

Consciousness Clarified
With 2020 Vision.

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The Problem:

A mother takes her six year old child to the zoo. Justin has never been to the zoo before but at age 6 he knows what most of the animals look like from books and TV. Justin is 3.5 feet tall and weighs 50 pounds. Mother and child stop opposite the elephant enclosure. An elephant stands 20 feet away separated by a low wall and a moat. The elephant is 12 feet tall and weighs 5



tons. Justin looks at the elephant. Let us consider what happens next. Like it or not, we all live in a swirling sea of electromagnetic radiation. These include radio waves, X-rays, microwaves, cell phone transmissions and light waves. Some pass through us and others bounce off. It would be a waste to process them all but as humans, we have evolved the capacity to process wavelengths

from about 400-700 nanometers (billionths of a meter). This is the visible light spectrum from violet to red. Light from the elephant is focused by the lens in our eye onto the inside of the back of the eyeball, the retina. The image is upside down but that is not the strangest thing. The cells of the photoreceptors convert the electromagnetic radiation to nerve signals. Elephant data is digitized into a staccato stream of impulses racing along the million fibers in each optic nerve, in total darkness. Note well that the elephant did not enter Justin's brain, coded impulses did. The nerve impulses travel backwards via the optic chiasm to form the optic tract around the midbrain and on to the lateral geniculate nucleus (LGN), then to the optic radiation and on to the primary visual cortex. The visual signals are processed, and the next thing Justin knows is that the elephant appears in his visual perceptual space. Justin is the percipient, but what and where is the percept, i.e. the elephant? Milliseconds before the percept appeared all the information describing the elephant consisted of nerve signals; the brain did

not construct a flesh and blood pachyderm! Justin's neurons exist in physical space but the percept itself is not a physical object in physical space; it is a non-physical construct in non-physical space. The percept is also scale free, it has no size. A 5-ton elephant will not fit into the head of a 50-pound child.

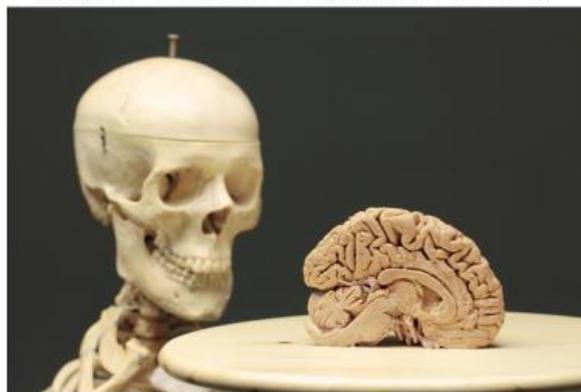
The real, physical elephant is 20 feet away from Justin and the visual image enjoyed by Justin seems to correspond with that estimated distance. However, we know that the neural machinery producing the percept is in the brain, so is the percept inside or outside Justin's brain?

The answer is neither.

To assign a location in physical space, either inside or outside the skull, to a non-physical object in non-physical space, is a non sequitur. As Bertrand Russell pointed out 90 years ago, "Physical and perceptual space have relations, but they are not identical, and failure to grasp the difference between them is a potent source of confusion". (1) An enormous amount of time and effort has been spent in the search for the fabled anatomical correlate of consciousness. The percept is in fact a veridical illusion. Like a rainbow it is real but intangible.

Is Consciousness **inside** or **outside** the skull?

Neither; a non physical perception cannot have a location in 3D physical space; it is the subjective counterpart of sensation, transduced into brain language. Like the rainbow, consciousness is intangible; a veridical (real) illusion.(SPOOKY)



Before we embark upon an explanation of consciousness, a small amount of background knowledge is required.

Koch Curve 1.26 D

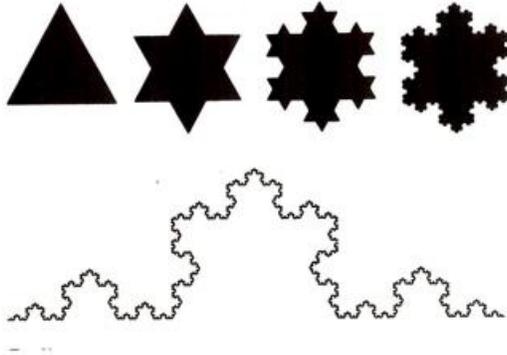


Figure 1.

In Fig. 1 triangles are added to triangles to create the “wiggly” line at the bottom where the original shape is repeated in smaller and smaller versions of the original. The line is more than 1 Dimension (1D) but less than 2D. It is a FRACTION of a Dimension, 1.26D. ($\log 4 / \log 3$) That is why the shape is called a FRACTAL. There are lots of fractal shapes in the human body, for example, the lungs, arterial tree, the venous system and neurons with their dendritic branching. (2)

1D Attractor in Phase Space.

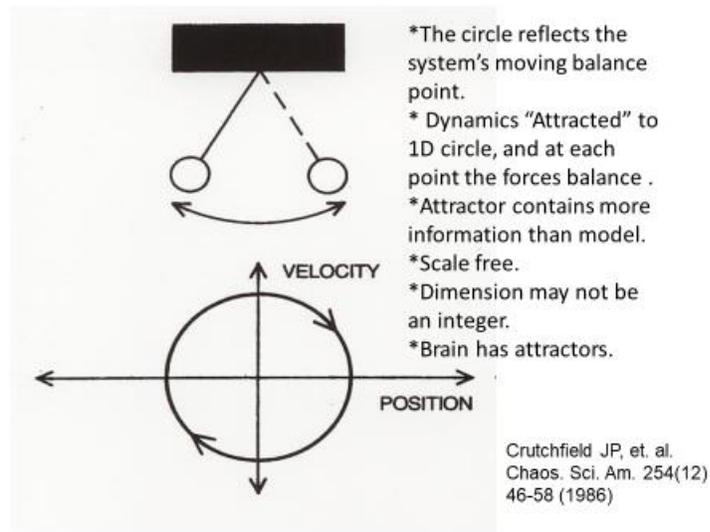


Figure 2.

In Fig. 2 the dynamics of a simple pendulum is expressed by plotting velocity versus position.

The circle is the ATTRACTOR and contains more information than observation of the pendulum itself. If you grab the pendulum and stop it swinging, all you can deduce is its position at the time of rest; by examining the attractor plot, the pendulum's position and velocity may be observed at that time. If the pendulum wobbles the circle becomes lumpy but it is ATTRACTED back into its circular shape, hence the name. Attractors are associated with the electroencephalogram (EEG) and like the Koch Curve their dimensions are non-integer.

Pendulum dynamics.

As GRAVITY gives weight to physical objects; ATTRACTORS give direction to dynamical systems. They are both invisible. If a brain is cut open, there are only neurons to be seen, no attractors.



Attractor has a DIMENSION which is one measure of its complexity.

Figure 3.

In Fig. 3 the 1D circular pendulum attractor is stretched out in time and viewed from the side. The resulting sine wave is beginning to resemble a scalp recording of brainwaves or the EEG.

Computer programs exist whereby the recorded EEG may be converted to display its own attractor in real time.

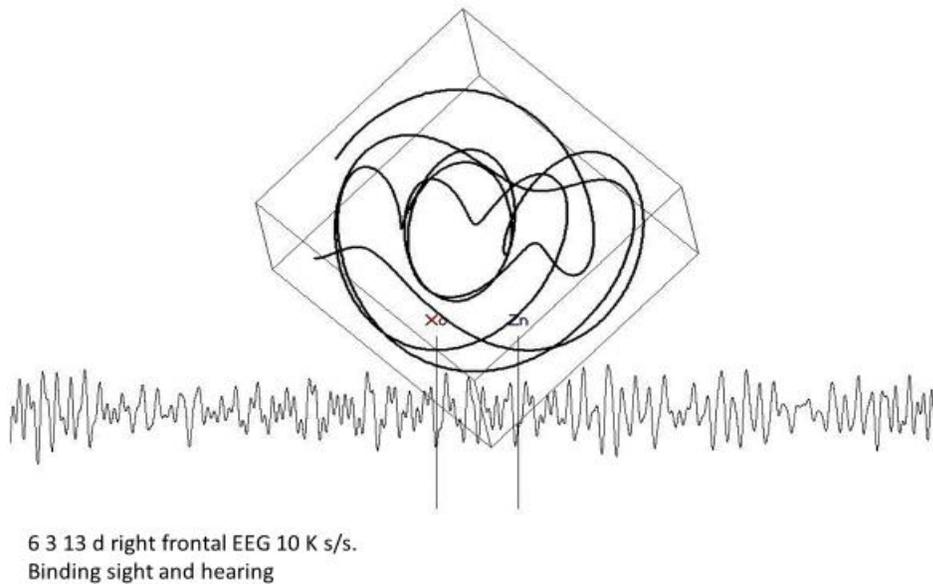
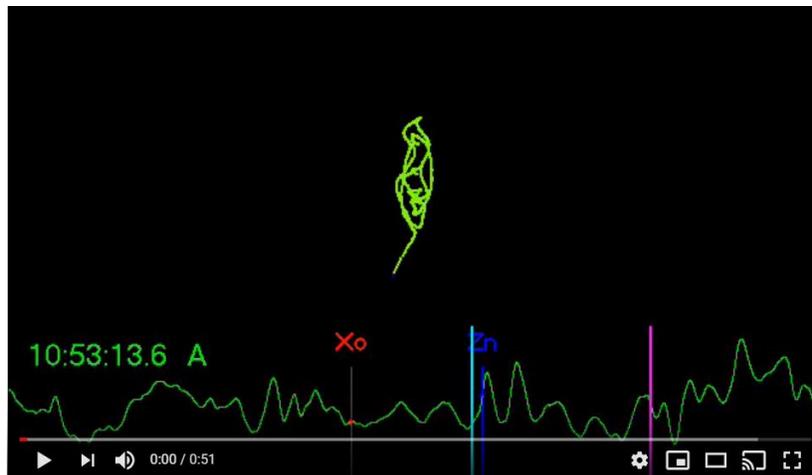


Figure 4.

Fig. 4 shows a frontal EEG with its associated attractor above. The EEG is a lower dimensional derivative of the attractor itself. The attractor is reconstructed by delay co-ordinate embedding and may be viewed in real time as a rotating movie.

The following Movie Clip is a frontal EEG with attractor recorded during mental arithmetic (Subtracting 17's sequentially from 500). Note that during intense concentration, without the senses intruding into perceptual space, the attractor is generally flattened, i.e. of a low dimension. Recorded at 1/1000 natural speed. (See separate attachment)



We studied the evolution of consciousness by plotting attractor dimensions of 21 species against the age of their oldest fossils. For example, fossil frog brains are virtually the same as the brains of today's frogs. The frog of today is a surrogate for its long dead ancestor. We measured the frog's EEG attractor dimension and plotted this at about 320,000,000 years ago, the age of the first frog fossil.

It did not surprise us that the maximum attractor dimension increased during vertebrate evolution (Fig 5.)

EEG Highest Attractor dimension vs. Time of Species first appearance.

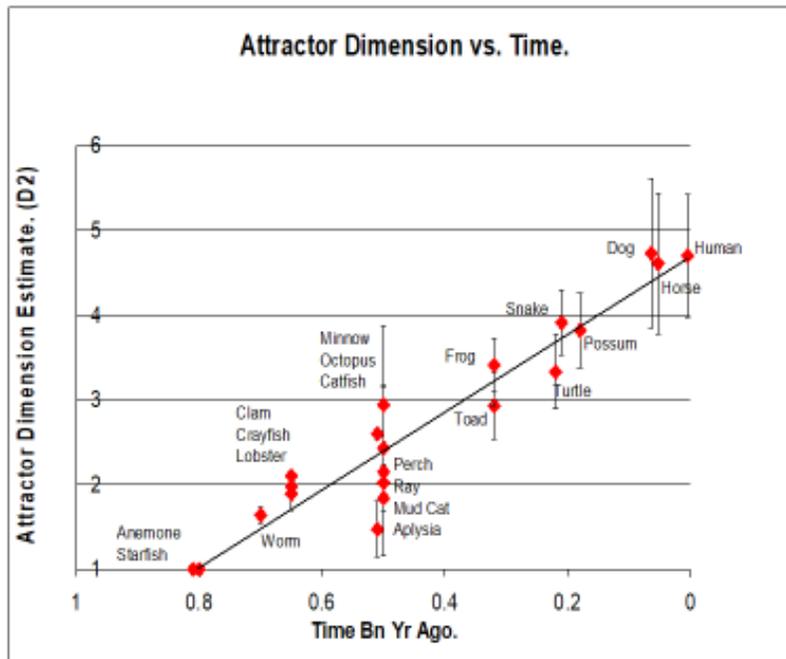


Figure 5.

When we looked at ALL the results, in Fig.6, not just the highest attractor dimensions, we were puzzled.

It was obvious that by concentrating on the highest attractor dimensions we had overlooked the variety of dimensions which the brain employs in everyday consciousness. This variety probably holds the secret to binding, which is one of the greatest mysteries of consciousness. How can we process different senses simultaneously, especially when the sites for sensory processing are scattered about in different parts of the brain?

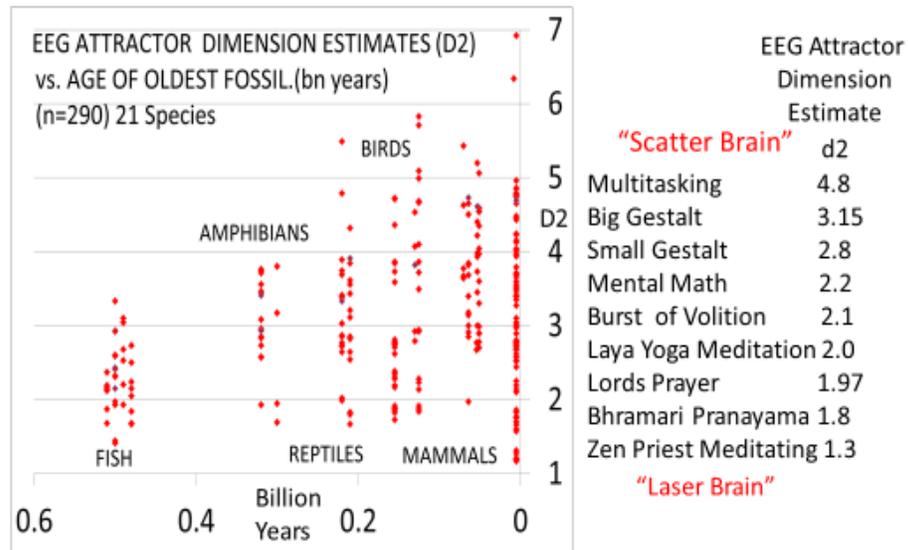


Figure 6.

Fig. 6 plots the EEG attractor dimension against the age of the oldest fossil. These are combined results from 290 recordings from 21 different species.

In Fig. 6 human studies are at the right-hand side of the graph. Why does each animal reside in its own cluster? Why do the clusters increase in size as the vertebrate brain evolves? How may a catfish sometimes have a larger attractor dimension than a professor? The answer lies in the number of senses being employed at the time of measurement.

The animal's chance of survival is improved if it can see, smell and listen all at the same time. How does the brain do this without mixing up the signals?

How does an animal cope with attractor dimensions over 3D? By looking back to see what the humans were thinking at the time of the EEG recording, I believe we have found the answer. We constructed a league table of human attractor dimensions, Laser-brain to Scatterbrain, from 1D to ~5D. (Fig. 6.)

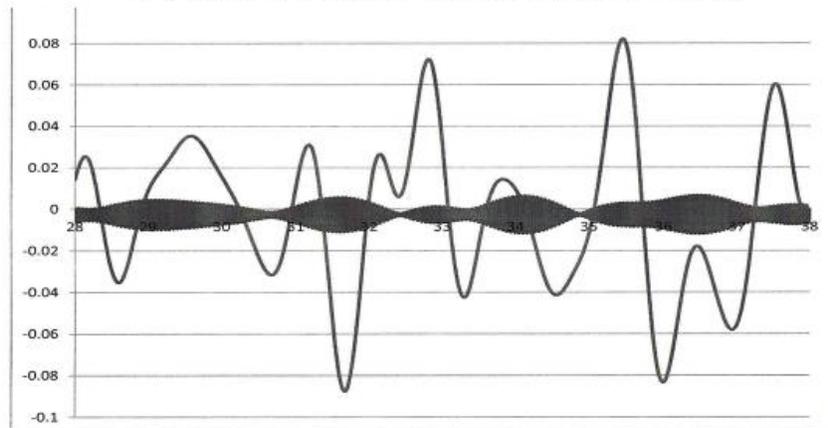
The smallest four attractors (1.3D-2.0D) all involve subjects meditating or at prayer. Under these conditions the conscious mind is closed to the senses while the subject concentrates on the prayer or "nothing". Ideally the subject sits comfortably with the minimum of sensory input. With the EEG burst of volition when the subject decides to hit a button, and with mental arithmetic, the subject is concentrating hard on a

single task. (Attractor dimensions 2.0D and 2.1D.) During the Small Gestalt, the subject is suddenly exposed to a clicking and flashing metronome which then occupy his perceptual space. (Gestalt in this instance means a combined sensory experience.) During the Big Gestalt, the subject tastes citric acid (lemon juice), listens to the weather radio, sniffs acetone and reads Plato's *Republic*. The dimensions increase accordingly till the subject is asked to multitask, when the attractor dimension increases to 4.8D.

It was beginning to appear that with every extra sense employed in perceptual space, another dimension is required. Why is that?

Figures 7 a & b.

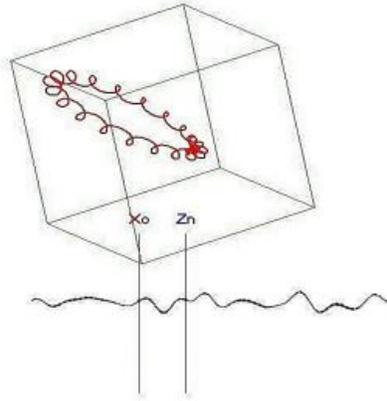
Two possible carrier frequencies; 0.15-1.6 Hz, and 18-19 Hz.
How may data be perceived simultaneously and yet retain separate qualities? (4/28/13/e 28-38 sec)



File 4/28/13 e Right Frontal
EEG 10K s/s
Click/Flash 40X/min.

The Natural State

“Separated” by 3D co-ordinate embedding.
Signals inhabit their own dimension.



File 4/28/13 e Right
Frontal EEG 10K s/s
Click/ Flash 40X/min.

Fig. 7a shows two carrier frequencies of about 1Hz and 20Hz. How may hearing and vision for example, be perceived simultaneously and yet retain their separate qualities.

In Fig.7b we see those two frequencies isolated from the Small Gestalt EEG and recombined. Remember that the EEG is a degraded version of the corresponding attractor. When the attractor is reconstructed the high frequency signal is embedded in the slower frequency signal. The lazy circle represents the low frequency while the high frequency signal is the tight coil embedded within it at right angles. The signals each inhabit their OWN DIMENSION. In this way the signals are both separate but bound together at the same time. In other words, sensory binding has been accomplished while the perception of vision and hearing have been kept separate.

We know that the attractor harbors information which produces our perceptions but how do we perceive complex attractors which are more than 3D?

Many investigators believe that consciousness is cinematographic; that it consists of rapidly sequenced frames at about 40Hz, like an old movie projector.

This may offer a clue as to how we, as 3D creatures, may comprehend the content of higher dimensional attractors.

In the story of Flatland, (3) a sphere arrives in Flatland to convince a 2D square that a higher dimension exists. Using this story as a model, assume that the sphere passes through the fabric of Flatland leaving a hole which gets bigger and bigger then smaller and smaller.

Sphere passes through the fabric of Flatland.
Square sees a 2D disc.

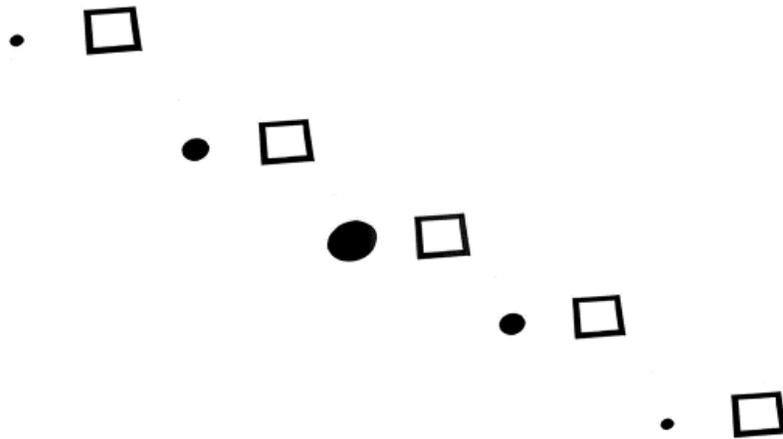


Figure 8 shows the sequence. Now if square can see and store these discs in his short-term memory, and stick them together, he will form an approximation of the sphere in his own perceptual space.

2D Square constructs 3D image by stacking discs in perceptual space.

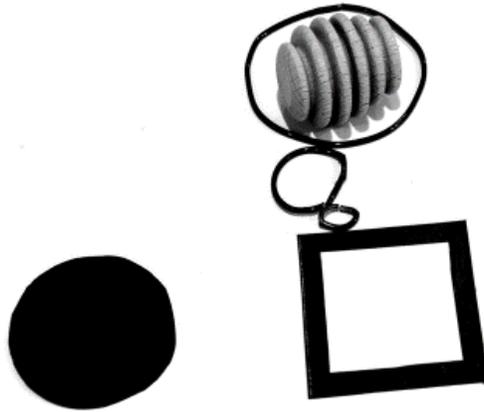


Figure 9 shows the square constructing the sphere in his perceptual space. The dimensionally impaired square exceeds his pay grade by perceiving a higher dimensional object than himself.

The “Honey spoon” theory of consciousness is outlined in Fig. 10. Successive frames of AM wave packets are added every ~ 25 ms only to fade at ~ 400 ms. The “Honey spoon” moves through the mind rather like a consciousness comet, adding dusty data at the front while losing matter from its tail. The “Honey spoon” is a multidimensional spatiotemporal construct providing a “location” for consciousness and a site for binding data (4). By using perceptual space, the percipient is freed from the constraint imposed by the event horizon of 3D physical space.

“Honey spoon” theory; the Conscious Moment. The thought going through your mind.

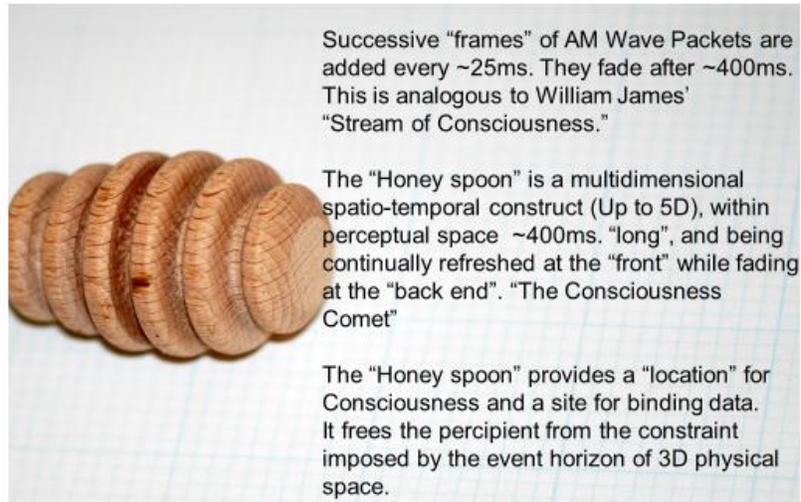


Figure 10 demonstrates the “Honey Spoon” theory of consciousness. This idea concurs with Freeman’s Mass Action. (5,6). Fig.11.

Freeman’s Mass Action (FMA).

Walter J. Freeman and Robert Kozma (2010), Scholarpedia, 5(1):8040.

- Memory stored as synaptic configuration.
- Neurons that fire together, wire together.
- Odor > Whole Olfactory Cortex responds.
- (Orchestra may remember many pieces).
- “Gamma Burst” > AM spatial pattern.
- Spreads to whole Sensory Cortex.
- Cortex > 2D arrays > Maxwell Vector Field.
- 2D arrays added like a 3D printer.
- In Forebrain, different senses > Gestalt.

Figure 11

In FMA, an odor, for example, stimulates the whole olfactory cortex which generates a Gamma burst in an AM spatial pattern. This spreads to the whole sensory cortex in 2D arrays like wind blowing over a wheat field (Maxwell Vector Field) to be deposited like the layers in a 3D printer, to construct a cinematographic image in perceptual space.

In this short article we have concentrated on neuro dynamics; our position would be described as substance dualist. The method of sensory binding which we have described may offer a clue as to the reason consciousness evolved in the first place; it could be a method of prioritizing sensory input to improve the speed and accuracy of executive action.

A significant group of consciousness investigators believe that consciousness arises from Quantum effects (7,8), while others think that consciousness itself is fundamental in the universe. Information integration has been addressed by Tononi and Edelman (9) while hierarchical aspects of perception and the free energy principle have been advocated by Friston (10).

Consciousness is so mysterious that we all may be right!

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Glossary:

Attractor; A point in multidimensional phase space that is used to describe a system towards which system tends to evolve regardless of the starting conditions.

Billion: In American English, one thousand million. Until 1976 a billion in British English was a million million at which time the American English usage was adopted.

Carrier Frequencies; Amplitude Modulated (AM) brain impulses which carry information from the sensory cortex to the frontal areas and into perceptual space.

Consciousness; A state of being awake and aware of one’s surroundings.

Delay Co-ordinate Embedding; When a digital signal is repeated three times with an appropriate delay the signal may be plotted in 3Dimensions to give an approximation of the associated attractor.

1,2,3,4,5,6,7,8,9

1,2,3,4,5,6,7,8,9

1,2,3,4,5,6,7,8,9 Plot 3,2,1. Then 4,3,2. Then 5,4,3 and so on.

Electroencephalogram (EEG); Recording of voltage changes at the scalp from underlying brain tissue. Measured in thousandths of a Volt.

Gestalt: Literally form or pattern. The brain creates perception that is more than simply the sum of sensory inputs. A combined sensory experience.

Hertz (Hz); The SI unit of frequency equal to one cycle per second.

Intangible; Unable to be touched or grasped; not having a physical presence.

Koch; 1904 Helge von Koch, a Swedish mathematician described the Koch Snowflake, one of the earliest fractals.

Maxwell Vector Field; Arrows in a vector field denote direction as well as size (e.g. a map of wind speeds with arrows showing wind direction). Scalar fields only numerate one measure (e.g. map showing temperatures in different areas).

Nanometer; One nanometer is one billionth of a meter.

Veridical; Genuine. A rainbow is a veridical illusion whilst still being intangible and real at the same time. This apparent contradiction is typical of the problem of explaining consciousness.

Suggested Reading:

Walling P.T. "Brain, Mind, Cosmos" 2014. Edited by Deepak Chopra. Chapter 30. The Dynamics of Consciousness.

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Anesthesiology. 2006 105: 927-935.

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