Responses of the Cerebellar Fastigial Neurones to Tilt*

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Summary. The activity of units located in the rostral portion of the fastigial nucleus has been recorded in decerebrate, unanaesthetized cats in response to tilt. The responses consisted of steady variation of the discharge rates when the animal was tilted in the median plane. The majority of the units exhibited a frequency increase on ipsilateral tilt and a frequency decrease on contralateral tilt. Some units displayed an opposite type of response, while some others responded with a frequency increase on tilt in both directions. It was possible to establish a relationship between the amount of the response and the degree of tilt. Some units exhibited a dynamic response during the movement of the tilt table and the amount of this dynamic response was related to the velocity of the movement. It was not possible to demonstrate a convergence of macular input on these dynamic units. The responses did not depend on proprioceptive feedback since they persisted after deep curarization of the animal. Since the rostro-fastigial neurones project on the dorsal ipsilateral Deiters’ nucleus the existence of a cerebellar fastigial loop through which macular information may reach Deiters’ nucleus has been postulated. This loop may be of relevance in the cerebellar and vestibular control of postural activities.

Key words: Natural Stimulation of Macular Receptors — Fastigial Nucleus — Postural Control — Decerebrate Cat.

The fastigial nucleus of the cerebellum sends both crossed and uncrossed projections to various structures in the brain stem, in particular to the vestibular nuclear complex and the reticular formation (Walberg, Pompeiano, Brodal and Jansen, 1962; Walberg, Pompeiano, Brodal and Hauglie-Hansen, 1962). An analysis of the physiological properties of the fastigio-bulbar connections has led to the present concept that they convey excitatory influences onto their target neurones, including the lateral vestibular nucleus of Deiters (cfr. Ito, Udo, Mano and Kawai, 1970). This nucleus exerts a monosynaptic influence on both α and γ static motoneurones innervating ipsilateral extensor muscles (Carli, Diete-Spiff and Pompeiano, 1967; Lund and Pompeiano, 1968; Grillner, Hongo and Lund, 1969) and this is somatotopically organized ((Wilson, Kato, Peterson and Wylie, 1967). There is evidence that the lateral vestibular

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nucleus is also under the control of the ipsilateral vermis of the cerebellar anterior lobe which has two means of influencing the nucleus; the first is through a direct inhibitory pathway originating from the Purkinje cells and terminating within the dorsal half of Deiters’ nucleus (Walberg and Jansen, 1961; Eager, 1963); the second is by inhibiting fastigial neurones, which exert an excitatory influence on Deiters’ neurones.

It has been demonstrated that the facilitatory influence exerted by the fastigial nucleus on Deiters’ nucleus is tonically present in the decerebrate cat, as shown by lesion experiments (see Moruzzi and Pompeiano, 1956) and may be maintained by several afferent inputs which reach the fastigial nucleus either directly or indirectly through the general afferent input to cerebellum (Eccles, Ito and Szentágothai, 1967). However, particularly pertinent to the problem of postural control is the anatomical (Cajal, 1909—11; Stein and Carpenter, 1967; Gacek, 1969) and the physiological (Arduini and Pompeiano, 1957, Precht and Llinás, 1968) evidence that vestibular pathways project to the fastigial nucleus. There is as yet no physiological information concerning the macular or ampullar origin of this vestibular input, or its distribution within the nucleus.

The present investigation has endeavoured to determine whether natural stimulation of the macular receptors may influence the activity of fastigial neurones and in so doing contribute to the maintenance and control of posture.

Methods

The experiments were undertaken in 19 unanaesthetized cats, decerebrated at precollicular level; decerebration was effected under ether anaesthesia. Arterial blood pressure and rectal body temperature were monitored throughout the experiment and were kept within physiological limits. The activity of fastigial units was recorded with conventional techniques by means of tungsten microelectrodes (4—8 MΩ).

The animals were mounted on an hydraulically driven tilt-table in which the head and the body of the animal could be tilted up to 30° in both directions in the median plane at constant velocity. Particular care has been taken in supporting the body of the animal by fixing the vertebral column at lumbar level to a rigid frame by means of a clamp, while the abdomen and thorax were supported in a special hammock; this ensured that during tilting the movements of the body and limbs were reduced to a minimum and may uneven pressure on the skin was avoided.

The table was automatically controlled by means of a series of electronic gates, which allowed orderly recording cycles composed of three periods of 60 sec each; during which the recorded unit could be studied with the head of the animal in the horizontal, tilted, and again in the horizontal position. These gates also provided synchronizing pulses, which were recorded on tape together with the fastigial unit discharge and a potentiometric record of the position of the table. The data were then processed by means of a computer (Correlatron 1024, Laben) in order to obtain sequential frequency histograms. Sampling intervals of 400 and 800 msec were used and in most cases, due to the very low spontaneous discharge frequency of the units, the responses obtained during several synchronized cycles of tilt were pooled to pro-