

Welcome to *Alternativz* Volume 1, Issue 16:
Does Coherent Breathing Wash The Brain?
This is one of the questions that Dr. Bob Grove and I had in mind in 2009, while musing over the possibility that the Valsalva Wave, the blood wave induced in the body by Coherent Breathing existed in the brain. (*Breathing & The Brain - Part I*).

In August 2012, the results of a study led by Dr. Maiken Nedergaard of The University Of Rochester Medical Center, published in *Science Translational Medicine*, shed some light on this question. The report, *A Paravascular Pathway Facilitates CSF Flow Through The Brain Parenchyma And The Clearance Of Interstitial Solutes, Including Amyloid Beta*, was made available on NIH public access in August of this year.

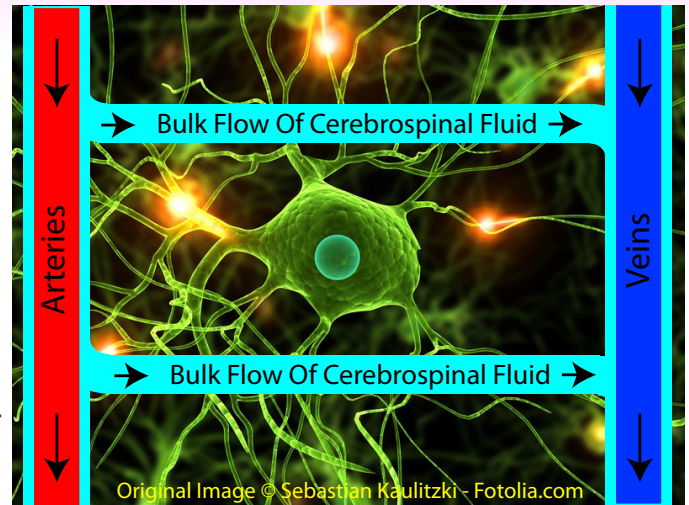


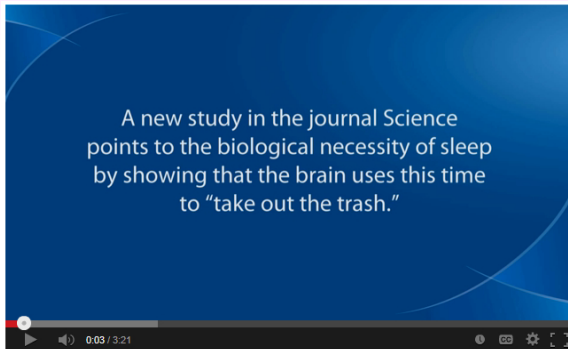
Figure 1: Movement of cerebrospinal fluid (CSF) through the interstitial spaces of the brain

Amyloid beta, a peptide, is the principle “pathogen” implicated in Alzheimer’s disease, a major cause of Alzheimer’s being its buildup in spaces between neurons. With increasing plaque, neurons die and as they perish brain function deteriorates and dementia results. Alzheimer’s is the primary cause of dementia in the world today.

The vertebrate body has two “circulatory” systems, one that transports blood, and a second, the lymphatic system, which has the job of collecting extra cellular fluid and the waste products of cellular metabolism, (including vitally important proteins) and transporting this “lymph” to the vicinity of the chest where the various branches of the lymphatic system empty into major veins. Of fluid delivered to the tissues of the body via arterial blood flow, about 90% returns via the veins, the remaining 10% being collected by the lymph system before entering the venous flow where along with venous blood it is ultimately recycled. Of course, this includes the branches of the lymph system of the neck and head. But relative to the head a major puzzle has remained...*the brain* does not have lymphatic vessels, nor does it have “lymph” per se.

It has been known for some time that cerebrospinal fluid is the medium that permeates intercellular areas of the brain, areas where extra cellular metabolic waste accumulates, CSF performing the function that lymph performs elsewhere in the body, but the means by which CSF circulates and is compelled through the brain has been a mystery.

An objective of Nedergaard et al was to understand this mechanism, i.e. How does CSF flow through the interstitial spaces of the brain? The method involved examining the brains of mice whereby fluorescent tracers were injected into the cerebral cortex, and tracking the movement of these markers in the CSF using 2-photon microscopy, a microscopic imaging technique



employing fluorescence that yields particularly good penetration and visibility.

They found that CSF flows into brain tissues along pathways surrounding smooth muscle cells of cerebral arteries, that there are spaces between cerebral arteries and brain tissue that support this transmission. From there, CSF sweeps through interstitial areas of brain tissue collecting metabolic waste products,

the same cleaning function that lymph performs elsewhere in the body. *CSF is compelled to move by the arterial pulse.* They propose that bulk flow of CSF is animated by “astroglial water channels”, channels in the brain structure that are highly polarized, thereby providing a driving current that flushes waste products from brain tissue. CSF was found to collect along veins ultimately re-entering venous blood flow for recycling, as does lymph.

The authors speculate that CSF flow into channels along cerebral arteries may be a function of localized pressure differential between arteries and veins, as physics would suggest. Physically, “flow” is a function of “pressure differential”, the greater the differential, the greater the flow. When we breathe “coherently” it generates a wave in the circulation. I hypothesize that breathing “coherently” can add as much as 40mmHg to blood pressure differential which is normally 40mmHg, i.e. the pressure difference between the cardiac systole and diastole can go as high as 80mmHg. That is why blood pressure while breathing “coherently” might be 115/55 (a more modest difference of 60mmHg), as opposed to “normal” blood pressure of 120/80 (a difference of 40mmHg). The point is, that breathing “coherently” generates a wave that increases pressure differential throughout the body. This Valsalva Wave rises in the arterial tree during exhalation and rises in the venous tree during inhalation, thereby providing alternating pressure differential between arteries and veins. This year, using HEG and EEG, we’ve observed that the wave does appear to exist in the brain. Per the present understanding, this wave would augment blood pressure in the brain, just as it augments blood pressure throughout the body. To the question, if Nedergaard and company are correct about pressure differential being the motive force for CSF flowing into brain tissue, then Coherent Breathing and its result - the Valsalva Wave - may in fact contribute to the effectiveness of brain cleaning by cerebrospinal fluid.

In this video, Dr. Nedergaard explains that the process is highly encouraged by sleep, and that it may be one reason that life requires sleep, i.e. that during sleep the brain cleans itself. Because humans sleep in a horizontal body position, with the hydrostatic pressure effects of gravity normalized along the length of the body, and because we tend to breathe more naturally while we sleep, I am also confident that CSF transport increases while we are asleep, for the average adult. If CSF transport is a function of pressure differential, then it should also increase while we are awake. If we are breathing coherently. Time will tell...

Thank you for your interest and consideration,

Stephen Elliott, President COHERENCE LLC

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