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LETTERS TO THE EDITOR

Comment on "The Timing of Conscious Experience" by F. A. Wolf

In his interesting article, "The Timing of Conscious Experience" (*JSE,* Vol. 12, No. 4, 1998), Wolf writes "Given Planck's constant, the speed of light, the gravitational constant... we cannot derive Boltzmann's remarkable constant." Why k is dimensionally independent of the h, c, G triad is that its definition stems from the *phenomenological* definition of temperature as independent of the mass (M), length (L), and time (T) triad, and that this definition is echoed in that of the entropy unit, let us say the *clausius.*

The universal constant R displayed in the experimental Boyle-Gay-Lussac law of perfect gases $pV = RT$ defines the absolute temperature T read on a perfect gas thermometer; so setting $R = 1$ with the dimension zero equates temperature to an intensive internal energy. This step was not explicitly taken, but the numerical value of R testifies to a practical choice of units.

Atomicity of matter, inferred by Prout and Dalton *via* chemistry, is implied in the fact that the equation $pV = RT$ is written for one mole of gas; RT thus is an internal energy per mole. Avogadro assumed that there exists a universal constant N such that (in today's nomenclature) by setting $k = R/N$ the equation $pV = kT$ holds *in the mean for one molecule.*

In the mean means probably, and probability bridges the gap from the discrete to the continuous. Maxwell, promoting the kinetic theory of gases, likened pressure to mean momentum and (up to some factor) temperature to mean kinetic energy per molecule; in this Boltzmann's constant k (so baptized by Planck in 1900) is implied.

Clausius, using $1/T$ as an integrating factor of the internal energy JQ, defined entropy as a state function *via* $S = J\int T^{-1}dQ$, and later Boltzmann likened entropy to lack of information, that is to imperfect knowledge and control of the gas. Setting $k = 1/\ln 2$ with the dimension zero expresses negentropy in *bits;* so $1/(k \ln 2)$ is the change rate from the essential bit to the practical *clausius. No connection can exist between k and h, c, G, because T was defined independently of the M, L, T triad.*

The fact-like enormity of the *clausius* as expressed in bits has a very significant existential import, exceeding even that of the fact-like largeness of Einstein's c as expressed in practical length and time units.

The largeness of c long hid, but its finiteness lately revealed, the relativity of time with an unexpected consequence: the time extendedness of matter. Time "passes" not in the relativistic paradigm but, as a French poet put it, "Le temps s'en va... las le temps non, mais *nous* nous en allons." So if the subconscious mind is time-extended, consciousness is misled in feeling that "*right now* I gain a knowledge or make a decision." No one playing with Feynman graphs doubts that matter is time-extended, and that the transition amplitude between preparations and/or measurements is the basic interpretative tool of quantum mechanics.

Prepared $<\varphi|$ and measured $|\psi>$ state vectors are named representations by Dirac, which is consonant with the Bayesian term estimation for a probability *and* with the meaning of $|<\varphi|\psi>|^2$ as a transition probability. Thus a back and forth reality-representation interaction is inherent in the quantum mechanical probability concept.

In cybernetical parlance, preparation is coding and measurement decoding. Then the Hermitian symmetry $<\varphi|\psi> = <\psi|\varphi>^*$ of a transition amplitude expresses a *law-like reciprocity between preparation and measurement* and confers *equal activity* to these interventions of the physicist. "The measurement perturbs the system" was a refrain of the twenties, and "The smoky dragon must bite no less than its tail must by grabbed," says Wheeler. Quantum mechanics endorses the information–negentropy equivalence concept, according to which coding impresses organization and decoding expresses knowledge.

The Lewis and Mehlberg fact-like irreversibility is formalized by the enormity of the change rate $\approx 10^{16}$ from the bit to the clausius: knowledge is very cheap and organization very expensive, or gaining knowledge is normal and psychokinesis is paranormal. The smallness of k long hid, but its finiteness lately revealed at one stroke, the minute cost of knowledge and the legality of psychokinesis.

Fallen cracked eggs do not jump off the floor into our stretched hands. That is true, but chemical elements do converge in building eggs; numerous information sources run against the Universal Negentropy Fall.

To summarize, independence of Boltzmann's k from the Planck triad h, c, G stems from the phenomenological definition of temperature as independent of the length, time, and mass triad, which is echoed in the definition of entropy. Insertion of Avogadro's number N in the equation of perfect gases, $pV = RT$, *via* the definition $k = R/N$ and Boltzmann's subsequent likening of *entropy* to *incomplete information* establish $k \ln 2$ as the change rate from the *bit* to (let us say) the *clausius*. As the quantal *preparation* and *measurement* correspond to the cybernetical *coding* and *decoding,* the enormity of the factor $1/(k \ln 2) \approx 10^{16}$ implies that *gain in knowledge* is cheap or *normal* and *organization* expensive or *psychokinesis* paranormal.

Wolf's interpretation of Eccles' and Libet's findings in terms of the "transactional interpretation of quantum mechanics" is *very significant.* But I feel more optimistic than he is concerning the ability of the probability, the information, the relativity and the quantum concepts to unravel "the mysteries of time."

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Reply to Costa de Beauregard

I would like to express my gratitude to Prof. Costa de Beauregard for his comments and observations. I would like to add a few comments to his remarks indicating where we are in agreement and where I sense there is some significant difference.

Costa de Beauregard is quite correct in pointing out that Boltzmann's constant k arises empirically from the phenomenological definition of temperature and its echo in the definition of entropy. Thus one should not expect to be able to derive it from any consideration of the triad of physical constants h, c, and G. The work done W on compressing an ideal gas, under pressure p, $W = -\int pdV$, is related to the hidden internal kinetic energy of the gas *via* $W = (2/3)N\langle mv^2/2\rangle$. Here N is the number of gas molecules each with mass m, in the volume V, and $\langle mv^2/2\rangle$ is the average kinetic energy per molecule.

The fact that a mixture of two different gases with molecular masses m_1 and m_2 in equilibrium would possess the same average kinetic energies, $\langle m_1v_1{}^2/2\rangle = \langle m_2v_2{}^2/2\rangle$, indicates the existence of a global, abstract, and empirical property associated with the average kinetic energy. This global property clearly does not depend on the individual characteristics that make up each particle in the gas. Defining this property by the term "temperature," T, then introduces a range of possibilities for the scale upon which it could be measured. Boltzmann's constant k then arises as a proportionality or scale term, $k = 1.38 \times 10^{-23}$ J/K. Hence, since the average kinetic energy per molecule is $3kT/2$, the ideal gas law equation, $pV = NkT$, arises.

Furthermore this law indicates the remarkable fact that any two distinct gases having the same temperature, pressure, and volume, each contain exactly the same number of molecules! (This suggests that temperature is as physical a concept as pressure or volume. Indeed doubling the temperature while maintaining the same pressure and volume would necessarily mean that half the number of molecules would be in the gas). Thus the chemists' notion of a *mole* arises as *the* number N_0 ($= 6.022 \times 10^{23}$) of objects in a gas such that one mole of the gas contains exactly the practically measurable amount

$R = 8.314$ J of energy at a temperature of 1 K. (Indeed $R = 1$ would be a logical choice with the scale of T appropriately defined.)

Brillouin (1962) pointed out that $k \ln 2 \approx 0.7k$ was the minuscule minimum entropy increase that had to occur in order to extract one bit of information from a system thus leading to Gabor's statement: *We cannot get anything for nothing, not even an observation.* But, to put enough bits of information back into the system, *i.e.* encode the system by changing any gross physical property is expensive, informationally speaking. To decrease the temperature of a gas by 1 K (cooling it around 8 J of energy), and thus to impart a *negentropy* to the system, using Costa de Beauregard's $1/(k \ln 2)$ factor, would require over 10^{22} bits. We might put it that it takes a lot of observation (encoding bits) to change the observable course of a practical physical system while it takes little (a few bits) to learn about it. This correctly explains the practical difficulty of achieving *psychokinesis* if by this term we mean transforming information into the movement of gross matter.

While Costa de Beauregard's observation that matter is time-extended (we know that it is space-extended) makes sense here, I don't believe the same can be said for the mind. Given... "that the subconscious mind is [also] time-extended," as he puts it, "consciousness is misled in feeling that familiar *right now*" sensation when a gain in knowledge occurs.

I don't agree. I would say that mind or consciousness is not misled. This is the way mind works. Clearly the extraction of knowledge arising from a sensation in the body causes the brain to do some bit of irreversible work. The brain's entropy must increase accordingly and that will take some time. One might put it that state preparation $|\psi\rangle$ and the ith state measurement $\langle\phi_i|$ producing probability $P_i = \langle\varphi_i|\psi\rangle \langle\varphi_i|\psi\rangle^*$ creates the "bit" entropy increase, $\Delta S_i = -k\, P_i \ln(P_i) > 0$, in the brain.

Thus, if we apparently know something before the brain entropy increases (I believe that Libet's data is telling us this), mind cannot be time-extended at all. Mind would need to be outside of time and space in order for it to gain knowledge before a measurement occurs (although after a preparation occurs). This knowledge then sets into motion activity of the body before the brain has time to record that this activity has occurred. (Perhaps this is the way the unconscious mind behaves.) It is only when the transaction is complete that entropy takes its toll on the brain.

We might say that when the transaction is complete the action becomes part of memory. Here, the Hermitian symmetry $\langle\varphi_i|\psi\rangle = \langle\psi|\varphi_i\rangle^*$ of the transition amplitude expresses a *law-like* reciprocity between preparation and measurement and indicates that at the unrealized or unconscious level of *law* there is no unique time order for a transition. The mind appears to be able to influence action at the level of law before the body records it at the level of *fact.* The *factlike* irreversibility formalized by the probability product P_i, is equivalent to the concomitant increase of the brain entropy, ΔS_i. The irreversible character of ΔS_i imposed by the practicality of the magnitude of k accounts for the completion of the irreversible action of consciousness on its physical substrate (the brain). It also accounts for the unlikelihood but not impossibility of "paranormal" phenomena (mind acting on matter to produce a decrease in entropy or increase in order).

Thus it isn't that coding, $|\psi>$, impresses organization and decoding, $<\varphi_i|$, expresses knowledge. It is that the complete "time-loop," $<\psi|\varphi_i> \ <\varphi_i|\psi> = P_i$, results in the physical reaction or correlation of matter to mind due to the beyond space–time action of coding and decoding. Mind, then, in being able to act outside of space–time, appears to be independent of matter, but nevertheless influencing its movement and perhaps the whole course of conscious history.

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Comment on "Correlations of Random Binary Sequences with Pre-Stated Operator Intention: A Review of a 12-Year Program" by R. G. Jahn, B. J. Dunne, R. D. Nelson, Y. H. Dobbins and G. J. Bradish

The Princeton Engineering Anomalies Research (PEAR) group is well known to readers of this journal. The longest run experiment conducted by this group has involved the Random Event Generator (REG) (Jahn & Dunne, 1988). The essential claims that have been advanced in experiments conducted with this device have been that the cumulative deviations from chance expectations when operators are invited to attempt to increase/decrease the mean count rate do indeed exceed that from chance alone when this is defined to be a terminal probability of less than $p = .05$ (*i.e.* a standard deviation of 1.64). Such a criterion is typical of work in this area but is substantially less stringent than that employed in the physical sciences where a deviation of the order of several standard deviations are more typical.

In previous reports (Jahn & Dunne, 1988) cumulative deviation plots are shown (see for example Figure II-5, p. 105) where the terminal probabilities for the data presumably influenced by operator intention do accumulate to less than .05, whereas the baseline data (accumulated in the presence of the operator but when the operator is instructed to ignore the apparatus) lies close to the horizontal axis and well within the $p = .05$ envelope. Several claims are