Hello all,

Welcome to Coherent Breathing®, Volume 3, Issue 4: ***It Is Time To Ask Again - Does Coherent Breathing Wash The Brain?*** I hope you enjoyed Volume 3, Issue 3: ***Is Internal State A Sixth Sense?***

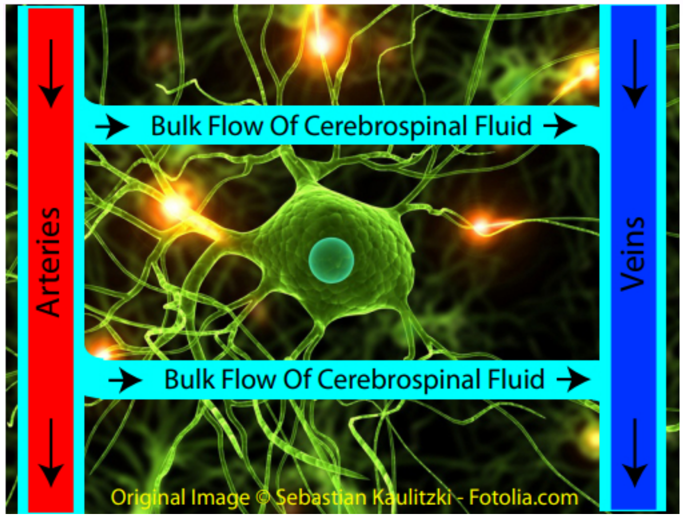

Figure 1: Movement of cerebrospinal fluid (CSF) through the interstitial spaces of the brain

The question of Coherent Breathing and blood flow through the brain was a most compelling thought that arose in the 2007-2009 timeframe, when observing the Valsalva Wave at the earlobe for the first time using the COHERENCE instrument Valsalva Wave Pro which was under development during this period. One cannot see the wave at the earlobe, and anywhere/everywhere else on the head where a sensor can be affixed and not wonder "if the brain is experiencing this same wave?" A question with monumental implications.

I originally published the title "Does Coherent Breathing Wash The Brain?" under the Alternativz imprint in November, 2013, having just learned of The University of Rochester Medical Center's research into *how* cerebrospinal fluid flows through the brain. Their report, *A Paravascular Pathway Facilitates CSF Flow Through the Brain Parenchyma and the Clearance of Interstitial Solutes, Including Amyloid β* having just been published in *Science Translational Medicine* and made available on NIH public access in August 2013. The lead researcher was Dr. Maiken Nedergaard.

Amyloid beta, a peptide, is the principal "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.

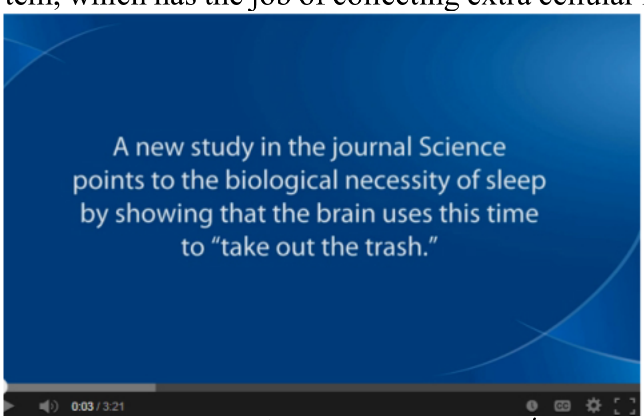

Figure 2: Maiken Nedergaard explaining discovery

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.

I emailed Dr. Neidergaard and sent her the view of the Valsalva Wave (at the earlobe) with the explanation that it is a name we have given the wholistic “respiratory arterial pressure wave”, a phenomenon described briefly in Medical Physiology, where what is missing in the name is the fact that there is a corresponding respiratory venous pressure wave - or there should be.) Dr. Bob Grove and I combined the terms to call it the Valsalva Wave, naming it after Antonio Valsalva, the discoverer of the Valsalva maneuver, “A/V”, arterial/venous. It is said that Antonio Valsalva was also the first to document the existence of the respiratory arterial pressure wave which he observed in his hounds.

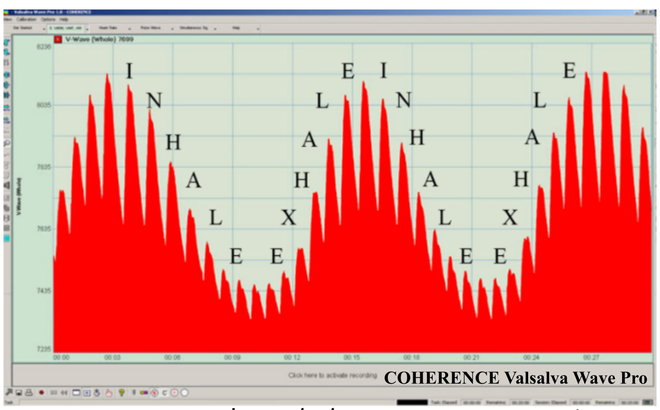

Figure 3:The Valsalva Wave generated by Coherent Breathing

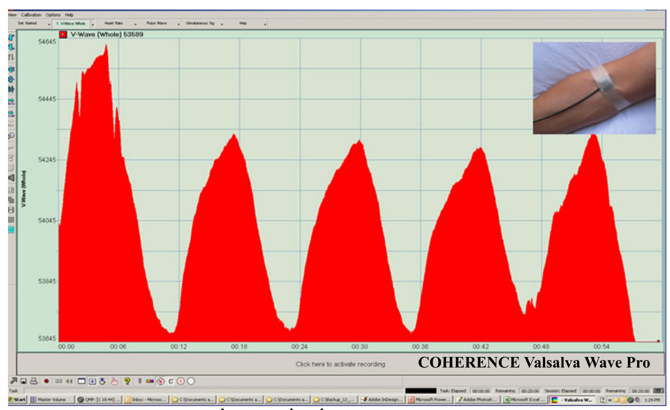

Figure 4: The Valsalva Wave generated by Coherent Breathing (monitored at the Medial Cubital Vein)

I went on to describe the fact that the heartbeat (the motive force described in the research) is riding atop a wave that is at least as large, when breathing is “coherent”, in effect doubling the pressure differential relative to the heartbeat alone, and in theory doubling the flow of CNS. (This results in a nominal blood pressure of 120/60 vs. the standard 120/80, when measured at the arm, adding 20mmHg differential when breathing coherently.) This pressure differential should be reflected between arterial pressure entering the brain via the carotid arteries during exhalation, and the pressure of venous blood leaving the brain via the jugular vein during inhalation, with an overall increase in the volume of blood flowing through the brain. This increase in flow happens when the body is erect and even moreso when the body is horizontal, as it is when we sleep and gravity is normalized. It is particularly important when we are awake and erect, as it is imperative for blood to flow upward against gravity. This includes venous flow from the feet to the chest and arterial flow from the the chest to the head. Negative pressure in the chest generated by inhalation is the motive force for venous return throughout the body.

In 2013, Tato Sokadze (University of Louisville, School of Medicine) and I, using HEG and EEG, both with low frequency filtering removed, observed that the wave does exist in the brain. HEG shows it to correlate very highly with the shape of the wave seen at the earlobe. EEG shows its amplitude to be ~10 times that of functional bands, gamma, beta, alpha, theta, and delta, which is why low frequency filtering was implemented in EEG instrumentation in the first place, the amplitude of the breathing induced wave obscures functional bands. This 10X amplitude signal was found to cease completely during a breath hold.

In February 2024, Drs. Burman and Alperin of the University of Miami, Department of Biomedical Engineering, and Department of Radiology, respectively, published an article in ***Journal of Sleep Research*** titled:

"CSF-to-blood toxins clearance is modulated by breathing through cranio-spinal CSF oscillation".

Referring to Figure 3 above, I posit that the oscillation they refer to is the Valsalva Wave generated by rhythmic breathing. The *oscillation* is the breathing induced slow wave with the heartbeat riding atop. It is this wholistic wave that drives pressure differential between arterial and venous flows and cellular fluid exchange.

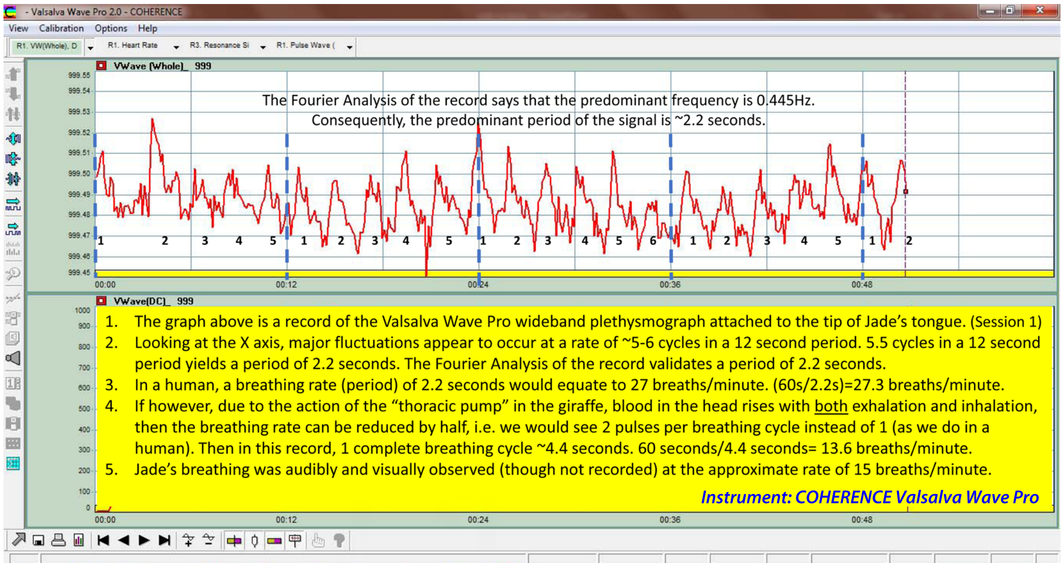

Figure 5: A record of blood volume changes at the tip of a giraffe tongue. Large waves are in keeping with Jade's breath rate rising with both exhalation and inhalation.

As fortune would have it, in 2017, I had the opportunity to examine the blood flow in the head of a giraffe (Jade) at Dallas Zoo (the tip of the tongue to be precise), as the giraffe is the most extreme case of circulatory challenge against gravity. In fact, many experiments have been conducted on giraffes to understand how they defy the laws of physics regarding the relative size of their hearts and the length of their necks, where the heart alone is incapable of generating the necessary pressure such that blood reaches the head and brain. Many of these experiments, if not all of the them of which I am aware where highly invasive and resulted in loss of life. The concept of breathing acting as a siphon relative to the jugular vein has been conceived but to my knowledge "disproven".

My giraffe experiment proved the opposite, that it is the *enormous* power of giraffe breathing that moves blood upward during exhalation (arterial side) and both downward (venous side) and upward (arterial side) during inhalation - in other words, giraffe inhalation is so powerful that it creates negative pressure in the head to which arterial blood flows, aiding the rise of arterial blood against gravity. In a recording of Jade's tongue all we see is breathing induced blood flow, where the heartbeat is barely visible, the length of the neck integrating relatively short pulses (heartbeats) out of the picture. Toward the end of the veterinary procedure, Jade held her breath, an indication that she she needed to be brought out from under anesthesia, and when she did, the wave action stopped completely. (Swan & Stone, V2, Issue 5: Jade A Thesis On Giraffe Circulatory Physiology.) If it were not for the powerfully deep inhalation of the giraffe, necessarily followed by an equally complete exhalation, it would not be able to survive without lying down. Again, I posit that these are the oscillations referred to by Burman and Alperin in human subjects, where the same thing is happening in Jade's brain but at twice the rate.

Due to their evolution, giraffes must breathe this way in order to exist. Where humans are concerned, breathing well supports cellular health, particularly that of the brain because it is carried above the chest – whereas breathing poorly harms our brains and consequently the entirety of the central nervous system. Humans have a choice, whereas giraffes do not.

Stephen Elliott, President, COHERENCE LLC

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