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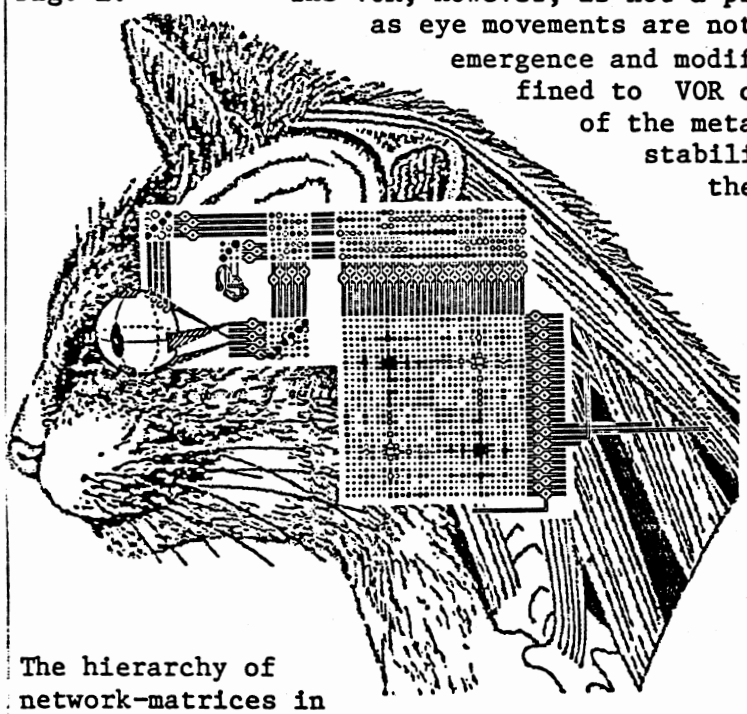
TENSOR MODEL OF GAZE. A.J. Pellionisz, New York, New York, 10016 USA, (212) 340-5422

This approach regards the understanding of how oculomotor activity emerges from neuronal networks as a model of sensorimotor transfer; the simplest model of brain function. Thus, if oculomotor modeling arrives at basic principles and procedures of how the central nervous system (CNS) operates, it becomes a focus for brain theory.

A basic principle appears to be that networks exert their function by multicomponental expressions. In oculomotor systems motor vectors are given by neurons providing components of the movement in the coordinate system intrinsic to the extraocular muscles and sensory components are measured by neurons connected to geometrically distinct sensors (eg. vestibular canals). Intrinsic frames usually differ from those applied by investigators (Simpson & Graf 1985). Quantitative anatomy supplies data to specify coordinate systems of the VOR (Volkmann 1869, Blanks & 1972,75, Curthoys & al 1972, Ezure & Graf 1984, Simpson 1983, Simpson & Reisine 1986), head-movements (J.Baker & al 1985), and even limb-movements (Gielen & Zuylen 1986). Given the fact that frames intrinsic to CNS are tipically non-orthogonal, one needs to consider general vectorial expressions in a variety of natural coordinate-systems and the covariant, contravariant and even mixed tensor transformations that connect them (Pellionisz [P]& Llinas 1980), eventually including analysis in unified spacetime manifold ([P] & Llinas 1982). Even without such general formalism, multidimensional CNS function necessitates 3D analysis and a study of oblique oculomotor function (Guitton & Mandl 1980, Evinger & al 1981, Robinson 1982, Goldberg 1984).

Tensor network theory resulted in a general sensorimotor model with overcomplete frames via networks implementing a contravariant sensory metric tensor, sensorimotor covariant embedding tensor and the Moore-Penrose generalized inverse of the motor covariant metric tensor ([P] 1984), elaborated for the VOR in man ([P] 1985), rabbit (Simpson & [P] 1984) and cat (Graf & [P] 1985). As for how networks can be generated and modified it was proposed ([P] 1984, [P] & Llinas 1985) that metaorganization, based on finding the all-important eigenvectors by proprioceptive reverberations, may be used by the CNS in order for a sensorimotor network to emerge.

Fig. 1.



The hierarchy of network-matrices in a tensor model of gaze

The VOR, however, is not a primary sensorimotor system ([P] 1985), as eye movements are not measured by the vestibulum. Thus, its emergence and modification cannot be determined when confined to VOR only. In contrast, tensorial modeling of the metaorganization of vestibulo-collic head-stabilization-networks is possible, involving the cerebellum ([P] 1985), after having established the neck-muscle frame (J. Baker & al. 1985, Peterson & al. 1985 1985). As exposed earlier ([P] 1985, [P] & Peterson 1985) and shown in Fig. a hierarchical tensor network could be constructed of the 1) cervico-collic proprioceptive metric reflex 2) oculomotor proprioceptive metric reflex 3) vestibulo-collic sensorimotor reflex 4) retino-collic sensorimotor reflex 5) retino-ocular sensorimotor reflex, 6) VOR; non-sensorimotor hierarchic reflex. Beyond a theory of sensorimotor function, the model relates experimentatal results on physical and functional geometries by means of the eigenvectors and generalized inverses.