SOME DATA ON THE ROLE OF HIGHER DIVISIONS OF THE BRAIN IN THE REACTION OF RESPIRATION TO THE ADMINISTRATION OF AMINAZINE

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The data obtained in our previous investigations confirmed the compounded concept of respiration as one of the most reactive functions, capable of rapidly changing upon the action of various external and internal stimuli. The reflex changes of respiration in animals are characterized by a small latent period; conditioned respiratory reflexes form rapidly and are stable [1, 3, 4, 6, 8].

It is accepted to relate these characteristics of the regulation of respiratory movements with the degree of corticalization of respiration, which is associated with a high mobility or reactivity of this function, creating the optimal conditions for rapid accomplishment of adaptive reactions.

Along with this, one may speak of the great steadiness and the unique functional "stability" of respiration. This one of its properties is demonstrated, in particular, during the action of factors that change the condition of the central nervous system. Thus, developed respiratory conditioned reflexes are extinguished with difficulty, are retained during the action of foreign stimuli, and suffer relatively little from a varying family of traumas, operative procedures, and pharmacological actions. The character of respiration and the respiratory reflexes change mildly after irradiation of the animal with roentgen rays. Significant changes in the activity of the respiratiory system only occur subsequent to irradiation with large doses and in the terminal period [1, 6, 8].

On the basis of the data which we obtained earlier on the formation of non-conditioned reflex regulation of cardiac activity in onto- and phylogenesis [4], it was logical to postulate that the functional stability of the respiratory system may be related to the activity of the adjusted mechanisms of the central nervous systems, actively organizing the constancy of this vitally important function. In order to verify this hypothesis, the present investigation was carried out. As the agent altering the functional condition of the central nervous system, we selected aminazine. As we know, this preparation acts primarily on the adrenergic elements of the central nervous system, and causes marked changes in the most diverse functions. At the same time, it was shown [2, 7, 8b] that aminazine does not give rise to regular changes in respiration. Starting from this, attempted, in the sample of respiratory reactions arising from the administration of aminazine, to elucidate to what degree the stability of the respiratory functioning may be secured by centers in the medulla oblongata, and what role in this process is played by higher lying divisions of the brain.

EXPERIMENTAL METHOD

We carried out 76 long and short term experiments on cats and rabbits. Respiration was recorded, and tracings were made on the drum of an ink-writing apparatus. In a series of experiments, we recorded the frequency of the heartbeat simultaneously. The experiments were carried out on intact animals, narcotized with uretane (10% solution intravenously) or ether, as well as on decerebrated rabbits and cats.

We investigated the reflex reactions of respiration to electrocutaneous stimulation and stimulation of the upper respiratory passages with carbon dioxide and ammonia, which, in high concentration, possess a trigeminal action. Aminazine was injected intramuscularly or intravenously in doses of 2-3 mg/kg of weight for the cats and 8-10 mg/kg of weight for the rabbits.

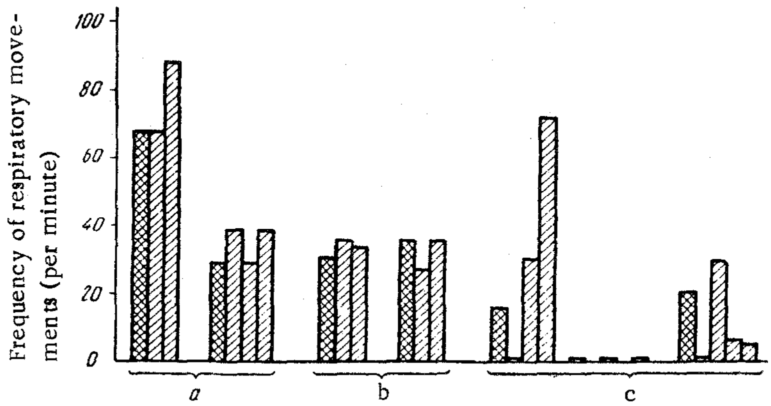

Fig. 1. The effect of aminazine on the frequency of the respira-movements in intact (a), narcotized (b) and decerebrated (c) cats. Crosshatched columns) original frequency of respiration; non-crosshatched) the dynamics of changes in the frequency of the respiratory movements immediately after, and 1-1½ h after, the administration of aminazine. Each group of columns represents an experiment on one animal.

EXPERIMENTAL RESULTS

The injection of aminazine in the indicated doses did not lead to essential changes in the frequency or character of the respiratory movements. In some cases, we observed an increase in the frequency of respiration by 5-10 per min, while in others there was a slowing in the frequency of approximately the same intensity. The character of the respiratory movements after aminazine administration often remained unchanged (Fig. 1,a). The reflex reactions, as a rule, remained at the starting level. Electrocutaneous stimulation after application of aminazine, as before, caused a motor reaction, which was accompanied by marked changes in respiration. The reactions to inhalation of carbon dioxide and ammonia, as before the injection of aminazine, resulted in the inhibition of respiratory movements or in marked lowering of their amplitude (Fig. 2).

We did not observe any essential differences in the respiratory reactions of the intact and narcotized animals in our experiments (Fig. 1, b). This relates to both the background frequency and character of the respiratory movements, and the manifestations of the reflex reactions. Only in the experiments where the injection of aminazine caused a deepening of the action of narcosis did we observe an inhibitory influence of the preparation on the respiratory reflexes.

The experiments presented do not afford a basis for discussing the degree of participation of definite divisions of the brain in this process, but they permit postulating that exclusion of the influences that come from the cerebral cortex, which are always markedly depressed in narcotized animals, does not result in essential changes in the reaction of the respiratory system to aminazine.

The injection of the same dose of aminazine into decerebrated cats (Fig. 1,c) was accompanied by a marked decrease in the frequency of the respiratory movements. Often, complete cessation of respiration occurred for a period of 15-30 sec; immediately after this, there arose a pronounced increase in the frequency of the respiratory movements (from 15-16 to 30-40/min), with a subsequent (after 1 min or more) striking decrease in frequency (to 5-10/min). This infrequent respiration lasted for the entire remaining time of the experiment (up to 1½ h). In several tirals, the injection of aminazine caused the appearance of periodic respiration, with its subsequent complete cessation. It should be emphasized that while in the intact animals the changes in cardiac activity arose earlier and appeared more pronounced than the changes in respiration, in the decerebrated animals the most markedly changed function was specifically respiration. These cats, and especially the rabbits, often died within 5-10 min after the injection of aminazine; in this case, death occurred as a result of the cessation of respiration, and only then did cardiac activity gradually slow and come to a halt.

The results obtained in the experiments on the intact and narcotized cats and rabbits coincide with the data in the literature. The essential difference in reactivity of the respiratory and cardiovascular systems, noted under the conditions of this investigation, bring to mind the different sensitivity of the morphophysiological systems, comprising the cardiovascular and respiratory centers, the blockade of adrenergic structures, caused by the injection of amina-

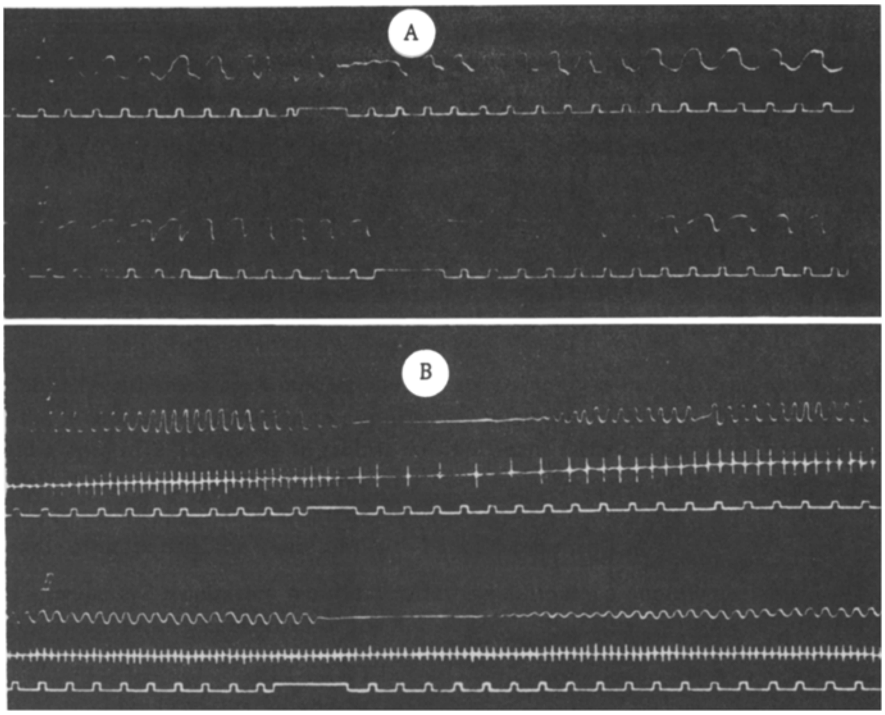

Fig. 2. Change in the reflex reactions of respiration in a rabbit during the action of carbon dioxide (A) and ammonia (B) on the upper respiratory passages, before (I) and after (II) the administration of aminazine. Meaning of the curves (from above downward): A) pneumogram; time markings (1 sec) with stimulation marking; B) pneumogram, EKG; time markings (1 sec) with stimulation marking.

zine. The impression is left that the sympatho-adrenal system, whose function is blockaded by aminazine, ensures the normal functional condition of the vasomotor centers to a significantly greater degree, influencing them both directly (region of the reticular formation) as well as by blackading the peripheral adrenergic receptors. However, from the experiments carried out on the decerebrated cats and rabbits, it would follow that the respiration of animals prepared in this manner is extremely sensitive to aminazine. In turn, we noted an increased sensitivity to aminazine of the cardiovascular system in the decerebrated animals [5]. We postulate that in this case, decerebration disrupts the compensatory capacities of the organism, including respiratory functioning. The elevation in reactivity of the respiratory system within the decerebrated animals apparently is a result of the absence of inhibitory influences from the higher divisions of the brain.

Thus, we consider that the weakly manifested and irregular changes in respiration following the administration of aminazine to intact animals are not explained by a low sensitivity of the central mechanisms regulating the respiratory functioning to blockade of adrenergic structures, but by the great compensatory capabilities of the higher divisions of the brain in the regulation of respiration.

SUMMARY

In acute and chronic experiments staged on cats and rabbits a study was made of the role played by various portions of the brain in the reaction of respiration to aminazine. In administration of this preparation in a dose of 2-3 mg/kg to cats and in a dose of 8-10 mg/kg to rabbits no significant shifts occurred in the frequency and nature of respiratory movements. The use of hypnotics, acting as a depressive agent on the brain cortex, did not change the reaction of respiration to aminazine. In decerabrated anaimals, aminazine injection led to marked respiratory disturbances. Such animals often perish, the cause of death being repsiratory arrest.

Evidently, weakly pronounced respiratory reactions following aminazine administration in intact animals were the result of considerable compensatory capacities of the higher portions of the brain in respiratory regulation.

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