartments of the 4-arm radial maze where the local intramaze visual signal was switched on. In one sleeve the rats received five drops of milk whereas the visiting of other arms they received only the one drop (Figure 1). In separate series of experiments the ability of animals to form the searching behavior was investigated under the delay of maximal reinforcement: 5 drops were applied in a discrete mode successively presenting by one drops in a row with increasing of intervals between each of five drops of reinforcement. Construction of the maze allows the animal to use the signal marks – clearly visible extramaze geometric figures for navigation under choice of preferable sleeve of maze. The ability of rats to remember the location of maze arm with preferred rein-reinforcement (5 drops of milk) was tested using the probe trials – the simultaneous switching the intramaze local cues signaling reinforcement in all arms of the maze (Figure 1).

The location of the greatest reinforcement (5 drops of milk) in the arms of the maze was varied daily in a random order. Testing the effects of the pharmacological injections on animal behavior in maze was carried out by introduction of amphetamine (i.p. 0.2-0.5 mg/kg), or the subseizured dose of pilocarpine (i.p. 45 mg/kg). Following pilocarpine administration, the animals were observed to confirm the absence of seizures, as evaluated by the Racine scale (Racine, 1972). The control rats were given the injection of saline. The number of correct choices of arm with the greatest reinforcement was recorded. Under statistical analysis of the results, the student t-test and nonparametric Wilcoxon T-test were used. The differences were recognized as significant under $p<0.05$. During experiments the juvenile rats were kept together with their females. The study was conducted in accordance with the ethical principles of the Basel Declaration and the recommendations of the Committee on bioethics of Pavlov Institute of Physiology.

Citation: Albertin SV. Performance of food seeking behavior in rats of different age. Neurol Neurosci. 2021; 2(1):1-3.

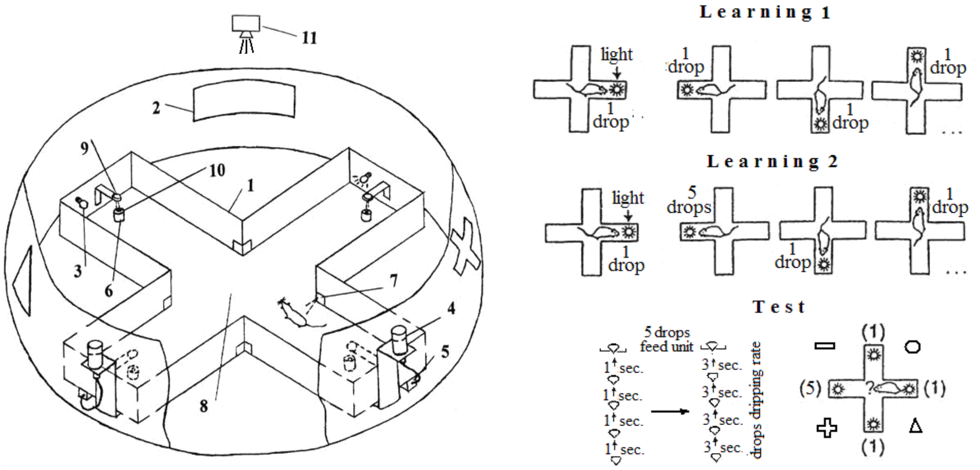


Figure 1. *Scheme of the radial maze and test procedure of rats. 1 – radial 4-arm maze; 2 – extramaze visual landmarks (geometric figures); 3 – intramaze signal (light bulbs); 4 – capacity with a pipeline for storage and supply of reinforcements in liquid form (milk); 5 – means for feeding reinforcement (solenoid); 6 – loci feeders; 7, 9 – infrared sensors to switch on the signal lights and drip feed system after approaching the animal to the trough; 8 – the central area of the maze; 10 – drip feed unit; 11 – video camera.*

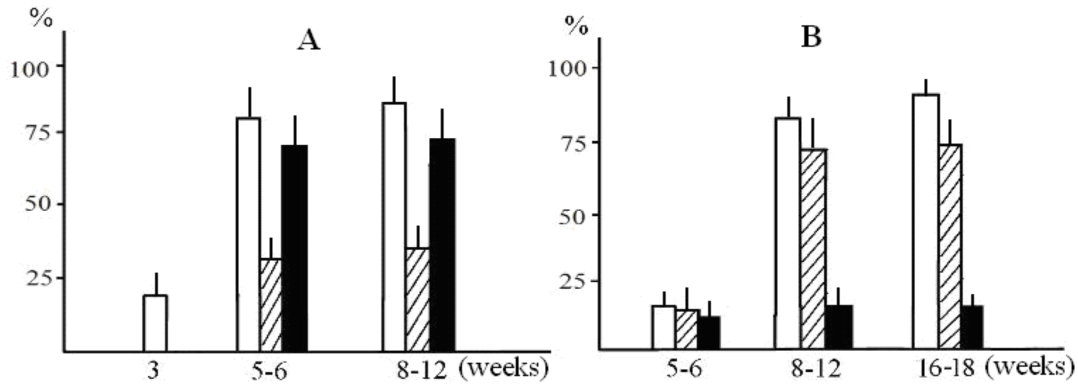


Figure 2. *Formation of selective attention to sensory signals (A) and the ability to form motor inhibition (B) in animals of different ages. On the abscissa axis – age of experimental rats; on the ordinate axis – the number of correct answers; light columns – intact animals; shaded – after injection of pilocarpine; dark – after injection of amphetamine.*

Results and discussion

The results of experiments demonstrated that intact juvenile rats are able for successful seeking of maximal food in the maze with the asymmetrical reinforcement at the age of 5-6 weeks using navigational landmarks located outside of maze (Figure 2A). However, under 5-6 weeks of age the rats were unable to solve this task under introducing the delay of maximal reinforcement between separate drops requiring formation the braking motor reactions and expectation the next portion of delayed reinforcement (so called impulsive or hyperactive type of responding). In case of impulsive responding the rats of this age were unable to wait at the feeder for the following portions of greatest reinforcement (5 drops of milk given in a row) preferring to run to the next arm of the maze to get only one drop of milk (Figure 2B).

The successful solution of the task with delay of reinforcement was observed in 8-12 weeks aged rats (the so-called reflexive type of responding). According to this type of responding the experimental animals become capable of generating a brake reaction while waiting for the next portion of reinforcement receiving as a result the maximally possible reward and minimizing the loss of energy directed to unprofitable seeking the reward in the maze. Injections of subcutaneous dose of pilocarpine resulting to change in the activity of hippo-campal neurons or amphetamine accompanied by an increase in the level of dopamine in the neo-striatum had in our experiments the different effects on the formation of processes of selective attention to navigatory landmarks or motor inhibition in animals of different ages. Particularly the injection of pilocarpine caused violation of selective attention on all studied terms (5-12 weeks) of postnatal development of rats regardless of the presence or absence of delay of reinforcement. At this low dose of pilocarpine, 45 mg/kg/d, no behavioral signs of epilepsy were observed in the animals (all rats presented with Racine's score of zero). Introduction of amphetamine in rats (8-12 weeks of postnatal development) caused predominant disorder of behavior with reinforcement of delay resulting to pronounced impulsive (hyperactive) behavioral responding.

The results of the experiments demonstrated that under complication of behavioral task tested it is possible to distinguish two groups of animals that differ in the character and rate of response ("impulsive" and "reflexive" types of behavior) as well as the rate of formation of selective attention reactions in the radial maze with asymmetric reinforcement. Thus, the adult animals demonstrate predominant "reflexive", and juvenile rats – "impulsive" type of responding. The impulsivity index in juvenile rats in comparison with adult animals varied significantly pointing to the different periods of morphologic and functional maturation of the brain brake systems in postnatal onto-genesis of rats. The rate of formation of selective attention reactions was increased with age in both groups of rats.

Behavioral experiments carried out on juvenile rats with using pharmacological probes demonstrated that the process of formation of selective attention to significant sensory stimuli and the development of the ability to form inhibitory motor reactions in rats tested under the delay of reinforcement appear at different age periods and probably to be controlled by different neuronal systems which include the hippocampus and striatum.

Our data related to the effects of the injection of a subcutaneous dose of pilocarpine on the ability of rats to choose the maze sleeve with the highest reinforcement is in agreement with electrophysiological studies [12-14] which showed a decrease in the theta activity of hippocampal neurons and associated brain structures after administration of small doses of pilocarpine which do not cause epilepsy in experimental rats. As shown by our previous studies [5,6] synchronization of pronounced theta activity of hippocampal neurons and ventral striatum was observed with the correct choice of rat preferred reinforcement in the radial maze. The results obtained in our experiments on juvenile animals and known data on clinical testing of children of different ages showed that nature of the responding under formation of selective attention reactions in juvenile rats has the common features with the typology of children responding. It gives a good opportunity to consider the juvenile animals with selective hippocampal and neostriatum injuries as an effective animal model of attention deficit and hyperactivity disorder, as well as successfully use a new developed method [12] for assessing attention disorders with hyperactivity in children and adolescents.

References

1. Albertin SV. Involvement of the nucleus accumbens in the formation of spatial behavior in rats in a radial maze. Neurosci Behav Physiol. 2003; 33: 777-781.
2. Albertin SV, Mulder AB, Tabuchi E, et al. Lesion of medial shell of n. accumbens impairs rats in finding larger rewards but spare reward seeking behavior. Behav Brain Res. 2000; 117: 173-183.
3. Packard MG, McGaugh JL. Inactivation of hippocampus or caudate nucleus with lidocaine differently affects expression of place and response learning. Neurobiol Learn Memory. 1996; 65: 65-72..
4. Eichenbaum H, Dudchenko P, Wood E, et al. The hippocampus, memory and place cells: is it spatial memory or a memory for place? Neuron. 1999; 23: 209-226. 1999.
5. Wiener SI, Shibata R, Tabuchi E, et al. Spatial and behavioral correlates in nucleus accumbens neurons receiving hippocampal or prefrontal cortical inputs. Excerpta Med Int Congr Ser Elsevier. 2003; 1250: 275-292.
6. Albertin SV, Wiener SI. Neuronal Activity in the Nucleus Accumbens and Hippocampus in Rats during Formation of Seeking Behavior in a Radial Maze. Bull Exp Biol Med. 2015; 158: 405-409.
7. Pennartz CM, Groenewegen HJ, Lopes da Silva PH. The n. accumbens as a complex of functionnally distinct neuronal ensembles: an integration of behavioral, electrophysiological and anatomical data. Progr Neurobiol. 1994; 42: 719-761.
8. Groenewegen HJ, Wright CG, Beijer AVJ. The nucleus accumbens: gateway for limbic structures to reach the motor system. Progr Brain Res. 1996; 107: 485-511.
9. Martin PD, Berthoz A. Development of Spatial Firing in the Hippocampus of Young Rats. Hippocampus. 2002; 12: 465-480.
10. Wills TJ, Muessig L, Cacucci Fr. The development of spatial behavior and the hippocampal neural representation of space. Phil Trans Royal Society B. 2014; 369: 20130409.
11. Cacucci F, Salinas P, Wills TJ. Hippocampus: Activity-Driven Maturation of Neural Circuits for Navigation. Current Biol. 2017; 27: R408-R430. 2017.
12. Albertin SV. Diagnosis of Attention Deficit Hyperactivity Disorder Using a Conditioned Reflex Approach. Neurosi Behav Physiol. 2011; 41: 906-911.
13. Chauviere L, Rafrari N, Thinus-Blank C, et al. Early deficits in Spatial memory and Theta Rhythm in Experimental Temporal Lobe Epilepsy. J Neurosci. 2009; 29: 5402-5410. 2009.
14. Francisco ES, Mendes-da-Silva RF, Lima de Castro CB, et. al. Taurine. Pilocarpine Interaction in the Malnou-rished Rat Brain: A Behavioral, Electrophysiological, and Immunohistochemical Analysis. Front Neurosci. 2019; 13: 981.
15. Racine RJ. Modification of seizure activity by electrical stimulation. II: motor seizure. EEG Clin Neurophysiol. 1972; 32: 281-294.2972. .