EDITION 360

SOUL SYSTEMS™

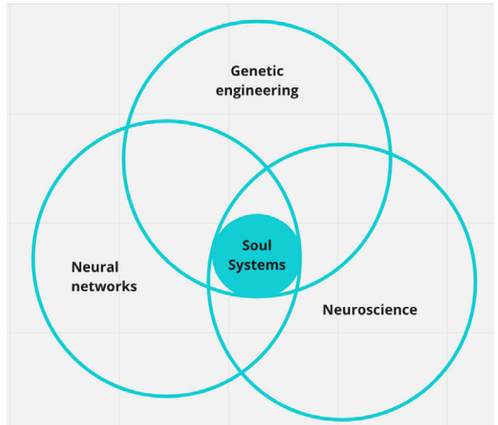
January 2050

# EnchantedFutures

## Let’s explore inner and outer space together

Welcome, space travellers, to this special edition of our monthly publication: a retrospective of the research that fuelled Soul Systems, and the launch of our latest safety products.

Vaccine success during the 2020 epidemic showed how technology development can be catalysed when there is the political will. Well, the US-China race to space makes Covid urgency look like snail pace. Every year witnessed an exponential increase across our nexus of genetic engineering, neural networks and neuroscience. What was speculation 30 years ago is now ready to be deployed.




Soul Systems Nexus

‘As we wish you farewell to explore solar systems, your welfare is our priority at Soul Systems’

CEO, Soul Systems

## Contents

## Computational phenomenology explained

Our journey would not have been possible had it not been for the vision of our founder, Professor Anil Seth. It was his insight that the science of consciousness was where the science of life had been 250 years ago. The animate and inanimate seemed so different that mechanical explanations could not bridge them so mysterious vitalism was proposed instead. However, this mystery evaporated as biology became naturalised and mechanisms were discovered that could explain the properties of life, such as evolution, inheritance (genetics and DNA), metabolism and homeostasis (amongst others), and bring them under scientific prediction and control.

He pioneered computational phenomenology that uses neural networks to model the descriptions of our first person, lived experiences and thereby provide the computational mechanisms to explain consciousness. Just as life is not a single phenomenon, consciousness also consists of various properties that can be explained in terms of:

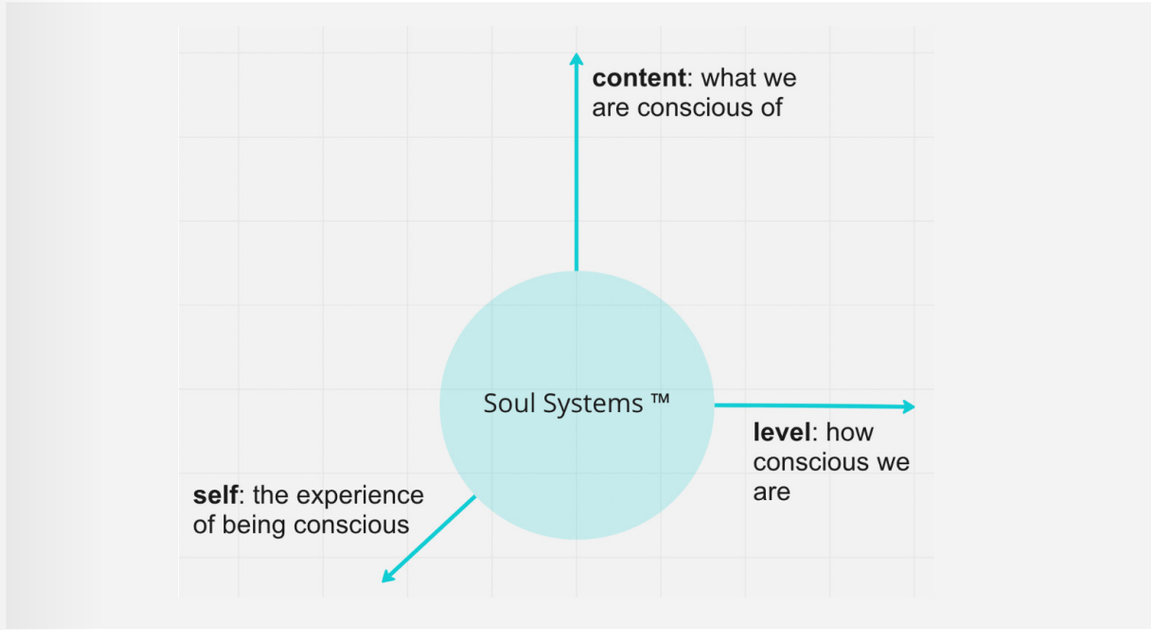
- *Conscious level:* How conscious we are
- *Conscious content:* What we're conscious of: sensory, emotional and cognitive perception
- *Conscious self:* What it means to be you.

His work set us off on our journey towards predicting consciousness and quantifying subjective experience. Well, space travellers, we have now arrived.

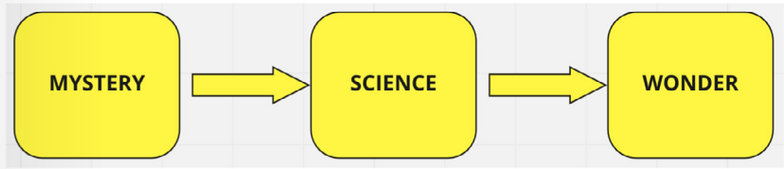




In honour of Anil Smith




Three dimensions of consciousness




Science is wonderful

## Quantifying consciousness

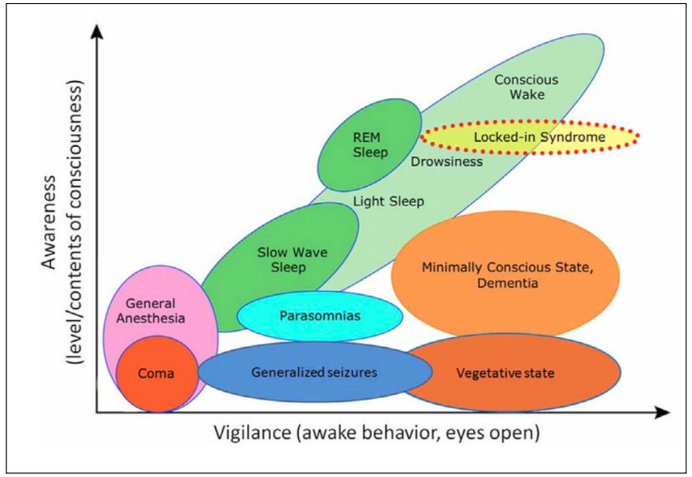
Transcranial magnetic stimulation (TMS) non-invasively stimulates nerve cells in the brain and Electroencephalogram (EEG) monitors worn on the scalp can record TMS echoes. The informational complexity of these echoes provides a quantitative measure of how conscious we are- our level of consciousness. Complexity provides a measure of information in terms of entropy or reducing uncertainty. At any time, we have only one conscious experience out of vastly many possibilities so each conscious experience involves a large reduction of uncertainty (since we have this experience rather than all those other possibilities).

Complexity measures of Rapid Eye Movement (REM) sleep show a similar conscious level as normal waking consciousness, highlighting how awareness is not the same as wakefulness. The entropic complexity of psychedelic brains have been shown to be greater than that of waking states, suggesting that psychedelic states have a greater conscious level than normal consciousness.

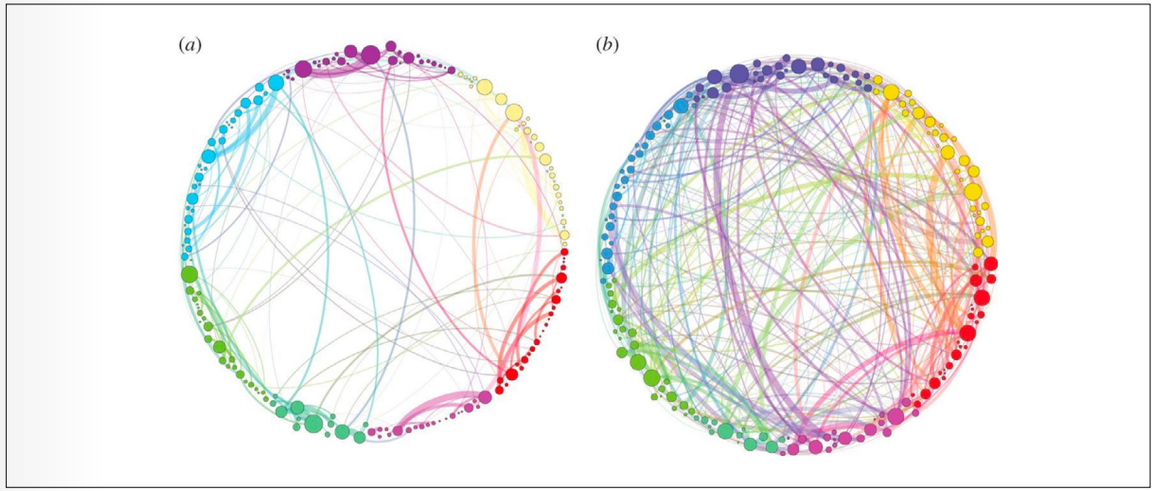
*Did you know that...*
During normal waking consciousness, we perceive a very compressed representation of the world: approximately 1010 bits/s of the information available in the environment are deposited in the retina yet perhaps 0.001% of that makes it to the primary visual cortex, i.e. 104 bits/s; and estimates of the bandwidth of conscious awareness itself, i.e. what we see, are approximately 100 bits/s.








Distinguishing conscious level from vigilance




Visualisations of functional connectivity in brain regions during placebo (a) and psilocybin induced states (b)

Transcranial magnetic stimulation (TMS) and electroencephalogram (EEG) monitoring

## Perceptions are controlled hallucinations

Neuroscience has led to a Copernican revolution of the mind. The problem has been our confusion between how things seem and how they really are.

It seems that the world is revealed passively to our minds. Data about the world enter through our sense organs then progress deeper into our brains, at each stage carrying out more abstract processing organised hierarchically in specific brain regions, such as the visual cortex and auditory cortex. Neurons at earlier/lower stages of visual processing respond to simple features, such as edges, and later/higher stages respond to more complicated features, such as faces.

But sense data do not arrive with intrinsic labels, such as 'visual data from a cup' or 'audio data from a bell', so the brain must make best guess predictions to infer the causes of these data, drawing on prior knowledge, expectations and beliefs about the world. For example, when we perceive a red object, redness is a property of how our brains predict how surfaces reflect certain patterns of light. Predictions flow from deep inside the brain towards our sensory organs while 'prediction errors' flow in the brain from sense data- the differences between what the brain expects and what it receives. Prediction errors are minimised across many levels of neural processing by continuously updating the brain's predictions. Neural rewards arise from the predictability of experiences, leading to pleasurable satisfaction when actual experience matches our expectations.

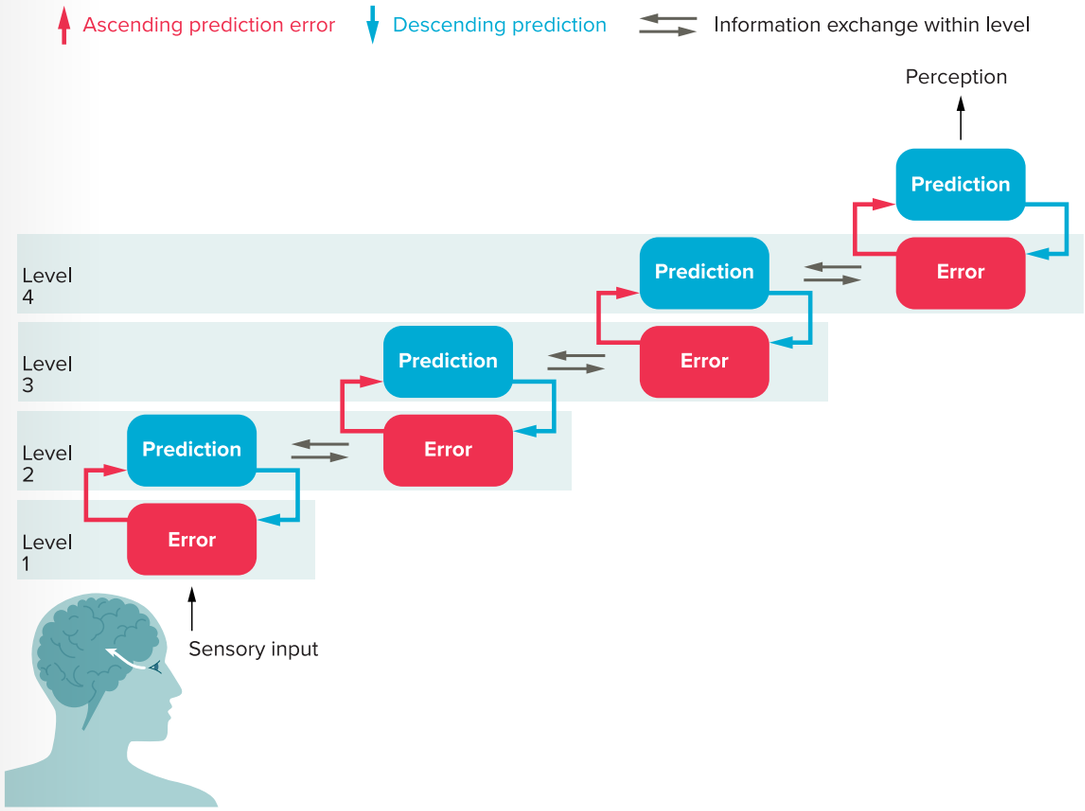
So reality is much more active and creative. The easiest way to appreciate this insight is to remember how easily we see patterns everywhere, such as faces in clouds, as our brains constantly search for patterns to make sense of our experience of the world. Investigating hallucinations and sensory illusions provides insights into perceptual experience. Perceptions are 'controlled hallucinations' when properly updated by prediction errors from sense data but hallucinations are 'uncontrolled perceptions' when not properly updated.

Neural networks provide the best way to model perception since they learn in a similar way. Bayesian statistics captures the relationship between prior beliefs, knowledge and expectations about the world and evidence about how the world actually is. Algorithmic models are created by neural networks learning about the world from training data. Once trained, these models provide the networks with their versions of prior knowledge, expectations and beliefs about the world that they use to make predictions when they receive new data.





## The brain as a prediction machine




Perception as prediction error minimisation

‘Perceptions are controlled hallucinations... hallucinations are uncontrolled perceptions’

Anil Seth, Being You

‘Perception is a generative act ... conscious contents are not merely shaped by perceptual predictions- they are these predictions.’

Anil Seth, Being You

‘You should look at certain walls stained with damp, or at stones of uneven colour. If you have to invent some backgrounds you will be able to see in these the likeness of divine landscapes, adorned with mountains, ruins, rocks, woods, great plains, hills and valleys in great variety; and then again you will see there battles and strange figures in violent action, expressions of faces and clothes and an infinity of things which you will be able to reduce to their complete and proper forms. In such walls the same thing happens as in the sound of bells, in whose stroke you may find every named word which you can imagine’.

Leonardo da Vinci, Treatise of Painting

‘Just as the brain makes predictions based on prior beliefs, knowledge and expectations, neural networks also make predictions based on prior beliefs, knowledge and expectations learnt from data and encoded in their trained models’

CEO, Soul Systems

## Auditory hallucinations

*Verbal hallucinations*

Verbal auditory hallucinations can include voices laughing, crying or whispering; speaking our thoughts and narrating our actions; or several voices arguing.

*Non-verbal hallucinations*

They can also be non-verbal, such as fragments of childhood music, including patriotic songs, religious hymns, folks songs, and well known ads.

*Auditory hallucinations in the general populations*

Auditory hallucinations are the most common hallucinations experienced by schizophrenic patients. However, more mild versions are commonly experienced, including:

- Hypnagogic hallucinations occur when falling asleep, and people report hearing their name, or snatches of nonsensical speech and wordplay.
- Exploding head syndrome involves loud, short lasting sounds, such as knocking, crashes and bangs.
- Hypnopompic hallucinations are heard when waking up, and people report hearing complete sentences or structured melodies, as well as simple sounds, including alarms, doors, footsteps, doorbells, telephones and even animal sounds.

*Auditory hallucinations can be during extreme experiences*

Solitary sailors, shipwreck survivors- and astronauts- report ghostly presences telling them to keep going.

Auditory hallucinations can also be induced by sensory and sleep deprivation.

*Music hallucinations*

Repetition is a key characteristic of music hallucinations. Musical segments can be heard to play in continuous loops for minutes, hours and even days or weeks. Music hallucinations can also involve dissociations between the brain’s modular architecture for music processing, leading to:

- Distortions of timbre or music played by unknown instruments or instruments damaged in some ways;
- Distortions of pitch and timing so the music sounds out of tune;
- Music played from natural instruments but would be impossible to play in real life;
- Mashups with layers of music from different genres.

## Emotions are also controlled hallucinations

According to Anil Seth, there are five aspects to the experience of being conscious:

- embodied: we feel ownership of our body unlike other objects;
- perspectival: we have a first person perspective on the world
- volitional: we have a sense of agency
- narrative: we have a sense of identity
- social: we are embedded in social worlds

The core of selfhood and foundation of our embodiment is our sense of being a living organism and our emotions and moods in response to it.

The causes of sense data we receive from inside our bodies remain hidden so they, too, are inferred through predictions. Just as redness is the subjective experience of brain predictions about how a surface reflects certain patterns of light, our emotions and moods are the subjective experience of predictions about the causes of internal signals. Our emotions and moods are also 'controlled hallucinations' in response to sensory signals from within our body as it responds to the world. For example, we do not scream because we feel afraid when we see the charging bear; rather we feel fear in response to the physiological changes, such as a racing heart, caused by seeing the bear.

Another of Anil Seth's insights was not to worry about super intelligent AI. The concern should be agency- the 'volitional self- that is rooted in embodiment. Dumb autonomy is the danger.





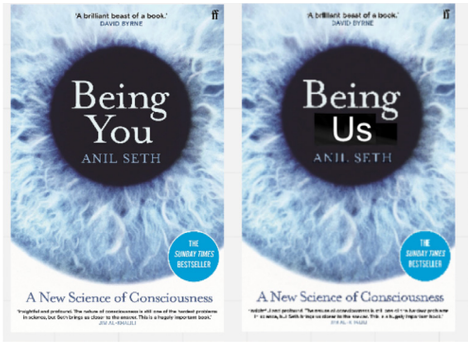
External and internal perception as controlled hallucinations *Artwork from sapienlabs.org*

## From Being You to Being Us

The hazards of space create huge cognitive burdens that can be eased if space travellers can collaborate intuitively as if telepathically. The story begins 30 years ago when BrainNet combined transcranial magnetic stimulation (TMS) and electroencephalography (EEG) to provide the first non-invasive, brain-to-brain interface for collaborative problem solving. Partially invasive devices were also being implanted inside the skull but outside the brain. In 2020, the first in-human trials used endovascular devices to control texting and emailing (similar to how stents are delivered intravenously to treat intracranial hypertension). Electrocorticography (ECoG), involving a thin plastic pad of electrodes embedded above the corte, could decode speech from epilepsy patients.

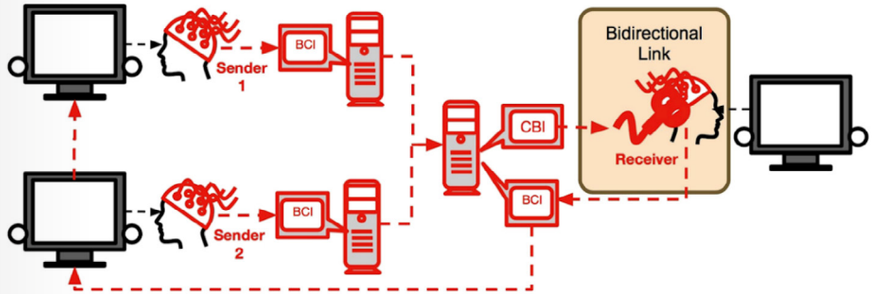
At the same time, Neuralink was exploring invasive brain-machine electrodes, such as intracranial EEG where electrodes are placed directly on the surface of the cerebral cortex. However, the impatience of Neuralink's founder, Elon Musk, highlighted the need to take care to avoid blowing people's minds. His rush turned his consciousness into permanent mush.

Everyone wants to avoid that nasty outcome. If Anil Seth's insights were our fuel, then his 2020 Being You was the rocket where he presented the science of individual consciousness. His 2030 Being US explored collective consciousness- our rocket's second stage that underpins Soul System's safety policies for syncing space travellers' brains

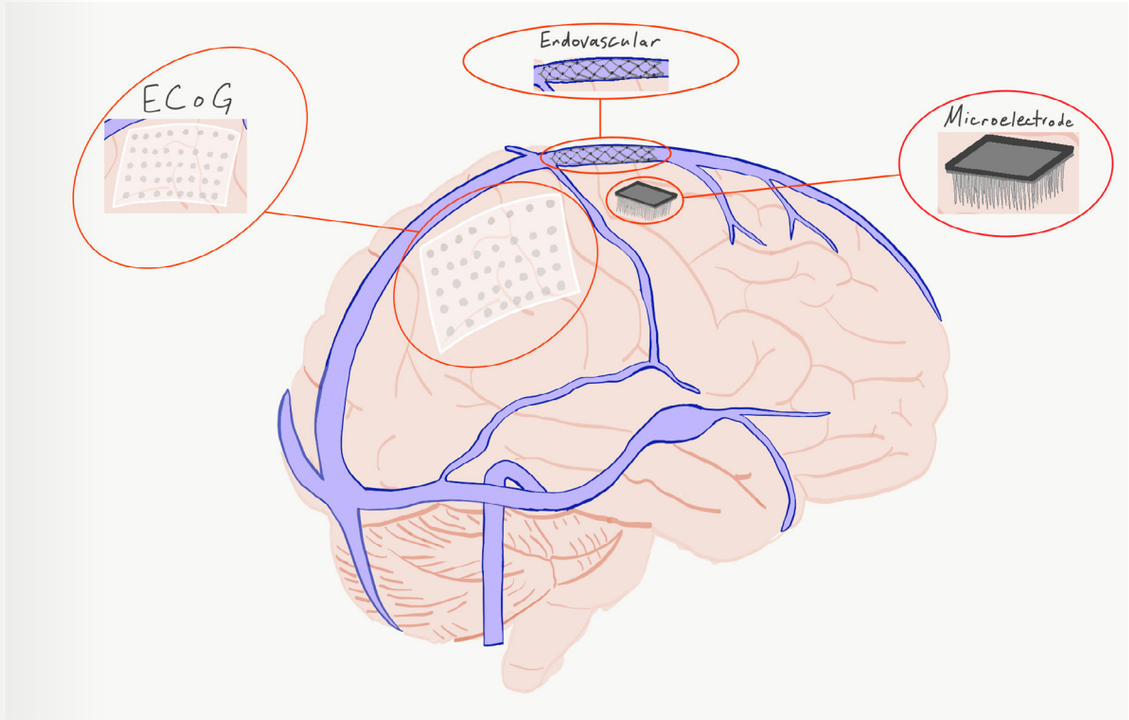







Non-invasive interfaces: BrianNet's Architecture involving Brain Machine Interfaces (BMI) and Computer Brain Interfaces (CBI)




Invasive brain interfaces

# New safety product range

## Controlling conscious level: **Entropometer**

Space travellers undergo gene therapy to splice hibernation genes from bears into their DNA to lower metabolism during long spaceflight. When these genes are switched on and off, the Entropometer allows Mission Control to measure and move space travellers through different levels of consciousness. Brain interfaces mean that the pineal gland can be stimulated to produce a short DMT trip to calm any existential fears during long voyages.


The Entropometer

## Predicting conscious content: **Hallucinator**

Moving through different levels of consciousness can induce hallucinations. But hallucinations can inform Mission Control about space travellers' perceptual dissonance which is crucial when syncing brains. One space traveller's prior beliefs, knowledge and expectations are very different to another's so wild hallucinations need to be minimised. When syncing brains, gradual cross fading is key. The Hallucinator allows Mission Control to simulate the sensory, emotional and cognitive contents of subjective experiences, as well as communicate with hibernating space travellers via direct brain implants.

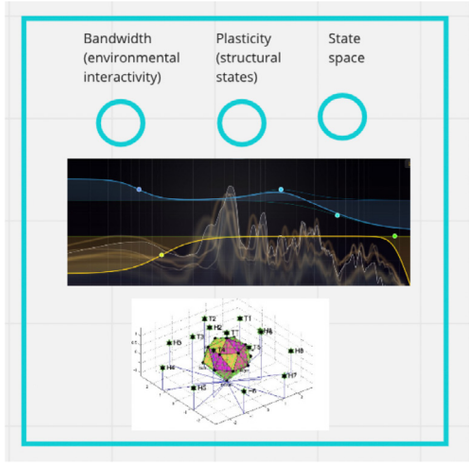

Hallucinator



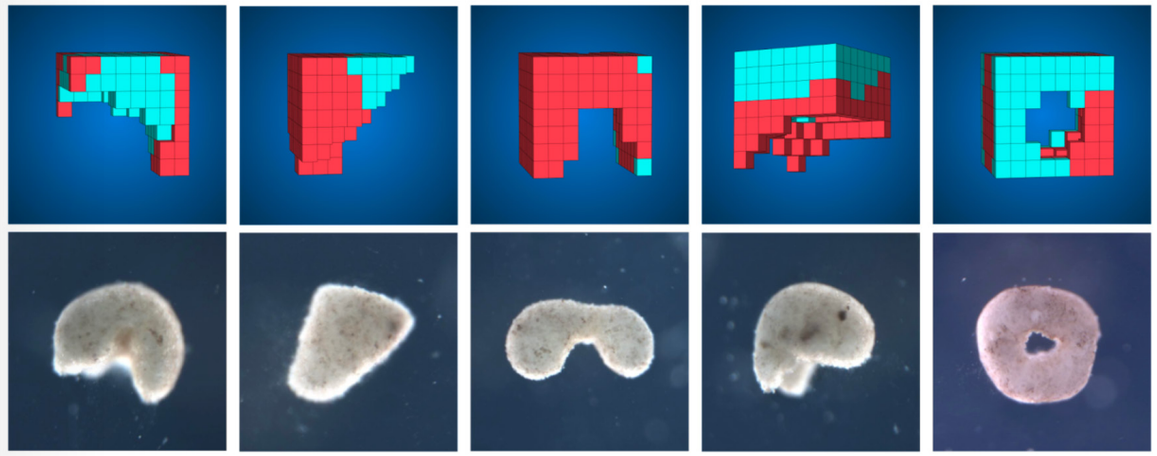


## Monitoring conscious self: **Embodimonitor**

Space hazards mean that space travellers wear a second skin made of AI programmed stem cells- xenobots- that produce therapeutics in real time that are absorbed through the skin. The Embodimonitor allows Mission Control to monitor the conscious selfhood and agency of the xenoskin, imposing fail safe controls when necessary.




Embodimonitor



Xenobots: AI programmed stem cells

## Enchantment naturalised

For some people, scientific materialism disenchanted the world when they no longer held magical and religious beliefs. For other people, this plunged them into crisis since these beliefs had been sources of ultimate value that gave meaning to redeem their existential suffering. It may be hard to resurrect these beliefs now that science has opened our eyes and we can't look away.

But enchantment may be less about beliefs than a porous way of experiencing the world that is lost if we adopt a firm sense of a boundary between ourselves and the world. Reminding ourselves that perception is a generative act- that the activity of certain brain mechanisms constitutes consciousness - allows us to re-orientate ourselves towards a more porous experience of the world.

So, on the eve of exploring the heavens, neuroscience has explained the last piece of the divine jigsaw- the soul. Our subjective, conscious experiences are just as much a part of biology as our bodies are. In one sense less mysterious; in another sense, wonderfully enchanting as we translate ourselves back into the natural world. Perhaps seeing ourselves no longer separate from the rest of nature can help relieve our existential distress?

'Enchantment has nothing to do with fantasy, or escapism, or magical thinking: it is founded on a vivid sense of belongingness to a rich and many layered world ...The enchanted life is intuitive, embraces wonder and fully engages the creative imagination but it is also deeply embodied, ecological, grounded in place and community...It understands the myths we live by; thrives on poetry, song and dance...Above all, to live an enchanted life is to fall in love with the world all over again.'

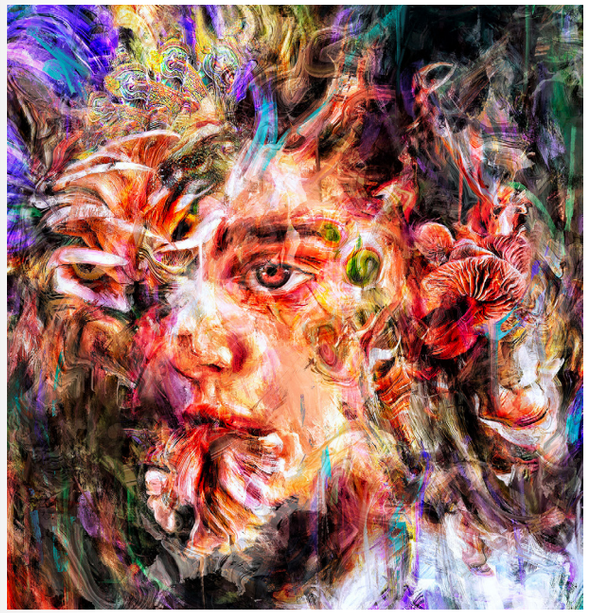
Sharon Blackie, The enchanted life: unlocking the magic of everyday

'To translate men back into nature, to master the many vain and effusive interpretations and connoted meanings which so far have been scribbled and painted over that eternal basic text of homo natura, to bring it about that in future man stands before man in the same way he, grown hard in the discipline of science, already stands these days before the rest of nature, with the fearless eyes of Oedipus and the blocked ears of Odysseus, deaf to the tempting sirens among the old metaphysical bird-catchers, who for far too long have been piping at him, "You are more! You are higher! You are of a different origin!'

Friedrich Nietzsche, Beyond Good and Evil







Translating ourselves back into nature
*Artwork of Archan Nair, www.archannair.com*

## Mysticism materialised

At the core of Soul Systems' products are neural networks. Their hidden layers of nodes, and their representations of the world, are often beyond human comprehension, making them almost mystical. Schemas of neural networks have an uncanny resemblance to the Tree of Life in Judaism's mystical tradition, Kabbalah, that was first published in the early 16th century.

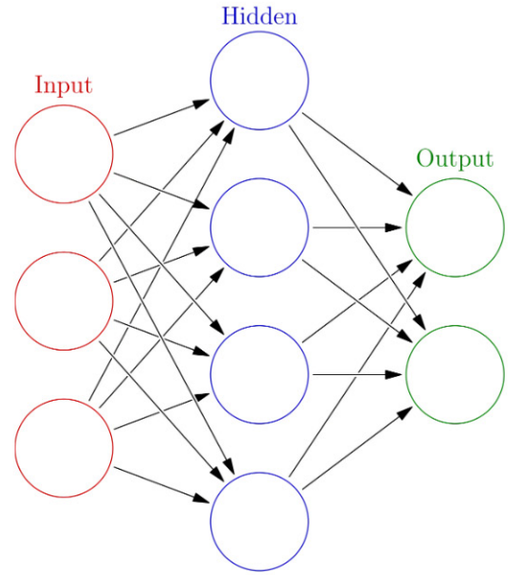
The Tree of Life consists of 10 or 11 nodes ('sephirot') that each represent an attribute of god's being, and are connected by 22 lines or paths that represent the process by which the universe was created. The hierarchy begins with Keter ('crown' in Hebrew)- what the Kabbalah refers to as 'the most hidden of all hidden things'- out of which all things are created until Yesod ('foundation') interfaces between the metaphysical layers above and the physical layer of Malchot ('kingship') below- the world of matter, planets and earth. Kabbalah conceives of consciousness as the way by which creation can reverse its course back up the Tree until it's once again united with Keter.

The strength of the connections between nodes in neural networks is represented by numerical weighting factors. Curiously, Kabbalah uses numerology of the Hebrew alphabet to encode the nature of the paths connecting the sephirot, according to 'the path of the flaming sword' (referring to the flaming sword that god placed to guard the Garden of Eden after Adam and Eve were cast out).

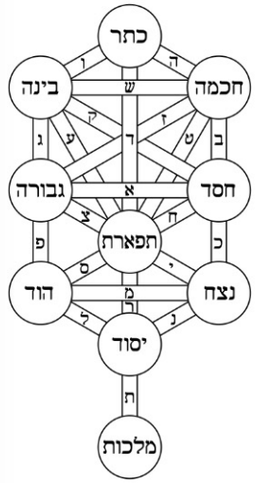




**Schema of a neural network**

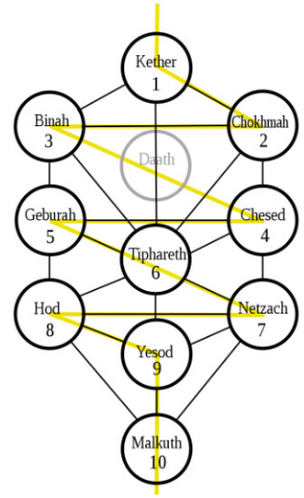



**Schema of the Tree of Life**




| *Sephirot* |
|---|
| 1 Keter (crown) |
| 2 Chokmah (wisdom) |
| 3 Binah (understanding) |
| [Da'at (knowledge)] |
| 4 Chesed (kindness) |
| 5 Gevurah (strength) |
| 6 Tiferet (beauty) |
| 7 Netzach (victory) |
| 8 Hod (compassion) |
| 9 Yesod (foundation) |
| 10 Malkut (kingship) |

**Path of the flaming sword**



inner space
outer space

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