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# A Life-Enhancing liquor

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One of the most fascinating structures of living beings is the brain, and the human brain is by far the most complex in terms of structure and function. As in all vertebrates, it allows us to receive information from the environment, process it, interpret it according to our needs, and respond to it appropriately. A social species, we humans have not only developed consciousness, but—a key milestone in our evolution—become a species that also builds civilizations. Many of these civilizations have grown up next to water, a fluid environment that has worked as a vehicle of cohesion and transport, favouring the survival of people living along its shores. For the Egyptians it was the Nile; for the Greeks and Phoenicians, it was the Mediterranean; and more recently for many nations on that continent, it was the great European rivers. It is a curious fact that our brain, like that of other vertebrates, is also organized from its embryonic origins and throughout adult life around an extraordinarily dynamic and complex fluid: liquor cerebrospinalis, better known as cerebrospinal fluid (CSF).

Researchers have for decades analysed the processes involved in the development and function of the brain at cellular, molecular and genetic levels. However, few of these analyses have taken into account the existence of the spaces containing CSF. CSF is a protein-rich fluid that has a role in the cohesion of the surrounding cells as well as in signal transmission. At both foetal and adult stages, this fluid is formed by molecules secreted by specific organs, the choroid plexuses. These also filter the blood to supply the CSF with some of its components and allow precise control of its complex and dynamic composition. Dynamic because its specific content varies not only with age, but also in the course of the day and depending on particular physiological conditions.

The roles traditionally attributed to this fluid have included transporting nutrients and eliminating waste, and keeping the brain in permanent flotation to reduce its weight and thus to protect its lower part from being squashed. However, the advent of increasingly sensitive techniques has shown that it also reflects many diseases of the nervous system. These include hydrocephaly—the accumulation of liquid in the brain—and other nervous system defects, as well as neurodegenerative diseases such as multiple sclerosis, Alzheimer’s and Parkinson’s, among many others. For this reason, analysis of the CSF is increasingly being used as a high precision diagnostic tool, and researchers are also examining the possibility of using this fluid as a pathway to supply the brain with therapeutic agents. This includes drugs to stimulate the regeneration of damaged tissues, or at least to reduce the rate of disease progression.

It is paradoxical that our understanding of the composition and roles of CSF during the early stages of brain formation has contributed to the study of the regeneration of brain tissue. Experiments performed by my team at the University of Barcelona, in collaboration with another team at the University of Valladolid (Spain), have shown that embryonic CSF contains several molecules that contribute to the survival, proliferation and differentiation of brain-forming cells, and also to the formation of neural structures. It has also been shown that these molecules are scarce or absent in adults, especially in people affected by the diseases mentioned above. Moreover, it has also been demonstrated recently that the only cells of the adult brain that are able to respond to these embryonic factors are in close contact with the CSF.

These results point to the possibility of synthesizing these embryonic molecules and administering them as drugs into the adult CSF—a new generation of drugs and medical treatments to further increase our quality of life. This is currently being investigated in my lab at the University of Barcelona, in collaboration with the team at the University of Valladolid as well as with a group at the University of Manchester (UK). This is not a short-term project; but one of the consequences of the civilization that our brain has allowed us to build is that we are able to make long-term plans. However, even in the short-term, the study of the formation of embryonic CSF has allowed us to detect a specific zone that controls and regulates its composition in a very precise way from the early stages of brain development. This finding paves the way for a more precise analysis of the effect of particular drugs on embryo development, an important goal of gynaecological medicine.