Pellionisz, A. & Llinàs, R. (1981) Genesis and Modification of the Geometry of CNS Hyperspace. Cerebellar Space-Time Metric Tensor and "Motor learning". Soc. Neurosci. Abst. 7, p.641.

Society for Neuroscience

211.6 GENESIS AND MODIFICATION OF THE GEOMETRY OF CNS HYPERSPACE. CEREBELLAR SPACE-TIME METRIC TENSOR AND "MOTOR LEARNING".

A. Pellionisz and R. Llinas. Dept. Physiology & Biophysics, New York University Med. Ctr., 550 First Ave., New York 10016.

Understanding CNS function is related, in our view, to defining the properties of the geometry of its hyperspace. Tensor network theory treats such geometry formally (Neurosci.Abst.1978), interprets motor coordination as a covariant-contravariant transformation through a cerebellar (CB) metric tensor (Neurosci. Abst. 1979), and features this metric as furnishing the CNS with an internal space-time geometry (Neurosci.Abst. 1980).

A fundamental question here however, is how such metrics arise in the CNS. The CB is an excellent candidate in which to define such task because the musculoskeletal geometry is innate, and thus the CB metric must be ontogenetically constructed. However, given the curvature of motor hyperspace such metric cannot be constant, i.e. the connectivity matrix must be dependent on the position of the motor vector in this hyperspace. The climbing fiber (CF) system has been considered as actively changing the curvature of the hyperspace by altering the physiological transformation of motor vectors through the CB metric. (Neuroscience 1980. Vol.5. p.1125.)

As for the question of CB involvement in "motor learning" we suggest that the inferior olive provides a covariant CF vector (CFV) that is the inner product of the covariant correction vector (the difference between intention and execution) and the contravariant motor status vector, both being expressed in the non-orthogonal motor execution reference-frame. This "motor adjustment" by CFV is an ongoing function that refines motor performance without invoking synaptic plasticity or anatomical modification of the CB metric. The more general "motor acquisition" of new movements arises in this model as an extracerebellar generation of new intention vectors using the existing CB metric. Finally, "motor adaptation" (e.g. in vestibular compensation: Science, 1975, Vol.190. p.1230) requires for its acquisition and retention the CF system indicating that such "adaptation" involves an alteration of CB nuclear activity. We suggest such alteration to be based on the confluence of covariant CFV (through CF collaterals into the nuclei) and the contravariant CFV that is transformed through the CB corticonuclear network.

Indeed, we conclude that co- and contravariant confluence is the basis for the genesis of epigenetically formed metrics throughout the CNS. (Supported by USPHS grant NS13742 from NINCDS)

11th Annual Meeting
Los Angeles, California
October 18-23, 1981

6 GENESIS AND MODIFICATION OF THE GEOMETRY OF CNS HYPERSPACE. CEREBELLAR SPACE-TIME METRIC TENSOR AND "MOTOR LEARNING".

A. Pellionisz and R. Llinas. Dept. Physiology & Biophysics, New York University Med. Ctr., 550 First Ave., New York 10016.

Understanding CNS function is related, in our view, to defining the properties of the geometry of its hyperspace. Tensor network theory treats such geometry formally (Neurosci.Abst.1978), interprets motor coordination as a covariant-contravariant transformation through a cerebellar (CB) metric tensor (Neurosci. Abst. 1979), and features this metric as furnishing the CNS with an internal space-time geometry (Neurosci.Abst. 1980).

A fundamental question here however, is how such metrics arise in the CNS. The CB is an excellent candidate in which to define such task because the musculoskeletal geometry is innate, and thus the CB metric must be ontogenetically constructed. However, given the curvature of motor hyperspace such metric cannot be constant, i.e. the connectivity matrix must be dependent on the position of the motor vector in this hyperspace. The climbing fiber (CF) system has been considered as actively changing the curvature of the hyperspace by altering the physiological transformation of motor vectors through the CB metric. (Neuroscience 1980. Vol.5. p.1125.)

As for the question of CB involvement in "motor learning" we suggest that the inferior olive provides a covariant CF vector (CFV) that is the inner product of the covariant correction vector (the difference between intention and execution) and the contravariant motor status vector, both being expressed in the non-orthogonal motor execution reference-frame. This "motor adjustment" by CFV is an ongoing function that refines motor performance without invoking synaptic plasticity or anatomical modification of the CB metric. The more general "motor acquisition" of new movements arises in this model as an extracerebellar generation of new intention vectors using the existing CB metric. Finally, "motor adaptation" (e.g. in vestibular compensation: Science, 1975, Vol.190. p.1230) requires for its acquisition and retention the CF system indicating that such "adaptation" involves an alteration of CB nuclear activity. We suggest such alteration to be based on the confluence of covariant CFV (through CF collaterals into the nuclei) and the contravariant CFV that is transformed through the CB corticonuclear network.

Indeed, we conclude that co- and contravariant confluence is the basis for the genesis of epigenetically formed metrics throughout the CNS. (Supported by USPHS grant NS13742 from NINCDS)