THE STUDY OF THE REASONING BEHAVIOUR IN DIFFERENT BEHAVIORAL TASKS

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Abstract. The current paper anticipates fixing the quantity of reasoning behavior in rats and the assessment of the frequency of correct and incorrect responses revealed in different experiments during food-obtaining behavior and passive avoidance memorization; defining its dynamics in the information processing and realization of this information. This is a scientific novelty of proposed research. In both experiments reasoning behavior is revealed in the same way: the animal stops the locomotion and begins head movement till decision making. When reasoning during the food-obtaining behavior rats estimate a correct decision go left or right toward the direction where the animal has obtained a piece of food in a previous trial. During the passive avoidance memorization rat reveals reasoning behavior toward and from dark chambers as well.

Key words: Reasoning behavior, difference behavioral tasks

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1. Introduction

Both humans and animals live in a rich worlds of events where some of them repeat themselves whereas other constantly change. Adaptively detecting and reacting to environmental variation is critical to its ultimate success. By their ability to learn, individuals adapt themselves to their own particular environment. Some animals exhibit a type of mental process which is not genetically determined and which is higher than learning, called Einsicht by Kohler, reasoning by Maier and symbolic processes by Morgan.

Early development of conception about animals reasoning ability is concerned with a name of Maier. Later his considerations was discussed by Dembovsky and Mening (see [10]). An extensive theoretical discussion of reasoning is given by Hull (1935). Hull also discussed whether the ability to solve the problem could be interpreted in terms of association theory. Animals reasoning behavior was considered by Beritashvili (see [4]) and Krushinsky (see [9]). Concerning with this actual question scientific papers published during the last years give an young estimate about rats reasoning ability.

Substantial advances have occurred in the last 20 years in how we think about the mechanisms underlying animal cognitive behavior. Today the actual subject of discussions among neuropsychologists and cognitive neuroscientists is peculiarity of reasoning, logical and rational behavior (see [9,15]), even metacognition in animals (see [2,4,6,14]). In thinking about animal rationality, it is useful to distinguish minimal rationality, doing something for reasons and doing something for good reasons, reasons that exhibit the behavior as contributing to goal attainment and desire satisfaction.

Modern comparative investigation of cognition contribute important and unique information to several important neuropsychological topics. Animal studies still our only means for exploring the relations between the cognitive and neural mechanisms of behavior (see [5,7]) and studying the evolution of mind and their underlying mechanisms.

The recent growth in interpretation of animals cognitive ability reflects certain trends. We should not forget Morgans (1984) canon: should we interpret an animals action as an outcome of a complex cognitive mechanisms if is simpler one will do. Overall, intensive study of animal cognitive mechanisms has been very successful and should be continued. It is required to examine a broader range and greater number of animal species by neuropsychologists. But they are faced with the dilemma validity of experimental methods for such studies. Sometimes restricting experimental situations may not permit our animals to display a full scope and power of their cognitive ability.

The current paper anticipates fixing the quantity of reasoning behavior in rats and the assessment of the frequency of correct and incorrect responses revealed in different experiments during food-obtaining behavior and passive avoidance memorization; defining its dynamics in the information processing and realization of this information. This is a scientific novelty of proposed research. In both experiments reasoning behavior is revealed in the same way: the animal stops the locomotion and begins head movement till decision making. When reasoning during the food-obtaining behavior rats estimate a correct decision go left or right toward the direction where the animal has obtained a piece of food in a previous trial. During the passive avoidance memorization rat reveals reasoning behavior toward and from dark chambers as well.

2. Materials and methods

2.1 Subjects

The subjects were naïve albino Wistar rats from our breeding colony weighing 250-300 g. at the time of experimental procedure. They were individually housed in plastic cages and maintained on a 12:12 h light/dark cycle at a constant temperature of 220C. Animals had ad lib access to food and water. All behavioral experiments were performed during the light phase of the light/dark cycle. Experimental procedures are consistent with the recommendations about animals' care and use designed by the Institutional Animal Care and Use Committee in accordance with the The Guide for Care and Use of

Laboratory Animals; 1999.

2.2 Apparatus

Passive avoidance conditioning apparatus consisted of two - a large A (illuminated) chamber with wall made of dark opaque plastic and a small B (dark) chamber with walls and ceiling made of black plastic. The floor of the large chamber was conditionally divided into 4 sectors; the floor of B chamber was made of stainless steel rods (2 mm diameter) spaced 1 mm. apart; the floor of the dark chamber could be electrified. Between the two chambers there was an opaque guillotine door. The apparatus was placed in an isolated room, kept at a constant temperature 220C. Illumination inside the lighted chamber was 60 lx.

Food-obtained behavior conditioning apparatus was a standard T-maze with the starting box and feeding ranks left and right.

2.3 Statistical analysis

The results are expressed as means and standard errors of the mean (S.E.M). Data were analyzed using analysis of variance (ANOVA) followed by Sheffe test for post-hoc comparisons ($P < 0.05$ was considered significant).The F-test were used to reveal whether the F ratio (F) of two variance estimates is significantly greater than 1 and to test the hypothesis that there is no differences between them (see [13]).

3. Procedure

3.1 Delayed reaction study method

Experiments for studying direct delayed reaction was undertaken in T-maze by modified method (see [11,12]). Food will be provided according to the time-spatial program, in conditions of fixed delay for each feeding rack and inter-trial interval throughout the whole experiment.

Daily test consists of two phases: a) pre-delayed reaction - during which the animal will be allowed to move between the feeding racks twice, *b*) delayed reaction, during which movement between the racks will be restricted. In case of an incorrect reaction, when the rack will be selected by mistake, the rat will be returned to the starting compartment without food obtaining and the next test will be started. In the pre-delayed reaction it will be necessary to provide food in one of the feeding racks.

Animal behavior will be described by sequence of 0 and 1. As a result, the data record will represent sequence of 0 and 1, which will make it possible to characterize animals behavior and identify algorithm of perception. 1 - means that the rat performs the action in 5 seconds time; 0 - means that researches interfered in the test. In choosing of feeding racks: 1 - means that the animal selects the rack where it has got food previously, 0 stands for the mistake.

3.2. Passive avoidance study method

Passive avoidance formation was carried out according to our modified method, which implied using of open field parameters for rats behavior multiparameter description.

Animals were given a 15 minute trial per day for 10 days. The test was divided into 60x5-min. intervals. Activity was measured by a number of passed sectors in A and transitions from A to B chambers. Reasoning behavior was registered toward both directions.

For habituation influence evaluation of passive avoidance formation experiments were carried out in three series: in I series rats were allowed free moving between the chambers during 5 days without deliverance of electric foot-shock. In II series foot-shock stimulus was presented on the first experimental day - after rats entered the B chamber, separator door was closed and electric foot-shock (20v) through electrified floor was delivered. After 30 sec. the door was opened and rats again were given possibility of free moving through the chambers. In III series rats were allowed free moving without painful irritation during 5-days and electric foot-shock was given on the 6th day when rats entered the dark B chamber. Passive avoidance memory retrieval ability was assessed 15-days later.

Such experimental approach gave us the possibility to compare passive avoidance reaction and reasoning behavior dynamic conformity in different experimental conditions - in presence or absence of habituation (latent learning).

4. Results

Rats behavior in T-maze was studied during 28 days. There was assessed dynamics of percentage of the days when the reasoning behavior has been revealed. The experiment has been divided into 7-day intervals (Fig.1). It was observed increasing in reasoning behavior percentage during T-maze task ($F(3, 24) = 4.21$, $p = 0,016$). Additional statistical test (Scheffe test) revealed a significant difference between 1-7 and 22-28 days. Reasoning behavior quantity before and after delayed reactions has been compared.

It has been shown that reasoning behavior quantity as well as its percentage before and after delayed reactions was increased toward the end of experiment. Statistical analysis confirmed reliability of increasing of reasoning behavior quantity as before ($F(3, 24) = 5.99$, $p < 0,003$) as after ($F(3, 24) = 8,034$, $P = 0,001$) delayed reactions as well. Advanced analysis (Scheffe test) has confirmed statistical significance of differences on exact days: on 22-28 and 1-7, also on 8-14 and 15-21 days. In our opinion such dynamics of reasoning behavior is concerned with latent learning. Supposition was confirmed by a thorough analysis of frequency dynamics of correct decision following the reasoning behavior before and after delayed reactions (Fig.2).

Frequencies of the correct responses following the reasoning behavior have been varied significantly only during delayed reactions ($F(3,24) = 7,531$, $p = 0,001$) and statistical trustworthiness has been revealed while comparing 1-7 $\leftrightarrow$ 22-28, also 8-14 $\leftrightarrow$ 22-28 days ($p = 0.02$ and $p = 0,013$ correspondingly).

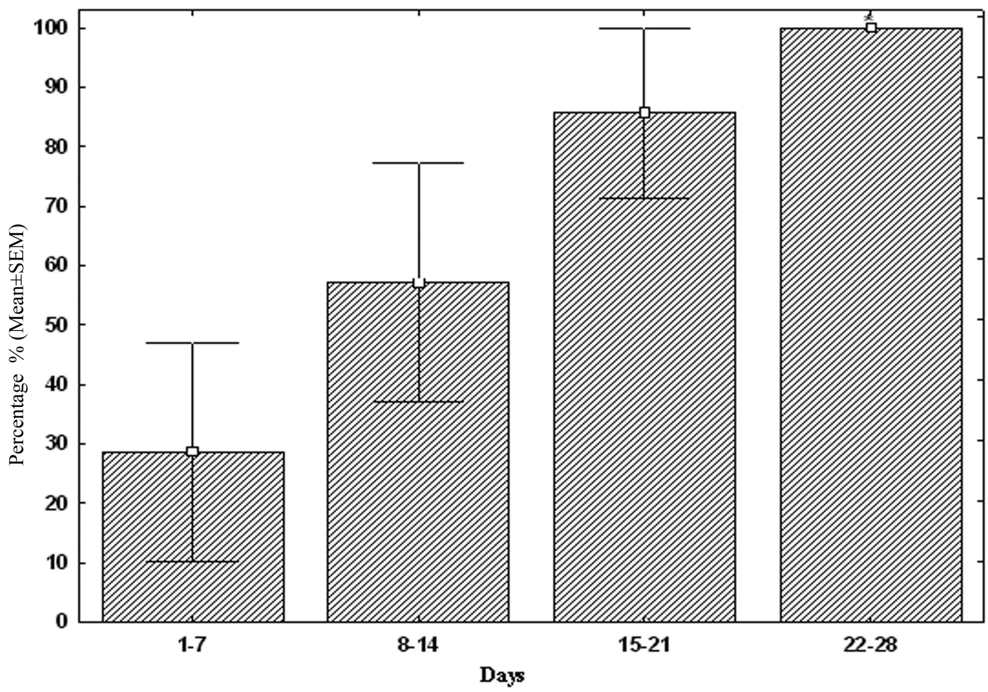

Fig. 1. Percentage dynamics of reasoning revealed in a maze by days (meanSEM). The experiment was divided into seven-day intervals and in each interval was estimated the percentage of those days when reasoning was revealed. It was stated that reasoning was observed every day towards the end of the experiment ($p < 0.05$).

The study of direct delayed reaction in T-maze by the method modified by us gives the possibility to assess food-obtain behavior by description of optimal and chaotic algorithms. At the initial stage of the experiment an optimal algorithm of food-obtain behavior had not been elaborated yet, accordingly, rats reveal reasoning behavior of less intensity. Therefore low frequencies of correct responses following the reasoning behavior are observed. In the second half of the experiment because of adaptation animals elaborated an optimal algorithm of food-obtain behavior. Consequently, reasoning behavior frequency increases. Behavioral algorithm is considered to be optimal if it promotes successful access of correct feeding-rack in minimal errors. Chaotic behavioral algorithm implies frequent intervention of experimenter in behavioral treatment.

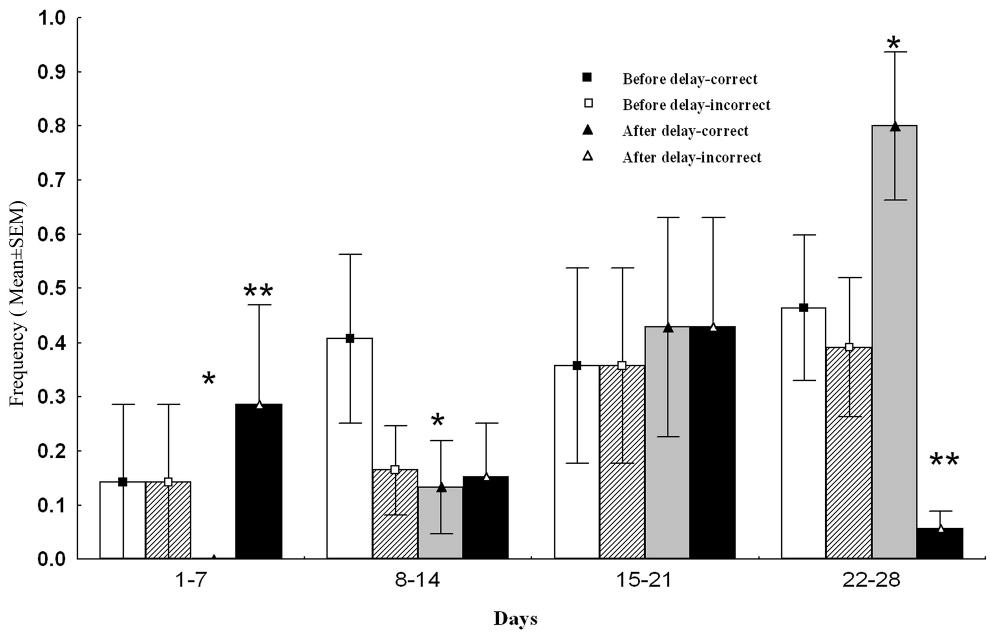

Fig. 2. Estimation of frequency of right and wrong pass in the maze after reasoning (ratio of number of right and wrong pass to the total number of reasoning). The certain statistical difference was observed between the frequencies of right passes performed only during delay. Besides The frequency of right passes in 22-28 days of the experiment is certainly different from the frequency of right passes in 1-7 and 8-14 days (i.e. in the starting and subsequent days) ($*p < 0.05$). It should be noted that the frequency of wrong passes exceeds the frequency of right passes in 1-7 days, while the frequency of right passes during delay certainly exceeds the frequency of wrong passes in 22-28 days ($**p < 0.05$ upon comparing frequencies of right and wrong passes).

During the above stated experiment rat reveals reasoning behavior only at making decision at T-junction - to go left or right where it has obtained food-ball. It is significant that rats fulfil reasoning behavior after latent learning of some extent. Quantitative conformities of animals latent learning is discussed in our recent article (see[11]).

Increasing of frequency of correct responses may be the consequence of virtual trials-errors accomplished by animals. Rats would remember food location and make correct decision on the basis of reasoning behavior (Fig.2). Reasoning behavior never occurred in the start box where the rats spend a long time; at feeding ranks; when they move away from feeding ranks on one's own or when experimenter turns them back to the starting box.

During the passive avoidance memorization there have been evaluated percentage of rats with reasoning behavior for each series (Fig.3), reasoning behavior to and from the dark chamber (Fig.4) and entrance and living-out quantity and frequency following the reasoning behavior. The preliminary obtained results of passive avoidance memorization tests gave us the possibility to

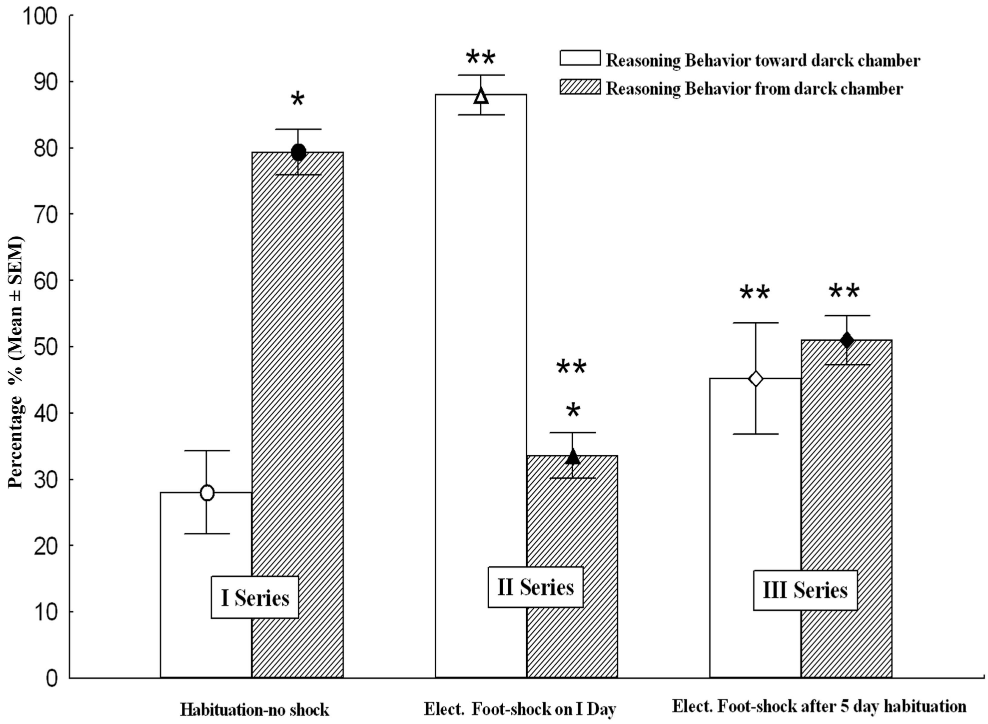

Fig. 3. Average percentage of rats with reasoning behavior in presence or absence of habituation during passive avoidance memorization.

adduce the following considerations: When comparing reasoning behavior conformities between the mentioned 3 series it becomes clear, that the rats showed significant difference between reasoning behavior from A toward dark $B(F(3,16) = 9,045,\ P = 0,001)$ and from dark B toward A ($F(3,16) = 8,23$, $P = 0,001$) chambers, between concomitant entrance ($F(3,16) = 4,47$, $P = 0,00001$) and leaving-outs ($F(3,16) = 8,64$, $P = 0,001$, $p < 0,05$). (Fig.3-4) Revealing of the difference between specific reasoning behavioral patterns was evaluated by Schefes test. A high correlation between reasoning behavior toward and from dark chamber and entrance and living-outs correspondingly has been revealed ($r = 0.72$ and $r = 0.9$).

In the I series when rats freely explored the chambers without painful irritation One-Way ANOVA showed significant higher percentage of rats with reasoning behaviour from dark chamber ($F(1,8) = 51,83$, $p < 0,05$) (Fig.3) and a high level of reasoning behavior from dark B chamber ($*p < 0,05$) (Fig.4), but there was not revealed a significant difference among entrance and leaving-outs frequencies following reasoning behavior. Following the reasoning behaviour toward the dark B chamber rats frequently enter but rarely leave ecologically comfortable condition and after reasoning prefer to stay in it.

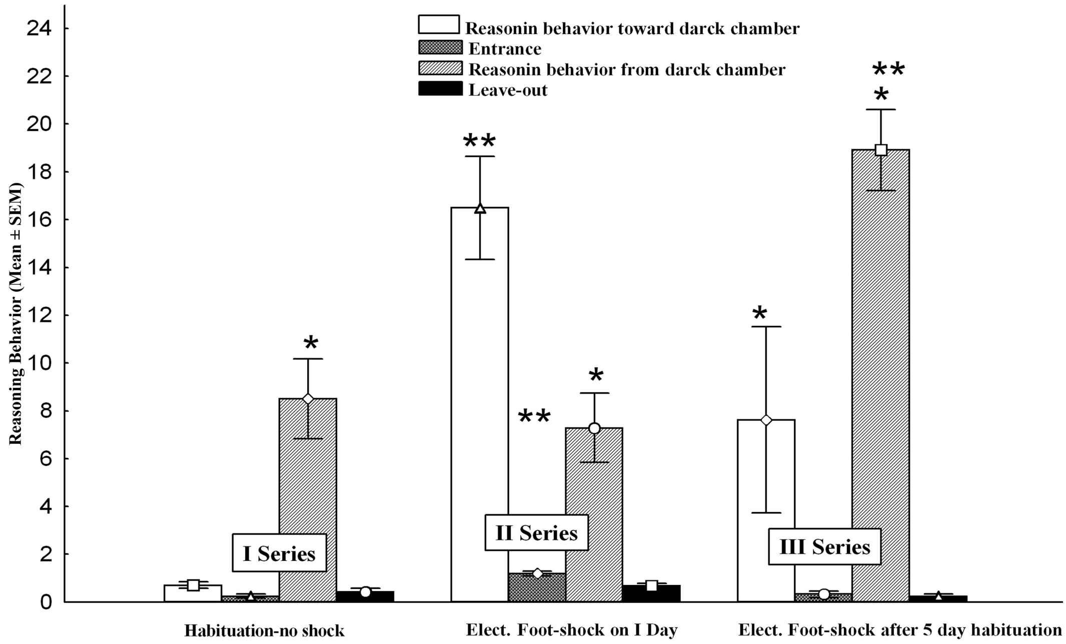

Fig.4. Reasoning behavioral patterns during during passive avoidance memorization task

In the II series after foot-shock deliverance on I day has been ascertained significantly higher percentage of rats with reasoning behavior toward the dark chamber ($F(1.8) = 142.5$, $p < 0.05$) (Fig.3). Rats displayed a high level of reasoning behavior from A toward dark B chamber (Fig.4), but concomitant entrance and leaving-out frequencies showed no significant differences. After the electric foot-shock deliverance rats still try to enter the dark B chamber but on the basis of memory remember the place of painful irritant and begin high intensive reasoning behavior - whether to enter the dark chamber or not. In comparison with the I series statistically reliable increased reasoning behavior toward the dark chamber and concomitant entrance quantity, but reasoning from dark chamber and leaving-outs showed no significant differences (Fig.4). There is clear evidence that in comparison with I series rats considerably frequently leave-out and rarely enter the dark B chamber following reasoning behavior.

In the III series as in the II series, upon electric foot-shock deliverance after 5-day preliminary habituation the percentage of rats with reasoning behavior is higher again (Fig.3). The level of reasoning behavior toward the dark B chamber prevails the reasoning from it. In the presence of reasoning behavior from outside rats of the III series prefer to stay in the illuminated department but after reasoning behavior from the dark chamber they choose not leave the dark chamber (Fig.4).

5. Discussion

Experimental data demonstrate the presence of reasoning behavior in white rats in different behavioral tests. During studying of direct delayed reaction in T-maze if rats retrieve food location with difficulty, they begin reasoning to choose the correct decision. As the rodents prefer to stay in the dark place, during passive avoidance memorization they reveal species specific behavioral motivation to find an ecologically suitable niche in the test cabin. Therefore motivated decision is preceded by reasoning behavior. It becomes more intensive after deliverance of painful electric foot-shock in the dark chamber. In this case the causal factors of reasoning behavior represent satisfaction motivation of both - innate species specific and passive defensive behaviors. In I series in absence of painful irritant rats reveal intensive reasoning to leave the dark chamber but for the animals mostly stay inside. In II series the entrance into the dark chamber before deliverance of electric foot-shock is caused by fixed complex of activity (instinctive behavior). After painful irritation on the 1st day rats try enter the dark department again but they remember foot-shock location on the basis of short-term memory. Therefore animals reveal intensive reasoning whether enter or not the dark department. The above discussed behavioral conformities demonstrate interaction of competitive behavioral strategy. In case of painful foot-shock deliverance after 5-day habituation (III series) reasoning from inside predominates over reasoning behavior toward the dark chamber. Such difference between II and III series might be consequence of less effect of painful irritation on rats emotional state in the presence of preliminary habituation.

Rats reasoning behavior in appearance resembles an orientating reflex but for the revealing of this reflex there must be the presence of fresh environmental stimulus. In both experiments before the reasoning behavior new stimulus had not presented. Reasoning behavior is guided by a psychoneurological process. Such behavior has been studied by Iv. Beritashvili (see [4]). It is the author's opinion that during automated food-obtained behavior, reaching the feeding rank the animal stops and begin reasoning behavior in case of new stimulus exposure. In the conducted research the short-term memory problems in food-obtained task and painful irritant influence represent the cause of intensive reasoning behavior.

On the basis of the obtained results we can ascertained that: 1) Rats reveal reasoning capability upon decision making both in the presence or absence of painful irritant. 2) Reasoning behavior is revealed in a similar way in various experimental conditions (during testing direct delayed reaction or passive avoidance memorization); 3) For the most part the rats make appropriate decisions that is the basis of adaptation to environmental conditions.

Changeable environment, where the large majority of events subordinate to probabilistic laws, there is the necessity for analysing and reasoning of incoming events. Preference of individuals will be obtained by the ability to make correct decisions on the background of memory and reasoning behavior that is very important for adaptation.

Rats propensity to reasoning behavior provides an avenue for revealing the neuropsychological basis of reasoning processes and can also be used as an assay of brain cognitive function. The revealing of reasoning behavior conformities promotes explanation of its role in the formation of correct behavioral strategy and relations between cognitive processes and neurophysiologic mechanisms of behavior consequently.

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