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DISTINCTIONS IN THE NEURONAL ACTIVITY OF THE RABBIT LIMBIC CORTEX UNDER DIFFERENT TRAINING STRATEGIES*

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Limbic cortex neurons as well as the temporal characteristics of the behavioral cycles were recorded in rabbits trained to perform a food-procuring behavior according to different strategies which were distinguished by the sequence of the stages of training. It was demonstrated that additional activations can appear in the nonspecific activity of neurons specialized relative to one of those behavioral acts for which the animal was trained directly in the experimental cage. Such activations appeared, depending upon the training strategy, during different types of the animal's behavior; the temporal characteristics of the behavioral cycles also varied. An inference is drawn regarding the activating influence of preceding experience on the behavioral acts formed directly after it.

Nerve cells have been found in recent years in neurophysiological experiments, both in animals and in man, whose activity entirely corresponds to the notion of J. Konorsky [6] regarding gnostic neurons, i.e., neurons associated with the storage and use of elements of life experience. In particular, E. T. Rolls et al. [13, 16] have demonstrated neurons of monkeys which were specifically activated only in response to slides of certain faces, and, moreover, to the face of a particular person at various visual angles and at various distances. G. Heit et al. [14, 15] have discovered in man neurons which are specifically activated in response to certain words. Neurons which were specifically activated during the performance of certain behavioral acts have been described in the experiments of many authors [8, 17, 18]. In our view, the activation of neurons only when a specific face is shown, when a specific word is spoken or heard, or when a specific behavioral act is performed, is associated with their specialization relative to elements of life experience, and reflects the use of these elements in a specific behavior [7, 4].

The activity of all types of the specialized neurons indicated above, independent of difference in behavioral situations, may be characterized by common features, among which the presence of dramatically pronounced activation of the neuron during the use in behavior of concrete experience which is specific for a given neuron (specific activation) is determinant. Specific activation exceeds the activity in the remaining behavior (nonspecific activity) several-fold with respect to the frequency of impulse activity. The latter [i.e., the nonspecific activity], in its turn, is distributed non-monotonically, i.e., additional activations or inhibitory pauses are detected in it when other elements of experience are used; this is apparently associated with the existence of specific relationships between elements of life experience.

In connection with the results we previously obtained regarding the reflection in the nonspecific activity of neurons of the history of an animal's training [4, 5], we have attempted to determine how various strategies of learning influence the formation of the pattern of nonspecific activity of specialized neurons.

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METHODS

Rabbits (sexually mature chinchillas, weighing about 3 kg) were trained to a food-procuring instrumental behavior in a cage with two food dispensers and two pedals at the corners (Fig. 1). In order to obtain food from a food dispenser, the rabbit had to press a pedal in the corner of the experimental cage which neighbored it. The effectiveness of pedal pressing was varied by the experimenter every 10-20 runs of the rabbit along each wall of the cage from the pedal to the food dispenser and back. Two different strategies were used during the training of the animals. In accordance with strategy I, rabbits Nos. 1 and 2 were first trained to obtain food from the right food dispenser, and then to press the right pedal for food to appear in the food dispenser. The same procedure was then repeated on the left side of the experimental cage, i.e., the rabbit was trained to get food from the left food dispenser, and then, to press the left pedal for the food to appear in the food dispenser. Thus, the rabbit was first trained to the cyclical behavior along the right side of the cage, and then along the left. In accordance with strategy II, the training of rabbit No. 3 was carried out in a different sequence: at first it was trained to get food from the left food dispenser, then from the right. The next stage was training to press the right pedal, then the left. Another group of rabbits was trained using the same strategies, but the training was begun from the opposite side of the experimental cage. Thus, rabbits Nos. 5 and 6 were trained in accordance with strategy I, starting with the left food dispenser, while rabbits Nos. 7 and 8 were trained in accordance with strategy II, but began with the right food dispenser. Thus, seven animals were used in the experiments, trained to a food-procuring behavior following two strategies: food dispenser 1 — pedal 1 — food dispenser 2 — pedal 2 (strategy I); food dispenser 1 — food dispenser 2 — pedal 2 — pedal 1 (strategy II).

The spike activity of single neurons of the limbic region of the cortex (P = 8-10, L = 2-3, according to atlas [12]) was recorded in the trained animals by means of glass microelectrodes filled with a 3 M solution of KCl, with a tip diameter 1-3 μm and a resistance 3-7 MΩ, at a frequency of 1000 Hz. The search for neurons was accomplished using the remote embedding of the microelectrode by means of a micromanipulator fixed to the animal's head. The neuronal activity, as well as the behavioral markers, were recorded on a Nihon Kohden (Japan) tape recorder with subsequent reproduction on paper, reduced 10-fold. The behavior of the rabbit was recorded concurrently on a video tape recorder. The statistical analysis of the data obtained was carried out on a Sega 3000 (Japan) personal computer.

The principal criterion for the selection of neurons for the analysis was the duration of recording of the neuron; those neurons were selected which could be recorded in no less than five behavioral cycles of the animal on each side of the cage.

Two independent indices were selected for the characterization of the activity of the neuron: the mean frequency of the spike activity of the neuron in a specific behavioral act, and the probability of the presence of activation in this act. Preliminarily each behavioral cycle, i.e., the segment of behavior between two successive seizures of a portion of food from the same food dispenser, was divided into five behavioral acts in accordance with the behavioral markers. Thus, the following acts were distinguished in the behavioral cycles on the left side of the cage: 1) chewing of food in a comfortable posture and/or the beginning of turning toward the pedal (prior to the turning marker); 2) approach to the pedal (from the turning marker to the pressing of the pedal); 3) pressing the pedal; 4) approach to the food dispenser; 5) the animal's muzzle being in the food dispenser and the seizure of food. Analogous acts (1'-5') were distinguished in the behavioral cycles on the right side of the cage (Fig. 1). The corresponding numbers of the acts are indicated along the abscissa in all of the graphs which represent the patterns of activity of the neurons in the behavioral cycles (the mean frequency of the activity of the neuron in a given act, normed relative to the frequency of the activity in the specific act, is given along the ordinate). We consider a specific act to be that behavioral act relative to which the given neuron is specialized. The presence of activation of the neuron during each realization of the given act in the behavior served as the criterion of specialization of the neuron relative to the behavioral act [3].

Graphs which make it possible to assess the activity of the neuron in each act of the behavior being studied over the course of the entire period of recording were plotted for all of the neurons analyzed. The significance of the differences of the activity of the neuron in the acts was determined on the basis of the Student t test through comparison of the mean frequencies of the activity for each pair of acts.

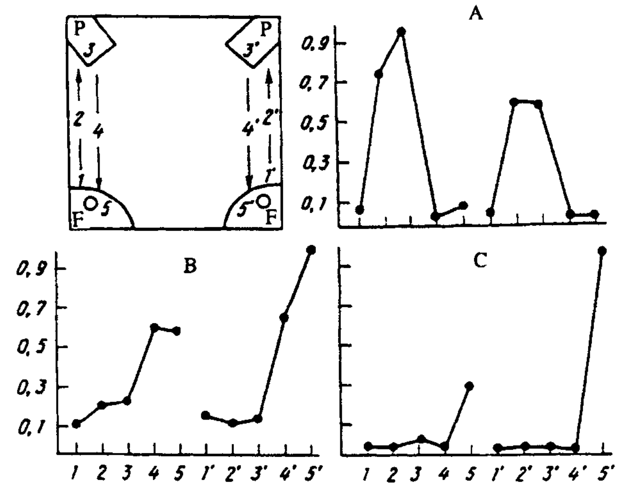

Fig. 1. Patterns of the activity of neurons demonstrating influence of the factor of commonality of goal. Above on the left, diagram of the experimental cage; P) pedals; F) food dispensers; arrows) movements of the animal during the accomplishment of food-procuring cycles; numerals) behavioral stages distinguished. A) Averaged activity of the neuron specialized relative to the approach to and pressing on the left pedal; B) relative to the approach to and seizure of food from the right, and C) from the left food dispenser. Here and in succeeding figures) along the abscissa) numbers of the behavioral stages (behavioral acts); along the ordinate) average frequency of the activity, normed with respect to the frequency of impulse activity in the specific act.

INVESTIGATION RESULTS

Features of the Behavior of Rabbits Trained in Accordance with the Different Strategies. For the purpose of identifying a possible relationship of the duration of the food-procuring cycle of the animal along each side of the cage to the learning strategy, the duration of all behavioral cycles on the left and right sides were averaged for each rabbit. The data obtained are presented in Table 1. As can be seen from Table 1, significant differences of the duration of the cycles on the different sides of the experimental cage were found in rabbits Nos. 1 and 5, while in rabbit No. 6 a tendency toward a significant increase in the duration of the cycles on the right side of the cage as compared with the left was detected. All of these rabbits were trained in accordance with strategy I, i.e., during training in the food-procuring behavior, a complete behavioral cycle was formed in them at first on the one side of the cage, and only then was the formation of behavior on the second side embarked upon. It is easy to appreciate that the shorter duration of cycles was observed on the side in which the animal's training was begun. With regard to the rabbits trained according to strategy II, i.e., with the alternation of training to the individual stages on different sides of the cage, significant differences in the duration of the cycles on the right and left sides of the cage were not found for them.

Neuronal Activity. Types of Specializations. We recorded the activity of 808 neurons in seven rabbits. For subsequent analysis 543 neurons were selected; 285 of them proved to be specifically associated with the accomplishment of acts of a specific food-procuring cyclical behavior; it was not possible to discover such an association in the activity of 258 neurons. The number of neurons of different types of specialization is shown in Table 2. Neurons specialized relative to those behavioral acts which were formed only in the experimental cage during the animal's training to the food-procuring behavior were of special interest for us. We classified approaching the pedal and pedal pressing, as well as obtaining food from the specific food dispenser, as such behavioral acts, since the rabbit saw the pedals and learned to differentiate the food dispensers for the first time in the experimental cage. More than half of all of the specialized cells analyzed by us (161 out of 285) proved to be neurons of such "pedal" and "single food dispenser" specializations; this confirms the inference we previ-

TABLE 1. Average Duration of Behavioral Cycles of Rabbits Along the Right and Left Sides of the Experimental Cage

Rabbit number	Side of cage on which training began	side 1 m ± σ	side 2 m ± σ	t Test value	p
1	Right	7004,8 msec ±2071,6 msec	7680,4 msec ±2407,6 msec	2,3	0,024
2	»	6737,4 msec ±2139,0 msec	6599,3 msec ±2266,5 msec	—0,45	0,656
3	Left	5758,8 msec ±2182,9 msec	5885,4 msec ±2312,6 msec	0,41	0,685
5	»	5579,3 msec ±1631,4 msec	6868,9 msec ±1847,8 msec	5,39	0,001
6	»	6079,7 msec ±1608,6 msec	6513,8 msec ±1892,2 msec	1,79	0,077
7	Right	6395,3 msec ±1277,3 msec	6482,6 msec ±1408,5 msec	0,46	0,65
8	»	8221,2 msec ±3326,8 msec	8150,3 msec ±3534,9 msec	—0,15	0,88

TABLE 2. Number of Neurons of Different Types of Specialization

Type of specialization	Number of neurons
"Pedal"	
Approach to specific pedal	48
Approach to and pressing specific pedal	23
Pressing specific pedal	15
Approach to and pressing both pedals	6
"Food dispenser"	
Approach to specific food dispenser	24
Approach to and seizure of food in specific food dispenser	20
Seizure of food in specific food dispenser	25
Approach to and/or seizure of food in both food dispensers	27
"Neurons of place," "neurons of movements"	12
Various head movements	32
Diverse turns of rabbit's body	47
Gnawing and chewing	6
Total of specialized neurons	285

ously drew [8, 19] regarding the preferred representation in the limbic cortex of neurons specialized relative to the newest behavioral experience. The majority of these were specialized relative to approach to and/or pressing on one of the pedals, and somewhat less relative to the approach to and/or seizure of food from a specific food dispenser.

PATTERNS OF NON-SPECIFIC ACTIVITY

Neurons of identical behavioral specialization exhibited fairly similar patterns of activity in the behavioral cycle containing the specific act, and highly diverse patterns in the behavioral cycle on the other side of the cage. At the same time, several most typical variants among the different variants of the nonspecific activity can be distinguished, and factors can be identified which promote the appearance of additional activation of the specialized neuron.

Commonality of Goal. The appearance of this factor in the activity of the neuron is characterized by the fact that in a behavioral act analogous to the specific behavioral act, weak activation of the neuron was observed on the other side of the cage. Thus, in neurons specialized relative to the seizure of food from the right food dispenser, weak additional activation is observed during the seizure of food from the left, while in the cells specialized relative to approach to and pressing on the right pedal, additional activation is seen during the approach to and pressing on the left pedal. Examples of patterns of this type, of the activity of neurons of various specializations, are shown in Fig. 1. In the upper left part of Fig. 1 is depicted a

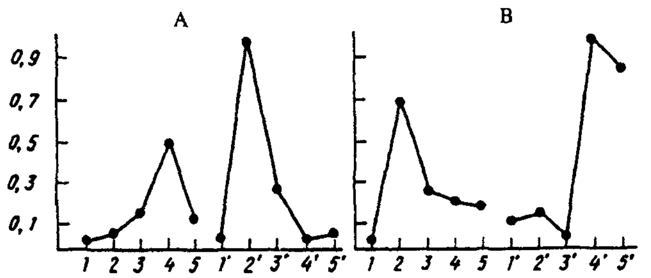

Fig. 2. Patterns of activity of neurons demonstrating the influence of the factor of commonality of movement. A) Averaged activity of a neuron specialized relative to the approach to the right pedal; B) relative to the approach to the right food dispenser and to the seizure of food from it.

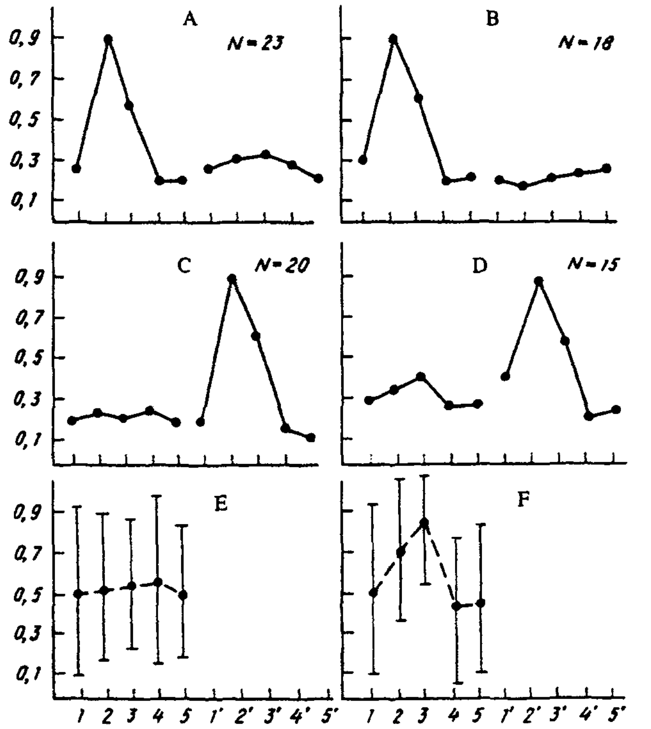

Fig. 3. Patterns of activity of "pedal" neurons as a function of training history. Collective activity of neurons specialized relative to pressing on the first (A, B) and second (C, D) pedal in the order of training in rabbits trained according to strategy I (A, C) or II (B, D); E) Collective activity of neurons represented in C, in nonspecific acts, normed with respect to the maximal frequency of activity on its side, with confidence intervals; F) the same for neurons represented in D; N) number of neurons in the averaging.

diagram of the experimental cage in which the movements of the animal during the accomplishment of food-procuring cycles are indicated by arrows, and the numbers of the acts used in the plotting of the graphs are designated. The averaged patterns of activity of specific neurons of various specializations, in the activity of which the effect of the factor of commonality of goal is manifested, are shown in the three graphs. Thus, in A, the pattern of the activity of a neuron specialized relative to approach to and pressing the left pedal (acts 2 and 3) is shown. It can be seen that activation during the approach to and pressing the right pedal (acts 2′ and 3′) is observed on the other side, but the frequency of the impulse activity in these acts is substantially lower. The pattern of activity of a neuron specialized relative to the approach to and seizure of food in the right

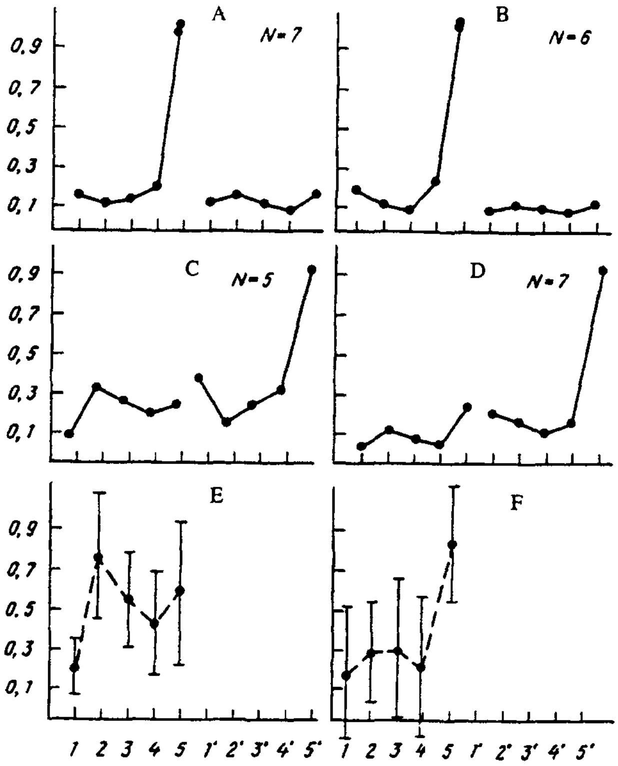

Fig. 4. Patterns of activity of "food dispenser" neurons as a function of training history. Collective activity of neurons specialized relative to the seizure of food from the first (A, B) and second (C, D) food dispensers in the order of training in rabbits trained according to strategy I (A, C) or II (B, D); E) collective activity of neurons represented in C, in nonspecific acts, normed with respect to the maximal frequency of activity on its side, with confidence intervals; F) the same for neurons represented in D.

food dispenser (acts 4′ and 5′), in which activation during approach to the food dispenser and seizure of food (acts 4 and 5) is also observed, is represented in B. The similarity of the diagram of the pattern of activity on both sides of the cage can also be seen from graph C, in which the pattern of activity of a neuron specialized relative to the seizure of food from the right food dispenser (act 5′) is represented. In the activity of patterns represented, the manifestation of the factor of commonality of goal appears as the identical form of the curve in the left and the right cycles with a difference in the amplitude of the peak of the activity. This factor is manifested most dramatically in the activity of neurons which were specialized relative to both analogous acts of cyclical behavior (two pedals, two food dispensers).

Commonality of Movements. In addition to neurons that were highly specialized relative to specific movements of the animal, we recorded a large number of cells in which additional activation was manifested in the nonspecific activity during a movement of the animal which was similar to its movement during the accomplishment of the specific behavioral act. Thus, some neurons which were specialized relative to approach to the right pedal were additionally activated during the approach of the rabbit to the left food dispenser, i.e., during an analogous turn to the left, just as in the case of cells specialized relative to the approach to the right food dispenser, during the approach to the left pedal (turn to the right). The direction of the turn of the animal's body was the common parameter of these acts. Examples of the patterns of activity of individual neurons for which the influence of this factor was significant are shown in Fig. 2. In the activity of the neuron represented in Fig. 2A, specific activation is observed in act 2′ (approach to the right pedal), while additional activation is observed in act 4 (approach to the left food dispenser), which, as in the case of the specific act, was accomplished through a turn of the rabbit's trunk to the left. The neuron represented in Fig. 2B was specialized relative to approach to the right food dispenser and seizure of food in it (acts 4', 5'). Additional activation was also observed in it when the animal was on the other side and during the turning of the body to the right (act 2, approach to the left pedal), as it was in the specific act. Additional activation during turning to the same side as in the specific act is present in the activity in each of these neurons. However, by contrast with cells specialized relative to turning in a particular direction, the activity in these neurons during the approach to the pedal and approach to the food dispenser differed significantly.

Factor of Training History. We compared the patterns of activity of neurons specialized relative to behavioral acts formed during training in the experimental cage for different learning strategies of the animals.

The averaged patterns of activity of neurons specialized relative to the approach to and pressing on a specific pedal are represented in Fig. 3 as a function of the sequence of the formation of the given act in the training history (first or second pedal in the sequence of formation of the stages of the behavior) and as a function of the animal's learning strategy (rabbits Nos. 1, 2, 5, and 6 and Nos. 3, 7, and 8). The patterns of activity of neurons specialized relative to the approach to and pressing on the first pedal in the order of training are represented in Fig. 3 in the case of the training of the animal in accordance with strategy I (A) and II (B). It can be seen that the activity in the nonspecific acts is approximately identical (activity in acts 1'-5' did not differ significantly). The patterns of activity of neurons specialized relative to the approach to and pressing on the second pedal in the order of training during training according to strategy I (C) and strategy II (D) are shown below. By contrast with the uniform activity in acts 1-5 in C, a pronounced peak of activity in act 3 is seen in the same acts in D. For a more precise comparison of the pattern of nonspecific activity of these neurons, we averaged the activity on the "nonspecific" side (acts 1-5), having preliminarily normed it with respect to the peak of activity for each of the neurons on that side. The averaged patterns of nonspecific activity thus obtained are depicted in E and F for the same neurons which were represented in C and D, respectively. It can be seen that pronounced activation in acts 2 and 3 are observed in F (the approach to and pressing on the first pedal). At the same time, the activity in act 3 differs significantly from the activity in acts 1, 4, and 5, while the activity in act 2 differs from the activity in acts 4 and 5. At the same time, differences are not observed in the activity in various acts in E.

For neurons specialized relative to the seizure of food in a specific food dispenser, the averaged patterns of activity as a function of the sequence of the formation of analogous acts in the history and learning strategy represented in Fig. 4. Neurons specialized relative to the seizure of food in the first food dispenser in the order of training in rabbits trained in accordance with strategy I (A) and strategy II (B) are represented at the top. In both graphs the activity in nonspecific acts 1'-5' is fairly uniform. At the same time, in rabbits trained in accordance with strategy I (C) and strategy II (D), the nonspecific activity on the side opposite to the specific act is far from uniform (acts 1-5) in the patterns of activity of neurons specialized relative to the seizure of food from the second food dispenser in the order of training. The nonspecific activity of the same neurons as in C and D is represented in E and F, but normed not with respect to the frequency in the specific act (5'), but with respect to the peak of activity in nonspecific acts 1-5. The activity in act 2 (approach to the first pedal) differs significantly in E from the activity in act 1 (chewing and turning of the head toward the pedal). The average frequency in act 5 (seizure in the first food dispenser) represented in F differs from the activity in the remaining acts with a high degree of significance.

As can be seen from the figures presented, if the animal was on the side of the cage in which the specific act was accomplished, the pattern of activity of all of the neurons of identical specialization proved to be similar independent of the order of formation and the learning strategy. Such activity of the neurons in the nonspecific acts which were included along with the specific act in one behavioral cycle can be considered the reflection of the existence of a strict structure of relationships of the elements of memory within one behavioral cycle.

At the same time, we found differences in the nonspecific activity of neurons which were associated with the different learning strategies of the animal when the rabbit was on the other side of the cage . Thus, it can be seen from Fig. 3 that additional activation in acts associated with the behavior at the other pedal (2, 3) is detected in rabbits trained in accordance with strategy II, in the activity of neurons specialized relative to the second pedal in the order of training, while in rabbits trained in accordance with strategy I, additional activation of the neurons was not found. At the same time, when the animal was on the "nonspecific" side, significant differences were not identified in the activity in different behavioral acts in all of the neurons specialized relative to the first pedal in the order of training. Similarly, when the animal was on the other side, as can be seen from Fig. 4, significant differences in the nonspecific activity were not found in neurons specialized relative to the seizure of food from the first food dispenser in the order of training. Additional activation during the act of pedal pressing on the other side is detected in neurons specialized relative to the seizure of food from the second food dispenser in the order of training for rabbits trained in accordance with strategy I, while in rabbits trained in accordance with strategy II, additional activation is detected in the act of seizure of food from the other food dispenser.

It must be noted that in the case in which additional activation associated with the training history was observed in the act analogous to the specific act, it was more pronounced (Figs. 3F and 4F as compared with 4E). In our view, this is associated with the summation of the factors of commonality of goal and training history. At the same time, the presence of activation of *"food-dispenser"* neurons of rabbits trained in accordance with strategy I during the approach to the pedal (Fig. 4E) suggests the independence of these two factors. Such activation cannot be also associated with the influence of the factor of commonality of movement, since the animal's movements during the tilting of the head into the food dispenser and during the seizure of food differ fundamentally from the movements in the case of approach to the pedal.

DISCUSSION OF RESULTS

The results presented suggest a difference in the temporal characteristics of the food-procuring behavior of the rabbit depending upon the training strategies used. Thus, the duration of the food-procuring cycle on the different sides of the experimental cage may be identical or may vary. It should be noted that this fact does not depend on the average duration of the behavioral cycle of each rabbit, which markedly varies in different animals and, apparently, reflects individual characteristics of the rabbits. A difference in the duration of the behavioral cycles on the left and right sides of the cage was found only in those rabbits, the training strategy of which presupposed the formation of the entire behavioral cycle first on one side of the cage, and only then, on the second side (strategy I). At the same time, in the case of training in accordance with strategy II, which presupposes the alternating formation of the individual stages of the behavioral cycle ("piecemeal training"), the duration of the behavioral cycles on the different sides of the experimental cage did not vary.

The difference we found in the duration of the behavioral cycles formed at the beginning and the end of training suggests that experience acquired earlier is realized more readily than experience acquired later. These results are in agreement with data obtained in a study of Yu. I. Alexandrov et al. [10], regarding the greater sensitivity of elements of new experience as compared with older experience to the administration of alcohol. In addition, the relationship of the duration of the behavioral cycles to the specific training strategy, in our view, attests to the formation in the animal's memory not only of elements corresponding to individual behavioral acts, but of combinations of these elements which acquire the properties of a whole as well. This phenomenon is well known from experiments carried out in people (typing a text and the Gobang game) [1, 9] or in animals (food-procuring behavior in a maze) [2] and demonstrating that when one and the same fixed sequence of acts is performed repeatedly, groupings of acts are formed which appear as an integral unit of memory.

It follows from the results we have obtained in the investigation of the neuronal activity that additional activations can be found in the nonspecific activity of specialized neurons in cycles of behavior when the animals are on the other side of the cage (i.e., opposite to the side in which the specific activity is detected). Additional activation was detected in neurons of specific specialization at the stage which was formed during training immediately before the specific act. Thus, in neurons specialized relative to the getting of food from a specific food dispenser, additional activations can be found in the acts of approaching and pressing the pedal on the other side, if the rabbits were trained in accordance with the food dispenser — pedal — food dispenser — pedal protocol. Additional activation of the neurons of the same specialization (obtaining food from a specific food dispenser) was identified in those animals which were trained in accordance with the other protocol (food dispenser — food dispenser — pedal — pedal) at the stage of obtaining food from the first food dispenser, i.e., at the stage which was formed during training immediately before the specific act. Additional activation in the nonspecific activity was observed in neurons specialized relative to the approach to and pressing on a specific pedal in the acts of approach to and pressing on pedal on the other side. This activation was detected only in rabbits trained according to the food dispenser — food dispenser — pedal — pedal protocol, i.e., additional activation was also found at the stage preceding the formation of the specific act in the course of training.

Apparently the additional activation which we detected in the nonspecific activity in specialized neurons reflects the activating influence of preceding experience on experience formed subsequently. The effect of preceding experience was found only for stages of the formation of animal's behavior in the experimental cage which directly followed one another. At the same time, additional activation in the nonspecific activity was not detected for neurons specialized relative to the approach to and pressing on the second pedal in rabbits trained in accordance with the food dispenser — pedal — food dispenser — pedal protocol. This is related to the fact that this stage was formed immediately after the training of the rabbits to get food from the food dispenser on the same side of the cage. Apparently the relationships of the acts linked in a unitary behavioral cycle are, in the first place, subordinated to the logic of that cycle and reflect the existence of a strict structure of connections of the elements of memory within it; this makes it impossible to detect an influence associated with a factor of training history.

An additional argument in favor of the existence of a strict structure of relationships between individual acts included in a unitary behavioral cycle, may be the high repeatability which we found of the patterns of activity in the cycle which includes the specific act for all of the neurons of identical specialization.

The influence of training history which we detected in this study on pattern of activity of neurons of the limbic cortex corresponds to the data of E. Bostock et al. [11] regarding the relationship of the activity of neurons of the hippocampus of rats to experience acquired by the animal in the experimental cage. At the same time, the results obtained confirm the inference we drew previously [4, 5] regarding the activating influence of preceding experience on behavioral experience formed immediately after it. It can be hypothesized that the same influence exists between all the experience on the basis of which a new act is formed and the act itself. However, due to the relative weakness of the influence of preceding experience, it is difficult to detect it. Nevertheless, it may prove decisive in some situations (search activity, problem situations).

CONCLUSIONS

1. A difference was found in rabbits trained to an instrumental food-procuring behavior using two different strategies which differed in the sequence of stages of training, in the temporal characteristics of the behavioral cycles, as well as in the pattern of activity of neurons of the limbic cortex.

2. The difference in the temporal characteristics of the behavioral cycles on the right and left sides of the experimental cage was found in those animals in whose training the complete behavioral cycle was first formed initially on one and then on the other side. A shorter duration of the cycles was observed on the side on which training began.

3. Additional activations may appear in the nonspecific activity of neurons specialized relative to one of the behavioral acts to which the animal was trained directly in the experimental cage. Their appearance depends on factors of commonality of goal, commonality of movement, and training history.

4. An influence of training history on the pattern of activity of neurons of the limbic cortex was found. It consisted in the fact that additional activation is detected in neurons of a specific (identical) specialization at the stage during which the animal's training was formed immediately before the behavioral act specific for that neuron.

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