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**Physiology.** — “On Optic “Stellreflexe” in the Dog and in the Cat”. By Prof. R. MAGNUS and A. DE KLEYN.

(Communicated at the meeting of January 31, 1920).

In a series of researches carried out in the Pharmacological Institute of Utrecht various animals were examined on “Stellreflexe”, i.e. those reflexes that make the animal resume its normal position, when it has been brought into an abnormal one.

In the first communication <sup>1)</sup> “Stellreflexe” in rabbits after extirpation of the cerebrum, were described and discussed in detail.

The ability of these animals to regain from any given position of the body their normal position finds its explanation in the cooperation of four different groups of reflexes whose centres lie in the *mesencephalon*.

These reflexes are:

1. “Stellreflexe” from the *labyrinths* towards the *head*, which make the head return from any given position to the normal one. They may be best seen when taking the animal by the pelvis and holding it up in the air in various positions.

2. “Stellreflexe” towards the *head*, provoked by *asymmetrical stimulation of the sensory nerves of the trunk*.

These reflexes may be best examined after bilateral extirpation of the labyrinths. When, after this operation the body lies in asymmetrical position on the ground, reflex action will cause the head to resume its normal position through asymmetrical stimulation of the nerves of the trunk.

3. “Stellreflexe” starting from the *neck*.

When the head has obtained its normal position through the above-named reflexes, but the body has not, a reflex is elicited by the abnormal position of the neck (rotation, flexion etc.) which makes the body resume its normal and symmetrical position with regard to the head.

4. “Stellreflexe” towards the *body through asymmetrical stimulation of the sensory nerves of the trunk*.

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<sup>1)</sup> R. MAGNUS. Beiträge zum Problem der Körperstellung. I. Mitt. Stellreflexe beim Zwischenhirn- und Mittelhirnkaninchen. Pflügers Archiv. Bd. 163. S. 405. 1916.

Also when the head is not in its normal position, the body lying on the ground in asymmetrical position can be restored by reflex-action to the normal position through asymmetrical stimulation of the ground.

*Optic* "Stellreflexe" do not appear in rabbits after extirpation of the cerebrum.

From the 2<sup>d</sup> communication <sup>1)</sup> it became evident that also *the normal rabbit with cerebrum* has only the above "Stellreflexe" at its disposal. *Optic* "Stellreflexe" could not be demonstrated in them either.

The 3<sup>rd</sup> communication <sup>2)</sup> deals with observations made by Dr. DUSSER DE BARENNE in experimenting on *two cats and a dog after extirpation of the cerebrum*. It could be proved that also with these animals only the four above-named "Stellreflexe" play a part; *optic* "Stellreflexe" could not be demonstrated in them either.

Now, whereas with rabbits there is no difference between animals with and without cerebrum, this is altogether different with dogs and cats.

From this paper it will be seen that *normal dogs and cats, that is with a cerebrum, dispose of optic "Stellreflexe"*, and that with them the eyes may co-operate to enable the animals to retain their normal position. If one wishes to examine these optic reflexes, it is essential to hold the animals free in the air, for only then can the "Stellreflexe", resulting from asymmetrical stimulation of the nerves of the trunk on body and head, be eliminated.

Under these circumstances the animal depends for the time being only on its "Stellreflexe", emerging from the labyrinth, and after bilateral extirpation of the labyrinth not any "Stellreflex" can appear in dogs or cats that have been deprived of the cerebrum, and in rabbits with or without cerebrum, if the animals are held up free in the air. It now appeared that dogs and cats with cerebrum, but without labyrinth, still dispose of "Stellreflexe", which enable the animals to bring their head into the normal position.

These "Stellreflexe" are brought about by the eyes.

In order to demonstrate this we communicate the following results with a little dog:

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<sup>1)</sup> R. MAGNUS. Beiträge zum Problem der Körperstellung. II. Mitteilung Stellreflexe beim Kaninchen nach einseitiger Labyrinthextirpation. Pflügers Archiv. Bd. 174, bldz. 134.

<sup>2)</sup> J. G. DUSSER DE BARENNE u. R. MAGNUS: "Beiträge z. Probl. d. Körperstellung III. Die Stellreflexe bei der gross-hirnlosen Katze u. dem hirnlosen Hunde". To be published in Pflügers Archiv. 1920.

The normal animal was first examined, on "Labyrinth-Stellreflexe", while held up in the air, that is, before the bilateral labyrinthectomy performed on it. In this experiment the eyes were blindfolded beforehand. The result was to the following effect:

Animal, held up free in the air by the pelvis.

Normal position of the pelvis: Head in normal position.

Held up on its right and left side: Head about normal (deviation  $\pm 30'$  from the normal position).

With its back placed in horizontal position: Head brought in normal position, either because the front of the body i.e. the neck and the upper part of the thorax is bent ventralward, or because the front of the body performs a spiral rotation of  $180^\circ$ .

Animal suspended with head downward: Head and muzzle are held vertically downward; the neck, however, is distinctly dorsi-flexed.

Animal suspended with head upwards: Head in normal position.

When carrying out the experiment without the eye-bandage, the result is precisely the same; only the head is brought into a perfectly normal position when the animal is held up free in the air, horizontally placed on its side.

On the 6th of June 1919 a bilateral extirpation of the labyrinth was performed. Some hours after the operation the animal keeps its head straight and no nystagmus is seen. Neither in this investigation nor in any of the following did the animal prove to possess any labyrinth-reflex.

June 7, 1919. When investigating in the air *without the eye-bandage* (so with open eyes) it appears that the animal *does not possess any "Stellreflex" in the air*.

Holding the animal in horizontal direction on its right or left side: Head falling to the right, resp. to the left side.

Holding the animal in horizontal direction on its back: Head falls on its back.

Suspended with head downwards: Head held as lying on its back.

Suspended with head upwards: Head in various positions (now latero-flexed to the right or retro-flexed).

From this investigation we conclude that *on the day after that of the operation (bilateral extirpation of the labyrinth) the animal, when held up in the air, does not dispose of "Stellreflexe" and the eyes do not act compensatively.*

An investigation of other dogs gave evidence that after bilateral extirpation of the labyrinth the animals *gradually* recover the ability of bringing their heads into the normal position again when they are held up in the air. It was also evident that the animals obtain this ability through the eyes and by fixing different objects around them. *When the eyes are blindfolded, the "Stellreflexe" will immediately disappear, so we have to do with optic "Stellreflexe".*

We have not made an inquiry of the successive appearance of the optic "Stellreflexe" in the above-named dog, since it was one of the first dogs, in which "Stellreflexe" were found and these had already been fully developed at that time.

July 1. 1919 we found:

*Blindfolded* the animal (in the air) has completely lost its sense of orientation.

Pelvis held on its right side: Head held on its right side. (Fig. 1).

Pelvis held on its left side: Head held on its left side.

Pelvis held on its back: Head held on its back.

Suspended with head downwards: Head held on its back.

Suspended with head upwards: Head retro- or latero-flexed.

*Not blindfolded (i.e. with eyes open)* the animal presents quite another image.

Pelvis held horizontally on its left or right side: Head in normal positions. (Fig. 2).

Pelvis held horizontally on its back: Head in normal position, the front of the body flexed ventralward, the animal fixing his surroundings with great interest.

Suspended with head downward: Considerable flexion of the head towards the back, muzzle upwards and head in normal position.

Suspended with head upwards: Head in normal position.

The above observations and other investigations of various dogs not reported here, tend to show that the dog, held up in the air, completely loses its sense of orientation directly after bilateral extirpation of the labyrinth, but also that after a few days it gradually learns by the aid of his eyes to bring its head into the normal position. Already after two or three days this ability begins to appear; it is almost complete after a week and quite accomplished after about a fortnight.

It is noteworthy that the development of optic "Stellreflexe" could be traced in a dog, of which on Dec. 4 1918 Dr. DUSSEY DE BARENNE had removed the greater portion of the cerebellum, so that at the post-mortem only the frontal part of the vermis and small remnants of the cerebellum were found laterally from the medulla oblongata. When DE KLEYN on March 3<sup>rd</sup> 1919 had performed on this animal the bilateral extirpation of the labyrinth, no trace of "Stellreflexe" could be observed during an investigation on the 23<sup>rd</sup> of April and on the 26<sup>th</sup> of May, when the animal was held up free in the air with bandaged eyes. On the other hand the optic "Stellreflexe" were



Fig. 1.

quite distinct while the animal was investigated with open eyes. Lying on its sides, on its back and when the animal was suspended with the head upwards, the head was brought into its normal position. When hanging with the head downwards, the cervical vertebral column was flexed considerably. It is evident, therefore, that *also after removal of the greater portion of the cerebellum optic "Stellreflexe" still react.*

In cats the same optic "Stellreflexe" may be observed as in dogs. Young, tame cats are fittest for this purpose, as most full-grown cats are too wild when being examined in the air, and thereby hamper the experiment.

#### S U M M A R Y.

Cats and dogs deprived of their cerebrum possess the same four groups of "Stellreflexe", that have been described in a previous paper for rabbits.

In the air these animals depend on the "Labyrinth-Stellreflexe" towards the head and on the cervical "Stellreflexe" connected with them. When in such animals both labyrinths have been extirpated, they have completely lost their sense of orientation.

It is quite different with dogs and cats with cerebrum. When they are trying to find their orientation in space, they make use also of their eyes.

This may be demonstrated by examining them freely in the air after bilateral extirpation of the labyrinth.

Directly when the extirpation of the labyrinth has been carried out, dogs lose their sense of orientation almost completely, cats in a large degree. After a few days the animals have learned to use their eyes and sooner or later they are able, without labyrinths, to bring their heads into the normal position from the most varying positions in space. When watching the animals, it will be seen a



Fig. 2.

once that they make use of their eyes and that the optic "Stellreflexe" reveal themselves after the fixing of the surrounding objects. On examination of such animals without labyrinths, blindfolded or not, the "Stellreflexe" can be made to appear or to disappear at will.

The fact that the optic "Stellreflexe" react only in animals with unimpaired cerebrum, points to a correlation of the optic "Stellreflexe" with the presence of the cortex. This follows as a matter of fact, since dogs and cats deprived of their cerebrum, do not show optic reactions, except the pupillary reflex and the closing of the eyelids on exposure to light.

It is interesting to observe the contrast between the dog and the cat on the one side and the rabbit on the other. The normal rabbit with cerebrum has no optic "Stellreflexe", and as regards "Stellreflexe", does, therefore, not differ from a so-called Thalamus-rabbit. The apparatus essential in the rabbit for standing and for posture, is, indeed restricted to the brain-stem; in dogs and cats connections with the cortex, probably with the optic cortex, as the experiments have proved, also come into account. Special experiments are needed, of course, to ascertain whether the mere circumstance of the optic cortex being intact, is sufficient for the optic "Stellreflexe" to present themselves.

The fact that dogs and cats, directly after extirpation of the labyrinths lose their sense of orientation more or less, leads to the conclusion that, in normal life, these animals use their labyrinths to obtain the orientation in space (in the air), and that for this purpose they use their eyes only when the labyrinths do not function properly.

Within the first few days after bilateral extirpation of the labyrinths it is easy to see how the animals gradually learn to use their eyes.