

## What is Ontological and What is Psychological in **Ayahuasca** Visions?

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**For a long time** I have thought a suitable explanation for psychedelic experiences argues that a psychoactive substance such as dimethyltryptamine is chemically similar to neurotransmitters. Once it reaches the synapses, sites of receptors for neurotransmitters, it will influence how synapses transmit signals between nerve cells. Therefore patterns of neural activity will be altered. Since conscious experience is believed to be correlated with the formation of neural activity patterns, a user's experiences will change as well.

A mathematical rendition of this model was able to successfully reproduce patterns frequently reported by users of psychedelics such as spirals or tunnels (Bressloff et al 2002). A closer look at the equations reveals that these structures appear due to symmetries in the organization of neurons in the primary visual cortex. Thus, what the user is really "seeing" is a reflection of the anatomy of his own brain. Yet anyone with experience with ayahuasca knows that the content of the visions during the peak of the experience is far more complex than spirals or tunnels.



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Ayahuasca visions and ideations often convey well-formed insights that hold up to rational scrutiny applied after the session. Images seen during the visions are highly aesthetic, seemingly infused with deep meaning and not noisy. The visions are exceedingly complex and information-rich in the sense that if one were to attempt to write a computer graphics program to render such images it would have to be highly sophisticated and would consume enormous computational resources. For example, it appears to me that it would be insufficient to invoke a program that produces fractals to approximate the visions. The structures vary too much across scales and the content is a blend between abstract patterns and concrete objects such as beings or astronomical vistas.

I believe it is an important question whether the content of these more complex visions can still be explained entirely as reflecting the synaptic layout of neural networks. Most neurobiologists would probably argue for this. This view implies that a large part of the visions are driven by the users' memories as neurobiology currently believes that memories are stored as patterns of synaptic strengths and that the foundation of human cognition lies in

the pattern of dynamic interactions shaped by the connectome.

The motivation to even consider whether sometimes other sources of information or processing mechanisms are involved in giving rise to the structure seen in ayahuasca visions stems from the fact that most users are left with that very impression and that for many it constitutes the reason to drink ayahuasca in the first place. The psychologist Benny Shanon writes, "Those who consume the brew may feel that they are gaining access to new sources of knowledge and that the ultimate truths of the universe are being revealed to them." (Shanon 2002). Rick Strassman, who conducted extensive clinical studies with dimethyltryptamine, notes that the patient is left with the impression that she gained "first-hand knowledge of the basic 'facts' of creation and consciousness" (Strassman 2001, see also Griffith et al, 2006).

To pose the question in different terms, is it possible that the visions should partly be accounted for in ontological and not in psychological terms? Before outright dismissing this as impossible we should keep in mind that sensory organs can be exceedingly sensitive. For example a single photon is sufficient to trigger a nerve pulse in humans (Rieke and Baylor

1998). The scenario I have in mind is that the brain by virtue of being a physical substrate participates in information exchange with the environment by fundamental physical interactions. Information gained through these processes may not just travel via the “official” visual, auditory or other sensory pathways. Thus a psychedelic experience report is in part explained by assuming that such information is received, amplified, processed and recorded in memory traces.

In the remainder of the article I will suggest two experiments that could help gather evidence for the idea that the information obtained in a psychedelic session is partially due to alternative means of perception and information processing. Taking user reports not as mere fantasy but as being in part a description of physical reality is akin to the approach taken by the archaeologist Heinrich Schliemann who took the stories of Homer not just as fiction but as historical report. Reading Homer in this way he was led to discover Troy and other sites that gave weight to the idea that Homer’s *Iliad* in part reflects actual historical events.

As an example of applying this point of view, let us look at folkloric accounts of how indigenous medicine men, shamans, find recipes for plant mixtures or a cure for a patient. It is often reported that Amazonian Pajés claim to “see” which plants match or which ones will cure a patient (Schultes and Raffauf 1992). Now it is known since some time that living biological materials emanate a very weak stream of photons referred to as biophotons (Popp et al 1988, Kobayashi et al 2009). The frequency of the photons is in the visible range and the intensity of the photon stream could just be strong enough to elicit nerve pulses. Add the observation that there is hardly a darker place than the floor of the jungle in a new moon night one and could imagine that shamans are literally able to pick up information about plants simply by looking at them. This could possibly be aided by ayahuasca in suppressing brain processes that impede the analysis of the weak stream of biophotons. Whether this indeed is a possibility could be tested by preselecting biological material exhibiting a strong stream of biophotons with

a photomultiplier and then asking dark adapted test persons whether they can discriminate this probe from others that do not emit biophotons. It may then come as a surprise that the “glowing forest” which was elevated to global meme by the movie *Avatar* has a biophysical correlate.

Another type of experiment I find fascinating serves to explore whether an explanation of psychedelic experiences requires references to quantum biological effects. Recently evidence accumulated that quantum processes are instrumental to biological function such as photosynthesis (Collini et al 2010). An intriguing role can also be attributed to quantum effects in solving difficult combinatorial optimization problems (Farhi et al 2000, Das et al 2005). Such problems frequently arise in learning or problem-solving tasks humans or animals have to master (Neven et al 2009). At this point there is no evidence yet that the nervous system employs quantum optimization. However I would like to propose that this propensity exists and that ayahuasca strengthens this ability. To the user this would appear as enhanced creativity which many scholars regard as the central effect of ayahuasca (Shanon 2002).

Moreover this notion offers a compelling duality. In computational terms solving a difficult optimization problem with quantum optimization corresponds to finding a low energetic minimum. In physiological terms this may mean that a cell or cellular substructure has reached a more stable homeostatic equilibrium, which could explain some of the medical benefits frequently reported for ayahuasca.

A first glimpse into whether quantum effects may indeed play such a role could be afforded by an experiment where one would show via animal-based substance discrimination that rats can tell the difference between the ordinary and deuterated version of a neuropharmacological compound (Nichols 2004). In this experiment one would prepare two versions of a psychedelic agent, say LSD-25, one in its naturally occurring form and a deuterated version in which some of the hydrogen atoms have been replaced by deuterium. This is hydrogen but with a neutron added to its nucleus.

Then we would study if rats can learn to tell them apart by rewarding them to signal whether they have received one or the other by pressing a corresponding lever. This is a central nervous system analogue of an experiment originally suggested by Luca Turin to show that our sense of smell is keen enough to discriminate between different isotopes of a molecule (Turin 1996). A positive outcome of the suggested experiment by itself would not yet be sufficient to show that the nervous system uses quantum optimization. Nevertheless it may trigger a paradigm shift in that it indicates that we can not safely ignore quantum mechanical effects when studying neural dynamics. This is because in order to understand how a small modification to a psychoactive molecule, normally considered as inconsequential by a neurochemist, can trigger behavioral changes one will need to integrate the Schrödinger equation.

I want to conclude by proposing a shift in vantage point that may prove useful in trying to discern what could be ontological and what is rather psychological in an ayahuasca *miraçao* (Polari de Alverga 1999). In this model we make the assumption that the physical fabric of reality itself has mental properties. Thus we would postulate that all matter, already at its most fundamental level, is experiential, that it possesses free will and that it is capable of performing intelligent information processing (Strawson 2006, Conway and Kochen 2006). In this picture the nervous system only enters insofar as it becomes the recorder of conscious experience but it is not its generator. Such a model which is logically parsimonious and permissible under contemporary physics is closer to how the world looks like during a *miraçao*.<sup>1</sup>

1. A more apt Brazilian term for ayahuasca vision, comprised of *mirar* (to see) and *açao* (action), since an experienced drinker is able to gently steer her visions.

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