

Neuromediatory Regulation of Aggressive Behavior

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Abstract

Study of the concentration of neuromediators - noradrenalin and serotonin - in the mice hypothalamus showed that in determining dominant behaviour a major role is played by a high level of noradrenalin, and of a submissive behaviour - a high level of serotonin. At the same time low aggressive animals (the so-called "transitional" group) were characterized by the correlation of noradrenalin/serotonin, which determined their place between dominant and submissive animals.

Keywords: *noradrenalin, serotonin, hypothalamus, submissive/aggressive behaviour*

Study of the concentration of neuromediators - noradrenalin and serotonin - in the mice hypothalamus showed that in determining dominant behaviour a major role is played by a high level of noradrenalin, and of a submissive behaviour - a high level of serotonin. At the same time low aggressive animals (the so-called "transitional" group) were characterized by the correlation of noradrenalin/serotonin, which determined their place between dominant and submissive animals. Despite numerous material on the mechanisms of aggressive behaviour, there has not been classified as of yet which neuromediators cause development of aggression.

From the list of the neuromediators that may have such a function, there should be mentioned noradrenalin and serotonin. It has been known that chemical stimulation of anterior hypothalamus by exogenic noradrenalin makes aggressive behaviour easier [1]. While studying different sections of animals' cerebrum, there was found a positive correlation between the noradrenalin content and dominance in them [2]. In the animals of different genotypes there was noticed a positive correlation between the noradrenalin content dominant males percentage in their cerebrum [3]. It was shown that in conditions of stable locomotory activity, a reduction of

noradrenalin concentration (despite a fluctuation of dopamine concentration) by means of catecholamines synthesis inhibitors, made dominant and subdominant mice "to be lowered" to subordinants [4].

At the same time, there has been accumulated a lot of data on the participation of serotonin in realizing aggressive and submissive behaviour. It has been stated that experimental increase of serotonin concentration in the cerebrum causes inhibition of an aggressive behaviour. Submissive animals [5] are characterized with a high level of the present neuromediator and aggressive individuals [6] - by a low level.

In fact, it remained vague, what was more important in the formation of an aggressive behaviour - growth of noradrenalin concentration or reduction of serotonin concentration.

The aim of the experiments conducted by us was to isolate those neuromediators, which played a major role in conducting aggressive and submissive behaviour.

According to the aggressiveness we have differentiated the animals during the agonistic attacks (in tests T1, T2

and T3), and determined noradrenalin and serotonin in the mice hypothalamus as in the organ playing a central role in the regulation of an emotional sphere and organization of behaviour integral forms [7, 8] (the results obtained are given in the table).

The fact, that in the "absolute" dominant mice (i. e. those winning all the attacks) a noradrenalin concentration was surely higher than in the rest of mice and especially in a group of submissive mice (i. e. those defeated in the attacks), witnesses that dominance was primarily connected with noradrenalin. A type of behaviour, which causes dominance, implies high aggressive behaviour by all means. It is interesting that the noradrenalin concentration in submissive mice did not significantly differ from the same parameter in the group of "transitional" animals (i.e. those which won some attacks and lost others). In the latter there were many not simply low aggressive animals but also those, which did not reveal aggressiveness at all. An animal of such behaviour itself will never become dominant in the population. This may happen only in case if all around are of submissive behavior and reveal the poses of submissiveness, without any provocation. There become clear from this position the results obtained in our experiments: absence of reliable difference of noradrenalin concentration between the two groups (submissive and "transitional") of subordinant animals - the latter takes part in forming of domineering. Domineering was a trait characterizing practically none of them.

It was also seen that serotonin played an important role in forming non-aggressive behaviour. There was significantly higher level of the present neuromediator in the hypothalamus of mice of a submissive group as compared with the "absolute" dominants. However, in our research the most interesting was just another detail: a statistical analysis showed that in the mice of submissive and "transitional" group a serotonin concentration differed from each other being lower in submissives. The fact of this difference existing points to the serotonergic mechanisms participating in establishing a submissive behaviour. As we connected domineering to the noradrenalin concentration and its concentration in the "absolute" dominants differed in submissive and "transitional" animals characteristics the same with the submissiveness which is connected with serotonin and, correspondingly, its concentration in the submissive animals is more than in dominants and groups do not differ in serotonin concentration (similarly, according to the noradrenalin concentration these is no difference between submissive and "transitional" groups). This is logical as well, if serotonin determines submissiveness, neither "transitional" nor dominant group members are characterized with this feature (which is connected with permanent defeat as well as domineering is connected with permanent victory). Our

consideration is supported by other (though indirect) evidences in the literature. According to one research, transfer of the ability for protective response is conditioned by the amount of serotonin 1A type receptors, genetically determined reduction [9]. It is stressed in other articles that a state of disturbance being formed on the basis of zoosocial emotional stress response, involves not catecholamine - or glutamate-mediatory system [1] of anterior hypothalamus, but serotonin - and GAEA-ergic. If we take into account that a state of disturbance is a factor of fear [10], and a strong fear is characteristic to submissive animals, it becomes clear that the present data prove our considerations.

Taking into account all said above we may conclude that in which category this or that organism "appears" depends on its catecholaminergic and serotonergic determinants in the central nervous system.

To evaluate the present phenomenon more precisely, we have introduced a coefficient of ratio of noradrenalin and serotonin concentration numerical determinants NA/SE (proceeding from the idea of dependence on neuromediators complex activity - a force of revealing each pattern of behaviour [11]). It turned out that according to the coefficient all the three groups differed from one another, which points to the fact that the quantity of this parameter determines as which group an animal will belong to and what behaviour it will reveal - dominant, submissive or some other. However, not just only this parameter conditions everything, it has certain limits as well. Our research has showed that the organisms, having low concentration of noradrenalin in cerebrum structures, cannot become dominants, as well as the organisms having low concentration of serotonin are submissive animals.

It should be mentioned that the idea, widely prevailing in the literature, on a reciprocal relation between the catecholaminergic and serotonergic mechanisms [12], is not strictly correct for all the groups of animals. It is clear that if noradrenalin determines domineering and serotonin - submissiveness, and there also exist the organisms (the so-called "transitional" group), differing simultaneously by high or low importance of both determinants, then in this case no talk is possible on reciprocal relations. This, probably, explains the fact that there was neither positive nor negative correlation between the noradrenalin and serotonin concentrations.

Therefore, there take part in the formation of an aggressive behaviour both exciting and impeding neuromediators and our research showed a precise role and function of these substances.

	I GROUP "ABSOLUTE" DOMINANT MICE	II GROUP SUBMISSIVE MICE	III GROUP LOWAGRESSIVE MICE
Noradrenalin	2254,0±213,32 * [#]	1182,0±155,99	1407,77±140.69
Serotonin	792,0±84,2259	1096,0±57,75* ⁺	781,1111±58.4391
Noradrenalin/ Serotonin	2.9300±0.2947* [#]	1.0720±0.12 ⁺	1.8556±0.2081

Tab.1 SAQ domains in depressed and non-depressed patients.

* Difference between groups I and II is reliable (p<0,05).

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Изучение концентрации нейромедиаторов - норадреналина и серотонина в гипоталамусе мышей показало, что в детерминации доминантного поведения главную роль играет высокий уровень норадреналина, а субмиссивного поведения - высокий уровень серотонина. В то же время, низкоагрессивные животные (т.н. "переходная" группа) имели отличное от остальных соотношение норадреналин/серотонин, что и определяло их место между доминантными и субмиссивными животными.

Ключевые слова: *норадреналин, серотонин, гипоталамус, доминантное/субмиссивное поведение*