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PRIMATOLOGY

Study the Differences between the Parameters of Learning and Exploratory Activities in Adult Male Rhesus Monkeys (*Macaca mulatta*) and Baboon Hamadryas (*Papio hamadryas*)

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We studied exploratory activity and learning ability in sexually mature male rhesus monkeys (*Macaca mulatta*) and hamadryas baboons (*Papio hamadryas*). The interspecies differences were analyzed by the following parameters: the level of exploratory activity, diversity of exploratory activity, concentration on the object, learning ability, training levels, and dynamics of learning. The studied group of hamadryas baboons showed higher levels of exploratory activity and learning ability than the group of rhesus monkeys.

Key Words: *rhesus monkeys; hamadryas baboons; exploratory activity; variety of exploratory activities; training*

The study of the cognitive abilities of primates is a priority area in modern science. The results obtained in this field make it possible to answer a number of fundamental and applied questions of comparative psychology, anthropology, and other sciences [4]. At the same time, learning ability and the level of exploratory activity can be considered as the main characteristics of the cognitive abilities in different primate species [5]. It should be noted that despite cognitive abilities of rhesus monkeys are extensively explored, most works can be characterized as applied studies focused on various aspects of biomedicine, and only a small part of them is devoted to the study of the cognitive abilities of these monkeys [12]. Studies of the cognitive abilities of hamadryas baboons are very scanty [8]. Similarly, there are only few experimental studies aimed at studying the exploratory activities of various species of primates [6,10]. Noteworthy is the fact that the effectiveness of applied research based on the results of cognitive testing of laboratory primates largely depends on the choice of experimental animals. Considering that macaques and baboons are widely used as laboratory primates [7,9,11], the comparative study of their cognitive abilities is obviously a prerequisite for correct selection of experimental animals and improving the efficiency of these studies.

Our aim was to analyze the differences between learning and research performance in mature male rhesus monkeys and hamadryas baboons.

MATERIALS AND METHODS

All experiments were carried out in accordance with the GOST 33215-2014 (Guidelines for Accommodation and Care of Animals. Environment, Housing and Management) and were approved by permission was obtained from the Ethics Commission of the Research Institute of Medical Primatology.

Sexually mature male rhesus macaques (n=12) and hamadryas baboons (n=10) were used in the study. All animals were born and kept before the start of the

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experiment in the open-air cage groups of the monkey nursery of the Research Institute of the Medical Primatology. The Adler Primatological Center uses a method of keeping monkeys, which assumes maximum correspondence of the social structure of groups and the mechanism of exchange of individuals between the species-specific groups with minimal intervention of the personnel into the life of groups (daily feeding and cleaning and annual preventive examination of the animals). All monkeys used in the study were experimentally naive. The study began from isolation of the animals from their native groups in individual cages, where they adapted to individual housing and constant presence of a human without training or domestication. After the 2-week stage of adaptation to individual housing, testing of the animals began.

The exploratory activities were tested using the "reaction to a new object" paradigm. The essence of this technique is as follows: the animal is provided with an object, the key characteristic of which is novelty. In this study, a multi-colored plastic cube (15×15×15cm) was used as an object. The animal was given 300 sec to explore each object. The tests were videotaped. The duration of the contact and the variant of the form of contact with the object were recorded. Experimentally, we identified the following types of animal contacts with an object: touching, turning over, holding, tightening, shaking, picking, pushing, moving, throwing out, gnawing, licking, examining, and sniffing. Termination of contact with the object was marked as "left".

Exploratory activity was assessed according to the following characteristics: 1) diversity of activities expressed in the number of variants of contact with the object; 2) level of exploratory activity expressed as the total time of animal contacts with the object; 3) concentration on the object expressed as the mean duration of episodes of contact with the object.

Learning ability was assessed using the skill formation methodology [3]. In brief, the animal was presented a food reinforcement (in this case, an apple) and 2 containers; then, an opaque partition was placed between the animal and the reinforcement, behind which the reinforcement is placed in one of the containers (in this case, in the left one); then, the partition was removed and the animal was allowed to choose one of the two containers. The training was carried out during 1 session consisting of 50 presentations (1 min each); correct (+) and incorrect (-) solutions were recorded. The analysis of the obtained results was carried out according to the following parameters: 1) learning ability expressed in the total number of correct decisions; 2) training level characterizing the learning outcome expressed in the maximum number of continuous correct decisions; 3) dynamics assessed as the number of correct decisions and refusals separately for each of 50 presentations for all monkeys followed by the formation of time series. In addition, the mean value was calculated over intervals for 10 presentations and the rate of increase in the number of correct decisions over the intervals was determined.

Statistical analysis was performed using Microsoft Office Excel 2010 and Statistica 6.0 (StatSoft, Inc.). Significance of differences was evaluated by the Mann—Whitney U test at $p \leq 0.05$; the Pearson correlation coefficient (r) was calculated. The data were presented as $M \pm SEM$.

RESULTS

Analysis of the parameters of exploratory activity and learning ability in the studied groups of rhesus monkeys and hamadryas baboons revealed an unambiguous regularity: hamadryas baboons demonstrate higher results than rhesus monkeys; the differences in the diversity of exploratory activities, and especially in learning ability and training level were significant (Table 1).

The differences in the indicators of exploratory activity and skill formation between rhesus monkeys and hamadryas baboons were in good agreement with the data obtained by us earlier in assessment of experimental activity, manipulative activity [1,2]. This fact, apparently, can attest to higher level of cognitive abilities of adult male hamadryas baboons compared

TABLE 1. Mean Values of Indicators of Exploratory Activity and Skill Formation in Rhesus Monkeys and Hamadryas Baboons ($M \pm m$)

Parameter	Rhesus monkeys	Hamadryas baboons	Mann—Whitney U test
Diversity (patterns)	3.3±0.5	5.5±0.6	25.5*
Activity, %	43.3±9.0	52.6±10.8	48.0
Concentration, %	28.5±7.9	31.9±10.7	58.0
Learning ability, %	68.5±5.8	90.4±1.6	21.5*
Training level, %	29.3±8.5	65.4±7.8	18.0*

Note. *$p \leq 0.05$.

TABLE 2. Dynamics of Skill Formation in Rhesus Monkeys and Hamadryas Baboons (*M*±*m*)

Interval	Rhesus monkeys			Hamadryas baboons		
	interval mean, %	difference between the means for adjacent intervals, %	rate of increase	interval mean, %	difference between the means for adjacent intervals, %	rate of increase
1	51.7±3.7	—	—	69.0±4.1	—	—
2	60.0±4.8	8.3 (*U*=33.5)	16.1	94.0±1.6	25.0 (*U*=3.0*)	36.2
3	70.0±4.3	10.0 (*U*=33.5)	16.7	97.0±1.5	3.0 (*U*=35.0)	3.2
4	82.5±4.0	12.5 (*U*=24.0*)	17.9	97.0±1.5	0.0 (*U*=50.0)	0.0
5	78.3±3.6	4.2 (*U*=37.5)	-5.1	95.0±2.2	2.0 (*U*=43.5)	-2.1

Note. *$p \leq 0.05$ (MannWhitney *U* test).

to adult male rhesus monkeys. This conclusion, to a certain extent, is also confirmed by the results of the analysis of the dynamics of learning (Table 2). In rhesus monkeys, the number of correct decisions gradually increased up to the fourth interval when the most intense and reliable increase in the number of correct decisions was observed. In hamadryas baboons, the most intense and significant increase in the number of correct decisions was observed as soon as in the second interval of presentations and remained at the maximum level up to the fourth interval. After that, the number of correct decisions did not increase in both rhesus monkeys and hamadryas baboons.

The analysis of the correlation values between the investigated indicators of exploratory activity and skill formation showed the following. In rhesus monkeys, there are high correlation values between three indicators of exploratory activity: activity and diversity (r=0.8), concentration and diversity (r=0.7), and concentration and activity (r=0.9). In addition, there is a high correlation between two indicators of skill formation: learning ability and training level (r=0.7). At the same time, the relationship between indicators of exploratory activity, on the one hand, and indicators of skill formation, on the other hand, was extremely weak (from r=0.1 to r=0.2). In other words, in the studied male rhesus monkeys, the level of exploratory activity and skill formation are two loosely coupled cognitive abilities.

For hamadryas baboons, the picture was not so unambiguous. The relationships between three different indicators of exploratory activity were weaker than in rhesus monkeys (r=0.3 between concentration and diversity and r=0.6 between activity and diversity), except the correlation between the level of activity and concentration on the investigated object (r=0.8). In hamadryas baboons, the level of correlation between two indicators of skill formation, learning ability and training efficiency (r=0.4) was almost twice lower than in rhesus monkeys. Moreover, high correlation between some indicators of exploratory activity and skill formation: a relationship between learning ability and diversity of exploratory activities (r=0.7), between the level of learning ability and the level of exploratory activity (r=0.6). Nevertheless, in hamadryas baboons, as well as in rhesus monkeys, we observed weak relationships between the level of skill formation and the level of concentration on the object (r=0.3), as well as between the level of skill training and all indicators of exploratory activity (from r=0.3 to r=0.4). Thus, the analysis of the relationship between the cognitive parameters of baboons and macaques showed that the relationship between different indicators of exploratory activity and different indicators of skill formation in hamadryas baboons was less pronounced than in rhesus monkeys, while the relationship between some indicators of exploratory activity and skill formation was more pronounced than in rhesus monkeys.

Thus, we concluded that the studied group of hamadryas baboons demonstrates a higher level of exploratory activity and better learning ability than the studied group of rhesus monkeys. The differences in the learning ability between the studied groups of monkeys were primarily determined by the speed of learning. The relationship between the level of exploratory activity and the level of learning ability observed in the group of hamadryas baboons in this work is ambiguous. It is obvious that additional research is required to clarify this thesis.

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