

Introduction to the International Symposium on Higher Brain Functions

FRANCISCO ABOITIZ*

Departamento de Morfología Experimental, Facultad de Medicina,
Universidad de Chile, Santiago, Chile

Key terms: *brain models, brain injury, brain pathology, cognition, cortical oscillations, higher brain functions, interhemispheric transfer, memory mechanisms, pain, psychoses.*

The following set of papers is a sample of the lectures presented in the International Symposium on Higher Brain Functions, held in August 1994 at the Graduate School, Faculty of Medicine, University of Chile. The term "Higher Brain Functions" usually refers to large-scale cortical processes that are somehow involved in aspects of memory, learning, language and especially conscious states. This definition usually leaves aside, on one hand, the more detailed cellular and molecular mechanisms involved in neural function and, on the other, all those processes that occur in the 'lower' (*i.e.*, subcortical) parts of the central nervous system.

This field is many times dismissed as 'soft' by neuroscientists; proof of this were some of the comments I heard on the title of the symposium: "higher brain functions, or whatever that means"; or "we should also make a symposium on lower spinal functions". Skepticism and irony aside, the neurobiological nature of conscious and mental phenomena may well be the most important problem of modern neurobiology (Edelman, 1992). However, this does not imply that cellular and molecular approaches, as well as the study of subcortical systems have no say in this question. Although large-scale cortical processes may be quite an important part in the generation of these functions, lower-scale properties as well as the coordinated operation of the cerebral cortex with so-to-speak

lower centers in the nervous system may greatly contribute to the generation of these 'higher' brain functions. To borrow the analogy from Searle (1992), mental phenomena and conscious states may result as emergent properties of the interactions between neurons in a specific type of network, in a manner similar to the way the macroscopic property of liquidity emerges from the properties of the molecules of water. In this sense, the structural and functional details of these neural networks, no matter how extended they may be, are of high relevance in the understanding of higher brain functions.

Therefore, although many conferences dealt with large-scale cortical networks and their relation to language, learning, attention and cognition, there were also lectures making emphasis on subcortical processes, and on cellular and molecular properties which may work as key features in the generation of mental phenomena. In addition, some problems related to mental dysfunction such as certain psychoses and the effects of early experience in the development of cognitive capacity, and even subjective aspects of pain were discussed in the light of their relation to these higher processes.

The **opening lecture** was given by Humberto Maturana, who presented his view of the nervous system as a closed network, where the main phenomenon is the reverberant activation of neural networks by

* **Correspondence to:** Francisco Aboitiz, Ph D, Departamento de Morfología Experimental, Facultad de Medicina, Universidad de Chile, Casilla 70079, Santiago 7, Chile. Fax: (56-2) 777-6916.

previous states of neural activity, while the environment plays a role triggering or modulating these recursive changes. In this way, the system does not distinguish between higher or lower levels in the hierarchy, or between internally or externally generated stimuli; these categories are inherent to the perspective that the observer uses to describe it. This view has important consequences for the biological understanding of mind, language and social interactions.

The **first set of presentations** described aspects of the specialized, so-called higher functions of the human brain. Eran Zaidel reviewed his studies on modularity of functions in the brain, by using interhemispheric callosal transfer as a model system. His findings suggest an interaction between hemispheric laterality and interhemispheric transfer that is specific to males. My own talk referred to the anatomical substrates of interhemispheric transfer and language, and to the analysis of diversity in convolutional brain patterns as an index of brain organization for language. Dahlia Zaidel spoke of interhemispheric and sexual differences in the cellular structure of the hippocampus, indicating that this structure is lateralized and sexually dimorphic for memory acquisition.

Joaquín Fuster talked about mechanisms of cortical memory in the monkey and man, proposing the thought-provoking and unconventional view that memory is essentially of one class, associative, and that at all processing levels, from the 'lower' to the 'higher', we find the same memory mechanisms in operation. Alfredo Kirkwood reviewed his latest research on long term potentiation as an ubiquitous feature in the cerebral cortex, revealing that plasticity at this level is possible throughout the cortex, and is not exclusive of the hippocampus.

Francisco Varela spoke of the generation of synchronized 40 Hz activity oscillations in the cells of the cerebral cortex and other systems and their relation to consciousness and awareness. His view is that the persistent saltation from one state of synchronization to the next gives rise to the flux, or stream of mental phenomena. Juan Carlos Letelier reviewed some of the history of computerized brain modelling from cybernetics to artifi-

cial intelligence to more recent developments in neural networks, and proposed a non-linear matricial solution for the dynamics of simple, self-organized networks that includes changing, Hebbian-type interactions.

The **second group of conferences** concerned aspects of pathology and response to injury in the nervous system, which are of relevance for the development of cognitive skills, psychoses and the subjective experience of pain. Rubén Soto-Moyano discussed central noradrenergic hyperactivity as an inhibitor of cortical development in cases of early-life malnutrition and/or sensory deprivation. Pharmacological reduction of central noradrenergic hyperactivity prevents malnutrition-induced brain functional disturbances and permits normal cognitive development. Luis Villanueva spoke about "diffuse noxious inhibitory control", which is an inhibition of some sensory neurones by a nociceptive stimulus applied elsewhere in the body. There is evidence that central systems higher than the spinal cord (possibly reticular) are involved in this phenomenon, and that the subjective experience of pain depends on the balances of activity in several sensory systems, rather than resulting directly from the activation of specific fiber types.

Other speakers, not contributing to this issue, were Archibaldo Donoso (University of Chile), Víctor Fernández (University of Chile), Ariel Gómez (University of Chile), Eliana Guic (University of Chile), John Nicholls (Basel University), Teresa Pinto (University of Chile), Ennio Vivaldi (University of Chile) and Marc Zeise (Max Planck Institut).

The symposium was supported by Fundación Andes, CONICYT, and ECOS-CONICYT, and it was sponsored by the Experimental Morphology Department and the Graduate School of the Faculty of Medicine at the University of Chile. Fundación Andes also financed the present publication. I must also acknowledge the help of the secretaries in the Graduate School and the advice given by Teresa Pinto and Víctor Fernández. Ximena Rojas helped during the organization of the symposium and in preparing posters and advertising pamphlets. I am also grateful to the speakers in this symposium, for all their dedication and the hard work it implied;

and to the large and enthusiastic audience we had, providing stimulating discussions in every lecture. Finally, I want to thank the Editorial Office of Biological Research for agreeing in publishing these conferences.

REFERENCES

- EDELMAN GM (1992) *The Remembered Present*. New York: Basic Books.
- SEARLE JR (1992) *The Rediscovery of the Mind*. Cambridge, MA: MIT Press.

