COHERENT BREATHING®
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Hello all,

Welcome to Coherent Breathing®,Volume 4, Issue 3, January, 2026: ***Entropy & The Arrow Of Time***.

Figure 1: Entropy & The Arrow Of Time

Many are familiar with the term *entropy.* It was coined in 1865 by Rudolf Clausius, a German physicist and a founding father of thermodynamics, specifically, the Second Law, "That heat cannot pass from a colder body to a hotter body". The root of the word entropy is the Greek *entropia*, meaning transformation, where Clausius intended it to capture the "transformation content" of a system. The initial principle arose with French physicist Sadi Carnot in 1824, as a limiting principle regarding steam engines, that the upper limit of any engine is set by the temperature differences between hot and cold reservoirs (components), the higher the temperature difference between the two, the more efficient the engine, i.e., less heat is dissipated and *irreversibly* lost. 100% efficiency or output = input, has proven impossible to-date as a consequence of this unavoidable physical behavior of energy/heat, when energy is transformed, heat is generated and some portion of that heat will escape. It is necessary that heat is generated and that some portion of it escape, otherwise the engine will fail to function.

Clausius postulated that the behavior of heat is an essential expression of nature, that it's unidirectional behavior demonstrates a fundamental physical principle, "irreversibility", which he generalized with his "arrow of time", which says that all of nature moves in a direction toward entropy, the meaning of entropy haven taken on a much larger context, *the dispersal of energy with time*, as mass is energy, $m=E/c^2$, the dispersal of mass with time, from order to disorder. Everything that exists is devolving from order to disorder, everything that comes into existence, eventually fades into nonexistence. Ice devolves from solid to liquid, the water evaporates.

Everything that nature and humankind creates by integrating the mass of Earth, employs energy to bring order from disorder, raw material into some object. We invest human energy in the creation of objects via organization of material/mass, the finished product possessing the mass and energy of the raw components but now concentrated into ordered object form. But, the object is temporary. In time, positive entropy will call the material back to Earth. Maintenance can delay this process, but the final outcome is inevitable, everything heads toward positive entropy and thermodynamic equilibrium, i.e., when there are no net flows of heat, matter, or energy – dispersal/disintegration is complete. This process is universal and goes on all the time at temperatures above absolute zero. Shaivist philosophy attributes this continuous and inevitable coming and going to Shiva, the creator and destroyer.

This sounds like common sense when we're discussing inanimate lifeless objects. But what about "life"? Doesn't it defy entropy and the arrow of time? Interestingly, it is (atomic) physicist Erwin Schrödinger, of Schrödinger's Cat thought experiment fame, that introduced the concept of negative entropy or "negentropy", as it relates to living systems (***What Is Life?***, 1944). Living objects come into being via negative entropy, a gradual increase in order at the microscopic level as a consequence of increasing energy. From conception through maturation the body accumulates and organizes energy and mass. Erwin Schrödinger, along with Paul Dirac was awarded the 1933 Nobel Prize in physics for the formulation of what became known as the Schrödinger equation, which describes the wave mechanics of atomic particles. This completed a picture demonstrating that atomic matter can be described as both particle and wave.

Life forms are successful in building and maintaining internal order by extracting order from the external environment, this order or *negative entropy* working against the positive entropy generated by internal "life" processes that transform energy, this success supported by the absorption of *ordered* energy from food life forms consume (think acorn, apple, egg, fig, grass, leaf, flesh, bone, soil), the water we drink, the air we breathe, and our electrical connectedness to Earth, from which electrons flow on a continuous basis.

Because Earth consists of ~50% carbon, carbon makes up about the same percentage of the food chain. Internal processes "burn" this carbon-rich ordered dietary intake, breaking down the ordered matter into disordered molecules,

breathing exchanging carbon dioxide for oxygen with every breath we take. This meta-process – disorder from order, i.e., metabolism – is internal entropy, the result being heat (98.6° as it relates to humans) and metabolic waste. Sunlight is the highly ordered negative entropy energy source on which plant life thrives, taking in the disordered elements of Earth to build ordered structures, all the while emitting heat.

The entropy generated by the act of breathing is naturally balanced, negenetropy inhaled and positive entropy exhaled. Macroscopically, inhalation is neg-entropic, air (ordered matter) entering the system from the external environment; exhalation is pos-entropic, metabolic exhaust, CO_2, heat, and water vapor exiting the body. Breathing itself is an entropic process, flexion of the diaphragm and inflation of the lungs require energy transformation employing ATP (adenosine triphosphate), which is hydrolyzed into ADP (adenosine diphosphate) + Pi (inorganic phosphate), releasing chemical energy that muscles employ to contract. This produces heat. Breathing has been modeled as a compliant/elastic loop, where inhalation is effortful (flexion) and exhalation is effortless (relaxation). So, the products of entropy released during the work of inhalation are exhausted with the proceeding exhalation.

Life requires that order exceed disorder, that negative entropy outweighs positive entropy, where the balance is very delicate and changes as we age according to the arrow of time, all internal systems and functions gradually degraded by metabolic stress, gravity, Brownian motion, and other factors. So, anything and everything we can do to place a finger on the scale matters. Here, I posit that breathing and resonance are the low-hanging fruit, where both contribute to internal order, synchrony, and coherence, an internal order in which all cells participate.

Of course, it is not just breathing that is of importance. All intake should be naturally "ordered", as opposed to unnaturally ordered, take highly processed foods for example. Highly processed foods have been in the spotlight in the last few years, as they appear to be at the root of a health pandemic in the U.S. Why? An explanation I have read is that these foods were created during wartime as fast food for soldiers who did not have time for fresh wholesome nutrition. But then, when war ended, production lines revectored to offer these foods to the public, as "convenience".

Does the typical fast food impart positive entropy when consumed(?), vs. the negative entropy of nature's order? Given the process that many fast foods and packaged meals undergo during manufacture, where the naturally occurring ingredients are pulverized and mixed with various chemicals, flavors, colors, additives, and preservatives would this be surprising? The process sounds more likely to impart positive entropy than negative entropy.

Major References:

1) ***What Is Life?***, Erwin Schrödinger, Cambridge University Press, 1944
2) ***Entropy Production and the Pressure – Volume Curve of the Lung***, Oliveria, C., Araujo, A., Bates, J., Andrade, J., Suki, B., Frontiers In Physiology, February 29, 2016.

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