Astrocytes in evolution and consciousness

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Bernhard Mitterauer Joined: 07 Jun 2005 Posts: 20	Posted: Thu May 31, 2007 9:28 am Post subject: Astrocytes in evolution and consciousness

Possible role of astrocytes in evolution and consciousness

Bernhard J. Mitterauer

The Astrocentric Hypothesis of James Robertson (2002) may be a milestone in brain research. According to this hypothesis, astrocytes play an essential role in the generation of consciousness and memory.

Let me support this hypothesis by considering recent findings on synapse formation. Barres and his coworkers (Miller, 2003) identified large proteins called thrombospondins secreted by astrocytes that trigger synapse formation. Most important, Preuss and coworkers (Cáceres et al, 2006) found that human brains produce up to six times as much thrombospondin messenger RNA and protein than do either chimps or macaques. These differences were seen in the cerebral cortex but not in the cerebellum, suggesting that astrocytes influence the evolution of biological brains. In addition, the evolution from animal brains to human brains connotes evolution of consciousness to self-consciousness.

Supposing that astrocytes are responsible for the increase of synapses in the human cerebral cortex in comparison to those of primates, the human brain should be capable to build more complex glial-neuronal networks. However, the question arises what degree of complexity is necessary to generate self-consciousness.

Let me outline a critical explanatory model. If one agrees that astrocytes are building glial-neuronal compartments via their processes contacting or enveloping bipartite synapses (Mitterauer, 1998), then the brain is organized in finite glial-neuronal units or domains. Within each tripartite synapse the astrocyte exerts a modulatory function of neuronal information processing by means of feedback mechanisms (Auld, Robitaille, 2003). Note that feedback is the technical term of reflection on the cognitive level. Generally, animal and human brain operations are based on feedback mechanisms that may generate consciousness (Koch, Crick, 1991), but not self-consciousness.

By theoretically supporting the Astrocentric Hypothesis of consciousness (Robertson, 2002), I hypothesize that astrocytes generate local units of self-observation. Here, the concept of self is defined as a finite system capable of self-observation (Mitterauer, Pritz, 1978). Therefore, the architecture of the brain may

be composed of abundant loci of self-observation. In this context, Baars (1996) speaks of the many selves.

Such abundant systems of self-observation determined by astrocytes make it possible to compute or reflect all the finite systems of the environment (objects, subjects) already within the brain. However, we are faced with the problem of how the brain is organized to be capable of generating self-consciousness. Cyberneticists try to explain self-consciousness by referring to the function of self-reference. But, where and how the brain generates the act of self-reference remains a mystery (Guenther, 1971). The reticular formation in the brain stem could perhaps be a candidate system (Mitterauer, Kopp, 2003).

Finally, the decisive role of astrocytes in the evolution of the cerebral cortex by enhancing the set of synapses may indicate that these glial cells are essentially responsible for the degree of the complexity of brain functions and consciousness. Unfortunately, the "qualitative jump" from consciousness to self-consciousness is very difficult to explain. One can only speculate that the increase of astrocyte-neuronal compartments in the sense of loci of self-observation could introduce novel thematic domains that only humans deal with, such as arts, religion or life after death.

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