Scientific Animism

By Lorenzo Sleakes

Panpsychism in the Natural World

We know that we humans are mental beings able to experience the world around us and act in reference to what we can experience. But because we cannot see that another individual sees it is impossible to know for sure where mentality or sentience exists in the world. We assume that because we are human and we are conscious then other humans must also have a subjective inner mental life. Although we may see the same objects another mental being sees we cannot see the seeing of another sentient being. We cannot observer observers for that would lead to infinite regress. Therefore the existence of other minds must always be inferred from behavior. This paper provides criteria to help decide where mental individuals actually exist in the world and applies those criteria to make inferences about the location of mental beings in our natural world. The criteria are simple and minimal and will apply to animals and other kinds of entities beyond those with complex nervous systems. The assumption is that subjective mental beings are part of the natural order and not necessarily dependent on complex brains and sophisticated thinking, memory or imagination.

In general we can say that another mind exists where there is a persistent source of individual activity that is purposeful and directed towards consistent goals. The purposeful behavior acts with reference to what appears to be perception of a local environment and operates in a teleological manner enabling flexible behaviors that can achieve or approach the same end goals from different starting points. Said William James: “pursuance of future ends and the choice of means for their attainment, are thus the mark and criterion of the presence of mentality.”
Mental beings are in a constant feedback loop with their environment, acting and perceiving and then acting again to approach a goal state. Mental beings are able to take into account the local environment as a whole scene and in doing so they are able to move in a manner which in itself is organized and holistic. Mental beings come with a history and an attitude. They have characteristic unique individual personalities that persist over time and adhere to a principle of conservation. Mental beings always have a history, having evolved from other mental beings. Mental beings are consumers of energy which is required for action. Mental beings are able to interact with their immediate local environment which includes the recognition of neighbor mental beings and in doing so are able to create a higher level order such as a social organization that is larger and more complex. Mental beings can only react to what is within their field of experience, so for example an object just outside the boundary of one’s visual field will cause no reaction until it enters the visual field and a thought that never enters consciousness cannot be acted on. In other words observers are self contained subjective worlds with boundaries and what is presented within those boundaries provide the input for goal oriented activity and continual monitoring or feedback. This guide for where to find sentience in nature will show that it is potentially ubiquitous.

Clearly certain entities do not qualify as mental individuals but are social aggregates created from the interactions of mental individuals operating at a lower level. I will contend that atoms, crystals, bacteria and plants are not true individuals with mentality and agency and instead fall into this social aggregate category.

Here are some writings from the biologist Charles Birch, a leading exponent of the panpsychic view.

Birch http://pandora.nla.gov.au/pan/20423/20011210-0000/www.alfred.north.whitehead.com/discussion_papers/birch_01.htm

> "An individual entity is that which acts and feels as one. To feel in this context means to take account of the environment such that the individual is, at least in part, constituted by such taking account. An electron is an example of an individual entity.
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> By contrast, an aggregate, as I use this term, is a grouping of individual entities that does not lead to a higher order of unified experience. There is as variety of aggregates. A chair, a computer and a motor car are aggregates. They have each a considerable organization but there is no evidence that they exhibit a unified experience. A motor car may be said to act as one when someone sits in the driver's seat and directs its activity. But it has no such directed action apart from some outside influence such as a driver, be that a human or a robot. A pile of sand is an aggregate and so too is as rock of granite. A rock of granite is far more organized than is a pile of sand but there is no evidence that either has a unified experience. Hartshorne (1977 p.91) gives four reasons for thinking that rocks, chairs and the like are devoid of mind; their inertness, they do not seem to do anything; their lack of freedom in the sense of initiative; their lack of individuality in the sense of unity and uniqueness (the parts of a chair such as nails, glue and pieces of wood have only a mechanical unity when stuck together) and fourthly their lack of intrinsic purpose. Panexperientialism asserts, not that all things have mind or feeling, but that all physical things are composed of individual entities that experience…
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> Panexperientialism generalizes experience (feeling) to all individual entities. Consciousness is understood as a high level experience which involves memory of past events and conscious anticipation of future events. At its highest levels it involves richness of experience with its components of zest and harmony. Experience generalized to all individual entities is conceived to have two components, something akin to memory of the immediate past and something akin to anticipation. Together these give meaning to the phrase 'to take account of the environment internally'. We can get clues to the meaning of this generalized experience both by analogy with ourselves and from quantum physics when it conceives the individual entities, not as parts of a clockwork but as a network of relations…
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> The doctrine that mind emerges from no mind implies that there was a stage in biological evolution when mind appeared for the first time. But where is that line to be drawn? In so far as any line is drawn it is completely arbitrary. The logical alternative is to propose that there is no line of demarcation any more than there is a line between living and nonliving in evolution. This overcomes the problem of why consciousness evolved…."

Birch says the world is made out of "individual entities" such as electrons and aggregates such as chairs. Individual entities have an inner aspect, a mental side and are active causes, while aggregates are

merely amalgamations of individual entities. How can we tell what kind of objects are individual entities and which are aggregates? Individual entities appear to be active and initiate some characteristic behavior. Furthermore, they are able to dynamically interact with other individual entities, by sensing them, to create some larger complex organic social whole. Based on the above criteria, in the following paragraphs I propose that the true sentient self-moving individual entities that create the world of complex objects here on Earth are the following from bottom up:

1. **Elementary point-like particles** such as electrons and quarks which interact to generate atoms, molecules and crystals; in short all the structure in the world. Atoms, crystals and coherent waves are aggregates made from the elementary particles.
2. **Protein molecules** which are the foundation of all life on the planet Earth and interact to create all living cells. Bacteria and viruses are protein aggregates.
3. **Eukaryotic cells** which are able to interact with each other to generate complex multicellular organisms and even more complex brains. Plants are aggregates made from eukaryotic cells.
4. **Animals with nervous systems** which are able to interact with each other to create families, societies and ecosystems.

The elementary particles

If electrons are individual entities with some inner existence then are atoms and molecules? I would say no. Electrons as understood in quantum physics are no longer like dead pieces of rock or marbles. They are fundamentally active and somewhat unpredictable. An electron uses energy by absorbing and emitting photons and in doing so is able to act or change its path of motion. While collections of millions of electrons averaged over time can behave in a highly predictable way, individual actions by individual electrons are not highly predictable. The fundamental particles of quantum physics such as quarks and electrons then do seem to be real individual entities. They are able to sense other quarks and electrons in their local environment as a whole scene and interact with each other to create larger more complex aggregates such as atoms, molecules and crystals. The fundamental particles "recognize" each other in the local environment and pass photons of energy back and forth as a kind of glue to hold the structures they create together. As the Natives believed, exchange is the glue that creates the world. From No Word for Time - the Way of the Algonquin People by Evan Pritchard: "...exchange is the axis upon which the world spins – it keeps Creation going. Every living thing must give and take in order to participate in Creation. "

The famous physicist Freeman Dyson said:

> "…mind is already inherent in every electron, and the processes of human consciousness differ only in degree but not in kind from the processes of choice between quantum states which we call "chance" when they are made by electrons.
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> Jacques Monod has a word for people who think as I do and for whom he reserves his deepest scorn. He calls us 'animists', believers in spirits. 'Animism', he says, 'established a covenant between nature and man, a profound alliance outside of which seems to stretch only terrifying solitude. Must we break this covenant because the postulate of objectivity requires it?' Monod

> answers yes; 'The ancient covenant is in pieces; man knows at last that he is alone in the universe's unfeeling immensity, out of which he emerged only by chance.' *I answer no. I believe in the covenant. It is true that we emerged in the universe by chance, but the idea of chance is itself only a cover for our ignorance. I do not feel like an alien in this universe*."

Elementary particles are no longer considered to be dead pieces of rock. Electrons, quarks and photons do not appear to be made of any constituent smaller pieces; they are truly fundamental. When we look at a rock we see only inert deadness but we know now that inside the rock the electrons and quarks are in constant motion and use energy to act and "swerve" somewhat unpredictably. On the other hand atoms, molecules and crystals appear to be nothing more than aggregates made out of the dynamic interaction of these fundamental particles.

We are often told by physicists that everything can be explained by the four fundamental forces which includes electromagnetism but in fact the complex structure of the material world of atomic elements, molecules and crystals is not completely derivable from such forces. For example a critical add-on known as the Pauli exclusion principle is used in order to predict how the elementary point-particles will behave to generate the atomic structures as they are actually observed.

From Harold J Morowitz in "The Emergence of Everything":

> "If the electron distribution of quantum mechanics stood as the sole governing principle, the world would be a sea of nuclei and quantized low-level electrons, but the Pauli exclusion principle means there are discrete associations of nuclei and electrons, so that the universe at lower temperatures operates as a world of ordinary atoms leading to chemistry, structure, and all other rules we are familiar with in working with ordinary material. The sophistication of distributing electrons in energy levels comes from the Pauli principle….The simple statement of the exclusion principle is that no two electrons in an atom can have the same four quantum numbers. This leads to an understanding of the shell structure of atoms, the facts of chemical valence, the spectra of atoms and molecules, and the structure of crystals.... Another feature of the exclusion principle is that it begins to illuminate how the whole may be different from the sum of the parts. For the exclusion principle has nothing to say about the behavior of an individual electron, yet it applies to a system of two or more electrons. The Pauli principle is a way of understanding why entities show in their togetherness laws of behavior different from the laws that govern them in isolation…The previous argument is worth restating. The emergence of the periodic table has a special character. The pruning rule is apparently a deep principle of physics, but it is unrelated to the other laws of physics."

The extended structure of matter which takes on the forms of atoms, crystals, molecules and electrical currents is based on complex patterns of behavior in which the active participants recognize each other and coordinate their relational activities as social beings to create complex and sophisticated structures. These abstract patterns of structure necessitated the formulation of new abstract principles added ad-hoc to the forces of physics in order to capture this self-organization and therein enabled us to understand at a deeper level the periodic table of the elements and the principles of chemistry.

It is much too simplistic to state that the Pauli Exclusion Principle states that each electron must have its own unique set of the four quantum numbers. The fact that there even are four quantum numbers is based on empirical observation and not derivable from first principles of simple attraction and repulsion. The four quantum numbers already represents a specific structural pattern of organization and all we can say is that social grouping of electrons and neutrons like to act in this way. But even this acting is always a propensity and the wave functions that describe it are merely probability waves for finding where within the organized structure of the atoms and molecules, the electrons are most likely to be found.

The structure of the electron configurations around the atomic nucleus creates the spatial extendedness of the atom and is a complex organization with its own game rules. Electrons revolve in discrete orbitals and there are never more than two electrons per each discrete orbital. Each orbital is unique as to its size or energy-level (distance from the nucleus), shape (spherical, plane polar, plane cloverleaf) and if planar - it's orientation (for example along one of three Cartesian spatial coordinates: x, y, z). In the simplest elements, Hydrogen and Helium the electron orbitals have just one size and a spherically shaped probability wave. As the elements get heavier and more electrons are added to balance out the protons in the nucleus, more complex patterns emerge but at the same time the simpler ones are never lost. For instance, the next shell of electrons still contains a spherical shaped orbital but now also adds the possibility of polar shaped orbitals in the three separate x, y or z orientations. Then the next size level (3) retains the spherical and polar shaped orbitals from the second level while adding five new cloverleaf shaped orbitals each with their own unique orientations. Note that the number of orbitals in a shell is the square of the level or shell number so for example, level one at size 1 has 1 orbital, while shell two has two squared or 4 orbitals and level three has three squared or 9 orbitals (1 spherical, 3 polar, and 5 cloverleaf). None of this emerging sophisticated and detailed structure would have been predicted or derived from electromagnetic forces alone. It was derived from empirical observations, and yet this abstract physical law stands at the very heart of modern physics and chemistry.

The electrons act as if players in a game. Imagine a baseball team where eight fielders are already on the field and in position – the ninth player who is sent into the game must look for the position where there is a hole and step in to fill the spot. But how can they do it without some form of awareness of their local environment?

From Dan Sewell Ward at http://www.halexandria.org/dward149.htm:

> "Perhaps, even more significantly, Pauli's Exclusion Principle is not enforced by any physical force understood by mainstream science. 'When an electron enters an ion, somehow it knows the quantum numbers of the electrons which are there, and somehow it knows which atomic orbitals it may enter, and which not.' This is nothing short of incredible!! It implies **consciousness** or **connectedness** between any and all elementary particles, and by a method totally unknown to the mainstream purveyors of quantum physics. In effect, an electron avoids occupied orbitals -- in much the same way most motorists might avoid parking in occupied parking spaces -- but this avoidance is not due to electrostatic repulsion or some

mechanical property. The avoidance is due instead to the anti-symmetry requirement of the wave function of this spin-1/2 particle…

Furthermore, when two atoms come within close proximity to one another, the concept of each being in a separate state loses its meaning. Thus two atoms with closed shells find they cannot form a chemical bond because the electrons in one atom find no available quantum states in the other in which to occupy. In effect, even though the atomic nuclei in molecules are surrounded by what is essentially empty space, the atoms cannot be forced together because the symmetry of the quantum wave functions forbid it. And the electrons know it! The electrons know what the other electrons are doing, and what quantum states they are in. And such knowing implies **consciousness** on the parts of elementary particles."

Proteins…the molecules of life on Earth

Molecules can become quite large and complex. One kind of very large molecule in particular, proteins, appear to meet the standard of being true individual entities. As elementary particles such as quarks and electrons are the building blocks for all material structure in the Universe; Proteins are the building blocks of all Life on the planet Earth.

Proteins are the workhorses of all life in all living cells and are the active players in creating the complex structures and processes that go on in each living cell. Proteins are long single linear polymer chain molecules that fold into complex shapes and can twist into more than one shape. These different shapes are called conformations and are what enable proteins to do work. Think of a protein as like your body which has areas in it that are flexible, such as the joints and rigid areas between them. Proteins can bend at their joints and in doing so do work to make things happen. Proteins like all "individual entities" use energy in acting. For elementary particles such as electrons the energy is supplied by photons of light. For protein molecules all energy is supplied by ATP molecules. ATP molecules act as little portable batteries that are able to supply the energy for proteins when they need it.

Proteins in the living body are workers and specialize in different tasks. Some proteins called enzymes can break up larger molecules into smaller ones or bring together small molecules to create larger ones. Some proteins provide structure and some physical movement such as the proteins that build muscles. Other proteins act as part of a complex signaling network and are essentially switches between information states which can then be carried down a chain of proteins acting almost as nerves inside a nervous system.

Boyce Rensberger in his "Life Itself: Exploring the Realm of the Living Cell" describes how the protein kinesin acts to transport small bubbles filled with cargo (vesicles) from internal to external locations inside a cell by pulling on microtubule structures made of other proteins:

> "Kinesin not only makes other things move, it does so by undergoing motion of its own - flexing and swiveling at points within its structure. The idea that molecules can change shape may seem odd to those who imagine them to be like rigid, stick-and-ball models. Some molecules are indeed as rigid as the models imply, but many, perhaps most of those that give life its distinctive properties, are flexible or, at least, as changeable as the shape of say a pair of pliers or a can opener or, for that matter, almost any windup toy. Like most machines, these molecules can move with respect to one another only if an energy source is available. For simple machines, the energy source may be the muscles of the human hand. For workhorse proteins, the energy comes from ATP.
> Kinesin is a motor. One end of the motor grabs onto the vesicle and the other latches onto the microtubule. Then the kinesin flexes and pulls the vesicle forward along the microtubule. The image is something like that of a man sitting in a rowboat and pulling it along a pier by using his arms and working hand over hand. The pier is the microtubule, the track of the transportation system. The boat is the vesicle, carrying a load of molecules to some other part of the cell. And the man is a kinesin molecule, a motor molecule. As the man flexes and swivels, the boat is hauled the length of the pier."
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> "…the discovery of the motors may be historic. After all, it is the autonomous movement – movement that is the result of some power within the moving object (and not simply the result of gravity) – that signifies 'life' most dramatically. It is motion that 'animates', providing the very root of the word animal. In early science, the motive power was the vital force. In its Judeo-Christian form, that source came from God, acting though the soul."

Rensberger goes on to say that we no longer need to view life as made of a protoplasm jelly imbibed with a vital force, because the very processes of autonomous motion so characteristic of life can be ascribed to molecules that we now know make up the protoplasm. If the motor power, the power of autonomous action is coming from protein molecules then perhaps what was considered dead pieces of matter are not so dead after all? Does it not make sense that the very building blocks of all life on earth are in some way we cannot easily imagine also alive? It certainly seems like these motor proteins are aware of their local environment and act in a purposeful manner. This reminds me of Will Durant in the Story of Philosophy in his critique of the vitalist position of the philosopher Henri Bergson: "...he never stops to ask what 'matter' is; whether it may not be, not life's enemy, but life's willing menial if life but knew its mind. ...And who knows that these things are not forms of life, and auguries of mind? Perhaps here too, as Heraclitus would say, there are gods."

Proteins today exist inside little walled off communities called cells and the most basic cells are bacteria. This is the earliest form of life on Earth and existed billions of years before more advanced plants and animals appeared. Bacteria appear NOT to be real natural individual entities with an inner life, but rather complex aggregates of interacting proteins. They are like little boats filled with complex protein communities and like boats many bacteria have their own little outboard motors or flagella. Flagella are cylindrical structures that are rotated and driven by a reversible motor at the base functioning much like the propeller on a ship. These flagella are *sophisticated* machines assembled out of about 20 protein components.

So far I have said nothing about genes which are considered by many to be in control of the entire life process. In the standard materialist view life is totally determined by genes. This view is incorrect. Genes are made from RNA or DNA molecules and are merely templates for manufacturing proteins. Unlike proteins which are flexible and use energy to perform tasks, genes are rather inert. They serve merely as stored blueprints or cookbook recipes that enable proteins to make new proteins. Genes can do nothing without proteins. Proteins are needed for genes to replicate. Proteins are needed to repair genes. Proteins decide which genes will be active and therefore used to create new proteins. The genetic cookbook recipes are not strictly adhered to either. Proteins have quite a bit of flexibility playing with the recipes as they can splice out and rearrange areas of the newly created protein made from the genetic template. Even after the proteins are created much processing by other proteins called chaperones are needed to nudge, guide and train the baby proteins into the properly folded shape. From this standpoint genes are seen not as the dominant factors in charge of life, but merely a tool used by proteins to help manufacture new proteins.

In the world that existed on earth for billions of years, proteins in their bacterial ships could exchange DNA with each other. Note – this form of "horizontal gene transfer" does not help the donor of the DNA that has simply gifted away for free "trade secrets" to competing bacteria. But it does help a new protein that may have been very useful in one cell to spread itself to the entire living world. This spreading of proteins throughout the entire living world and the spreading of protein biomass on the planet was largely made possible by proteins sharing a common language, the genetic code, through which they can swap useful cookbook recipes with each other for making still more proteins. These genetic recipes facilitated making newer, larger, and more complex proteins that created a bacterial biosphere on Earth way before true biological species in Darwinian competition first appeared. Says biologist Carl Woese: "One thing, at least, seems likely: horizontal gene flow …was essential to evolving the protein-based cellular organization from its onset. It is also likely that the genetic code has remained in effect universal because it is the lingua franca of genetic commerce. It is even reasonable to see the code originating as a lingua franca, being the product of, and belonging to, the community from the start."

Most bacterial species are either spherical, called cocci, or rod-shaped, called bacilli although others, can be spiral-shaped, called spirilla or tightly coiled, called spirochaetes. There also a wide variety of shapes beyond these basic ones. But in general the shapes are fixed and bacteria are encased in hard protective shells that are not flexible. With rigid protective cell walls, like the hull of a ship, bacteria do not show flexible changes in cell shape. While bacteria (prokaryotes) generally have symmetrical shapes that are rigid; the cells of all animals, plants, fungi and many of the more advanced and larger single celled organisms called eukaryotes are flexible, soft and moveable. Cells, like most animals, have skeletons, and as in many animals, the cellular skeleton can be either internal or external. Bacteria have an external skeleton; a strong wall of cross-linked sugar and protein molecules surrounds the cell membrane and is made rigid by the turgor pressure of the cell. The wall lends structural support. It is also impermeable to many macromolecules and thus helps to maintain a barrier between substances inside and outside the cell. Such an external skeleton limits the ability of the prokaryotic cell to move. It also limits communication between cells, a condition that probably accounts for the vastly decreased ability of prokaryotes to form multi-cellular organisms. It is the capability of self-movement and dynamic interaction with the local environment to create a more complex environment that most differentiates true individual mental agents from mere aggregates. Bacteria encased in rigid

geometrically shaped walls and with limited flexibility or awareness of local conditions appear to be sophisticated protein social aggregates and not true individual mental agents. However, with the evolution of the much larger and more flexible eukaryotic cell capable of forming complex multi-cellular organisms there once again appears a truly self-moving natural individual.

Eukaryotic Cells – the foundation of all multicellular organisms

The skeleton of the eukaryotic cell is internal; it is formed by a complex of protein tubules called the cytoskeleton. The internal placement of the cytoskeleton means the surface exposed to the environment is a pliable membrane rather than a rigid cell wall. The combination of an internal framework and a nonrigid outer membrane expands the repertory of motion and activity of the eukaryotic cell. For example, the cell can contract, as does a muscle cell. The key step in the evolution of eukaryotes is the development of the cytoskeleton. Since the cell's structural integrity is maintained by the cytoskeleton, the cell can afford to have a fluid outer membrane. Unlike bacteria which are aggregates of proteins living inside their hard symmetrical containers, eukaryotic cells such as amoeba are real individual entities, and the cell is the flexible body of the creature. Like any animal, an amoeba can control its body in an organized and purposeful way. At the core of this organized and coordinated movement is the cytoskeleton, a complex network of protein fibers and the heart of the cytoskeleton are microtubules. Both the cytoskeleton and its microtubule scaffolding are not just building girders but highly pliable and dynamic structures that are ubiquitous in all eukaryotic cells from fungi, to algae, to animals. Yet they are absent from bacteria.

Microtubules are long tiny hollow tube structures made from the protein tubulin. They fan out from centers of organization within the cell. Eukaryotic cells often have cilia which extend out from the cell and motor it. The cilia are also made from microtubules and are continuous extensions of the entire cytoskeleton. Unlike the rotating propeller flagella of bacteria, cilia are more like living arms and fingers as they move in coordinated fashion, flexing, lashing and enabling cells to swim.

For example, cilia are the locomotive structures of the paramecium. In order for the Paramecium to swim forward, its cilia beat at a 120-degree angle, backwards in unison (i.e., the cilium wiggles from tip-to-base). The Paramecium can also move backwards when the cilia beat forward at an angle in unison. If the Paramecium hits an obstacle it moves back, turns slightly and goes forward again. If it runs into the solid object again, it will repeat this process until it can get past the object. Paramecia feed on micro-organisms like bacteria. To gather its food, the Paramecium uses its cilia to sweep up food along with some water into the cell mouth. Note that cilia are used within cells for both sensing the environment as well as motor function.

From physicist Roger Penrose in “Shadows of the Mind”:

> “If we are to believe that neurons are the only things that control the sophisticated actions of animals, then the humble paramecium presents us with a profound problem. For she swims about her pond with her numerous hair like legs - the cilia - darting in the direction of bacterial

> food which she senses using a variety of mechanisms, or retreating at the prospect of danger, ready to swim off in another direction. She can also negotiate obstructions by swimming around them. Moreover, she can apparently even learn from her past experiences - though this most remarkable of her apparent faculties has been disputed by some. How is this all achieved by an animal without a single neuron or synapse? Indeed, being but a single cell, and not being a neuron herself, she has no place to accommodate such accessories. Yet there must indeed be a complicated control system governing the behavior of a paramecium - or indeed other one-celled animals like amoebas - but it is not a nervous system. The structure responsible is apparently part of what is referred to as the cytoskeleton. As it name suggests, the cytoskeleton provides the framework that holds the cell in shape, but it does much more. The cilia themselves are endings of the cytoskeleton fibres, but the cytoskeleton seems also to contain the control system for the cell, in addition to providing "conveyor belts" for the transporting of various molecules from one place to another. In short, the cytoskeleton appears to play a role for the single cell rather like a combination of skeleton, muscle system, legs, blood circulatory system, and nervous system all rolled into one!...The "control centre" of the cytoskeleton (if indeed this is really an appropriate term) is a structure known as the centriole. This seems to consist essentially of two cylinders of nine triplets of microtubules, where the cylinders form a kind of separated "T".”

Clearly there is a level of central executive control in eukaryotes not found in bacteria and it is based on a cytoskeleton that is centrally organized. While bacteria have complex computational networks of interacting proteins that are able to sense a chemical environment and turn on the propellers to swim forward as long as nutrients are improving, the level of executive centralized control and total perception of its local environment is much greater in eukaryotes. An amoeba or a white blood cell will chase after prey it senses at a distance and is coordinated, persistent and resilient in its efforts to catch and engulf it.

In euakarytoic cells the centrosome functions as the center of microtubule organization and in animal cells the centrosome contains two centrioles. Biologist Albrecht-Buehler believes that eukaryotic cells possess a kind of intelligence, and claims that the centrosome is actually the control centre (or "brain") of the cell, while the animal cell’s centrioles inside the centrosome function as the cell's "eyes". These "eyes" can detect objects and other cells by pulsating near-infrared signals, and steer the cell towards their source. This means that cells can order and integrate a large amount of visual data.

Albrecht-Buehler points to experiments with microplasts to prove his claim:

> “Microplasts are fragments of cells that remain alive for many hours. They come in various sizes. The smallest contain about 2% of a cell volume and consist mostly of cortex surrounded by a plasma membrane. Their movements are autonomous, but restricted to the universally observed shape changes such as spreading, attaching, ruffling, blebbing, waving of filopodia etc. Unlike whole cells they cannot move their entire body to another location after they were forced to round up and respread. This procedure destroys all directional properties that might have been left in their bodies from their parental cell. Microplasts cannot restore or create

> directionality of movement. The inability of microplasts to restore or create directionality of their movement suggests, that directionality of movement is the product of a higher level of control. Since the directionality of movement responds to obstacles and other unforeseeable events in the path of a moving cell this high level control appears 'intelligent' (i.e. signal integrative and decision-making)…. microtubules radiate away from the center of the centrosome. Originating at this center they lead unbranchingly to the cellular cortex which contains the autonomously motile microplast domains. The situation is very reminiscent of nerves connecting the brain (centrosome) to a set of muscles (microplasts)… Another line of arguments to support microtubules as good candidates for cellular 'nerves' comes from experiments that interfere with microtubules: If anti-microtubular drugs are given to the cell it can still move all parts of its body, but the remarkable coordination of the typical shape changes is lost"

Albrecht-Buehler says that centrioles are the near infrared 'eyes' of animal and mobile cells. See his website for more detailed evidence. He says:

> "Consistent with this conclusion, all cells that have centrioles have exactly this structure regardless whether they belong to humans at the top of the evolutionary tree or to protozoa at its roots. Cells which never migrate into unknown territory, such as higher plant cells which stay next to their sister cell all their lives, also have no centrioles. If a plant needs motile cells (e.g. sperms cells), it will make centrioles de novo. "

Interestingly, human egg cells have centrosomes but no centrioles whereas the highly mobile human sperm cells have the normal pair of centrioles in their centrosome.

Sexual reproduction is nearly universal among eukaryotes. Furthermore, while asexual reproduction is widespread among fungi, certain protists and vascular plants, various invertebrates, and even some reptiles and amphibians, sexual reproduction is also seen in these same groups. Some state that sex occurs in bacteria, which will exchange genetic material between donors and recipients. This is a matter of semantics. Many authorities consider the unidirectional lateral transfer of genetic material in bacteria to either not be reproduction, or at least not sexual reproduction, and biologist Ernst Mayr stated that sexual reproduction is unknown in bacteria (prokaryotes). True sex as defined here in agreement with Mayr, is NOT just the unilateral transfer of genes, but is the complete fusion of two whole living individuals to make one individual. This fusion of gametes is called "syngamy". Syngamy was invented by the eukaryotes and is ubiquitous amongst them. Unlike bacteria, eukaryotes have true sex or fusion to create a zygote, a union of two beings. If this theory is correct and eukaryotic cells are actually real mental agents then sex is nothing less than the fusion of two real conscious beings into one, a reduction into numerically one less being through a union that is both physical and mental. That joining of two into one has the capacity to share not just genes but histories and personalities; the useful, characteristic and learned behavior of each being as two selves become one. The one remaining self has the ability to retain the most useful learned traits and thereby combine the best behaviors of both creatures.

Sex involves two main processes: meiosis –gamete generation or return to a haploid cell state– and fusion of gametes or haploid cells. These two processes are present throughout the whole of the Eukarya domain, indicating that they both appeared simultaneously with the first eukaryotic cells. At that time of the eukaryotic world of single celled organisms, the sexual process had nothing to do with reproduction, and only later, with the arrival of multicellular organisms did sex and reproduction merge together. However, modern biologists don't really understand why sex appeared and why it is still being used today. A species is not just a group of similar individuals, but a group that can breed only amongst themselves, excluding all others. Sex then creates a private club, or species, made out of individual eukaryotic cells that can divide to create new individuals but also fuse together thereby in time creating something like a "single super individual". This is the real value of sex. Through syngamy or fusion positive learned and useful changes in the behavior, personality, activity, instinct, form, growth pattern, behavioral memory, the full epigenetic landscape of an individual can potentially spread out over time through a vast collection of individuals within the species and potentially even the entire species. Then useful behaviors encapsulated in the entire cell, unlike genes, does not necessarily get diluted as it spreads out through a sexually interacting population. Once some new useful behavior or action pattern is there in the progeny, as long as it is reinforced, it becomes part of the inheritance to the next generation and can eventually spread almost meme-like throughout the species.

Eukaryotic cells unlike bacteria appear to have an inner world and be intelligent, active, purposeful, self-moving beings. It appears that life must come from life, and mind which is the hidden inner dimension in life, must come from mind. The self must evolve from a previous self, and always has a history. This is the same law of conservation that science has discovered throughout the natural world. As particles form a space-time network of fission and fusion, living eukaryotic cells do the same. The ancient Greeks discovered this principle preventing the miraculous which is the bedrock of science: there is a limitation in nature such that "nothing comes from nothing". The same principle of conservation should be applied to the mental as well as the physical realm, as the inner and outer are just flip sides of the same thing. The materialist alternative would be to believe that inner beings come from nowhere, like a river emerging suddenly out of the desert without any apparent source. The rivers of consciousness must come from somewhere and each one of us came from the fusion of two sex cells (gametes) which came from other living cells going backwards in time in a continuous stream, splitting and merging all the way back to the earliest single celled eukaryotes.

And again from Charles Birch:

> "Is one to suppose..that at some particular point in that process of development, mind appears from no mind? When pressed, this is what most biologists believe. Yet is it not more reasonable to propose that the mind of a human being must develop from something of the nature of mind in the fertilized egg and back of this to the separate sex cells"

Eukaryotic cells have a remarkable ability to sense each other and interact with local neighbors to create something larger than themselves. All multicellular organisms are made from eukaryotic cells. Found in the bodies of just about all animals with the possible exception of sponges are a very special kind of eukaryotic cell called neurons. Most scientists believe that consciousness and intelligence only occurs

as a sudden eruption out of nothingness when millions of nerve cells interact with each other in complex ways. The theory here is that consciousness is never formed as an abrupt emergence out of nothingness and always has an evolution from which it grew. Might the very features of intelligence found at a high level in the brain already be dependent on the intelligence of its individual components...the individual nerve cells? Some scientific evidence has recently shown that far from intelligence always being the product of the interaction of billions of dumb neurons, even individual neurons have their own ability to recognize high level concepts. The recent discovery of individual specific recognition cells or so called "grandmother cells" illustrates this. That name was given because certain individual neurons seemed to specialize in recognizing individual people...like your grandmother.

In 2005, a UCLA and CalTech study found evidence of different grandmother cells that represent people like Bill Clinton or Jennifer Anniston. A neuron for Halle Berry for example, might respond "to the concept, the abstract entity of Halle Berry", and would fire not only for images of Halle Berry, but also to the actual name "Halle Berry". For example, one woman saw seven different photos of Jennifer Aniston alongside 80 other photos of animals, buildings or additional famous people such as Julia Roberts. The neuron almost ignored all other photos, but fired steadily each time Aniston appeared on screen…. The team found similar results with another woman who had a neuron for pictures of Halle Berry, including a drawing of her face and an image of just the words of her name. "This neuron is responding to the concept, the abstract entity, of Halle Berry," says Quiroga. "If you show a line drawing or a profile, it's the same response. We also showed pictures of her as Catwoman, and you can hardly see her because of the mask. But if you know it is Halle Berry then the neurons still fire." See: https://www.newscientist.com/article/dn7567-why-your-brain-has-a-jennifer-aniston-cell/

It is as if the neuron in its firing patterns tells us: "I know it is Jennifer Aniston, and it does not matter how you present her to me, whether in a red dress, in profile, as a written name or even when you call her name out loud." The neuron, then, seems to respond to the concept—to any representation of the thing itself. Thus, these neurons may be more appropriately called concept cells instead of grandmother cells. Concept cells may sometimes fire to more than one concept, but if they do, these concepts tend to be closely related.

See: https://www2.le.ac.uk/centres/csn/publications-1/Publications/scientificamerican0213-30.pdf

It seems then that intelligence of the whole is not created out of dumb parts but the collective intelligence is rather a manifestation of the individual intelligent neurons.

Neurons form complex communication networks with other neurons. The human brain contains hundreds of billions of neurons and each of these can have thousands of connections with other neurons. The neurons that form the brain stop multiplying in adolescence and in fact as humans mature experience causes some of the connections between neurons to be abandoned in a process called pruning. While the neurons in the adult brain no longer multiply, the connections between neurons continue to change as new memories and skills are formed. The dendritic spine which receives signals from other neurons is particularly dynamic as it is continually reaching out to make new and stronger connections while withdrawing and abandoning old connections. The cytoskeleton of dendritic spines is

important in their synaptic plasticity; without a dynamic cytoskeleton, spines would be unable to rapidly change their volumes or shapes in responses to stimuli. The cytoskeleton of dendritic spines is primarily made of filamentous actin. While tubulin monomers are present, organized microtubules are not present. Because spines have a cytoskeleton of primarily actin, this allows them to be highly dynamic in shape and size.

Neurons seem to be individuals with learned specialty knowledge rather than replaceable hardware cogs. Each neuron may be a subject matter expert and when a neuron needs more information about a subject it is not verse in, it reaches out to the experts. It is tempting to imagine that after I learned that Brad Pitt left Jennifer Aniston and married Angelina Jolie… my Brad Pitt neurons slowly began withdrawing their connections from the Jennifer Aniston neurons and began migrating new connections over to the Angelina Jolie neurons. The purposeful and intelligent behavior of the whole brain would be dependent on the purposeful and intelligent behavior of its living parts.

In **"**Nano-Intentionality - A Defense of Intrinsic Intentionality" W Tecumseh Fitch writes:

> "I suggest that most discussions of intentional systems have overlooked an important aspect of living organisms: the intrinsic goal-directedness inherent in the behaviour of living eukaryotic cells. This goal directedness is nicely displayed by a normal cell's ability to rearrange its own local material structure in response to damage, nutrient distribution or other aspects of its individual experience. While at a vastly simpler level than intentionality at the human cognitive level, I propose that this basic capacity of living things provides a necessary building block for cognition and high-order intentionality, because the neurons that make up vertebrate brains, like most cells in our body, embody such capacities. I provisionally dub the capacities in question "nano-intentionality": a microscopic form of "aboutness"....
>
> The key to my argument is the recognition of a specific capacity characterizing eukaryotic cells (the type of highly-organized cells with DNA sequestered in a nucleus, organelles, a cytoskeleton, etc, that includes a huge variety of life forms including amoebae, mushrooms, redwoods, and humans). I provisionally dub this causal power "**nano-intentionality**" - a microscopic form of aboutness, inherent in individual eukaryotic cells, that make up a goal-directed capacity to respond adaptively to novel circumstances. The core causal power underlying nanointentionality is the cell's ability to arrange and rearrange its own molecules in a locally functional manner, thus preserving and extending its individual existence, depending on local and perhaps somewhat novel circumstances. Crucially, this capacity is as characteristic of a neuron in the brain as it is of a free-living amoeba. Both deal, as semi-autonomous individual cells, with their local circumstances, and when novelty is coped with successfully, the cell can "remember" a solution by changing its own physical structure.…A crucial difference between a cell (including but not limited to a neuron) and a transistor on a silicon chip is that the former arrangement of matter can autonomously and adaptively modify itself in response to its circumstances, whereas the latter cannot. An everyday example of this biological capacity is provided by the healing response: a damaged organism can often stem the loss of precious bodily fluids, stitch itself up, and (with some scar perhaps) continue living. We all witness this capacity regularly in our own bodies and it is worth stopping for a moment to realize how amazing it is.…

In the same way that a plant adjusts its form to local lighting conditions, a neuron continually adjusts itself to its local, individual circumstances in the brain - producing more neurotransmitter when it runs low, extending spines out to make more effective contact with a preferred neighbor and withdrawing dendritic branches from noisy uncorrelated neighbors, adjusting its pattern of firing to the incoming flow of neurotrophins, and even curling up and neatly committing suicide when unable to integrate itself into its local processing environment. This dynamic rearrangement of its own matter is something that all neurons do, and indeed virtually all cells in our body do (omitting, e.g., red blood cells which lack their own nucleus and are more a bag of hemoglobin than a living thing). Not only do cells modify themselves, but they do so adaptively (in the physiological sense) - they autonomously arrange their form in such a way as to optimize their ability to perform certain quite specific functions. When some abstract goal remains unsatisfied, they try new behaviours, mostly at random, and "remember" the one(s) that work(s). Furthermore, such local adaptive changes can be incorporated into the cell's form for deployment in future similar circumstances. The cell can "remember" its successes and thus in this limited way can "learn" from its individual experience. This capacity to respond to circumstances includes *novel* circumstances (in a constrained range): circumstances that were perhaps never encountered in the lifetime of the species, or at least never led to inherited changes in the cell's DNA...Its information processing (in terms of firing) is processed into physical, cellular changes in its shape, both at the micro-level of synaptic boutons and at the whole cell level of changing dendritic and axonal arbors (Brown et al., 1991). This is where the eukaryotic cell's general ability to adaptively change its form, using its cytoskeleton, becomes hijacked for specifically informational purposes. These direct causal relations of a cell in its nerve net, adapting to local stimulation, remain nano-intentional.”