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PSILOCYBIN-CONTAINING MUSHROOMS, UPPER PALAEOLITHIC ROCK ART AND THE NEUROPSYCHOLOGICAL MODEL

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Abstract. Two recent papers authored by Froese, Woodward and Ikegami present the neuropsychological model of Lewis-Williams and Dowson as if it had just been published. This paper corrects their distortions of the work of critics, including Helvenston and Bahn, addresses neuropsychological errors and discusses the complexities of psilocybin-containing mushrooms. It includes a discussion of the mushrooms depicted in the Selva Pascuala mural found at the Villar Humo Cultural Site in Cuenca, Spain.

Froese et al. (2013)

In 2013 a paper was published in the journal *Adaptive Behavior* (21[3]: 199–214), entitled 'Turing instabilities in biology, culture, and consciousness: on the enactive origins of symbolic material culture' by Tom Froese, Alexander Woodward and Takashi Ikegami. This paper caused quite a stir among the supporters of the neuropsychological theory of Lewis-Williams and Dowson (1988: 201–245), because it linked that model with another theory associating geometric figures with Turing instabilities to account for the world-wide distribution of geometric figures on rock art. Froese et al. made their allegiance to Lewis-Williams clear when they stated in their abstract that '*It has been argued that the worldwide prevalence of certain types of geometric visual patterns found in prehistoric art can be best explained by the common experience of these patterns as geometric hallucinations during altered states of consciousness induced by shamanic ritual practice*' (my italics). This quotation is, of course, referring to the neuropsychological theory.

Froese et al. (2013) are touting a new theory concerning Turing instabilities based upon the neuropsychological model of Lewis-Williams and Dowson. Froese et al. considered it as it was first proposed in 1988 and did not review any of the opposition literature published over the past 25 years because they uncritically accepted the model as originally proposed and assumed it was scientifically valid. This was a major flaw of the paper as I suggested in comments critiquing the paper that were not published in *Adaptive Behavior*. For example, many critics over the years have discussed the numerous flaws in the theory including Bednarik (1988, 1990, 2013a, 2013b), Hromnik (1991), Solomon (1997, 1999, 2001), Le Quellec (1999, 2001, 2004), Hodgson (2000, 2006a, 2006b), Bahn (2001, 2010), Hamayon (2001), Frankfort and Hamayon (2001), Bradshaw (2003), to mention just a few. This present paper is concerned with the uncritical use of the neuropsychological model as a scaffold upon which to create a new theory about Turing instabilities in the visual system and perception of geometric figures. I will not be concerned with their major focus on Turing instabilities but upon their naïve acceptance of the neuropsychological model.

Paul Bahn and I first became involved as critics of the neuropsychological model in 2002. Over the years we published numerous papers critical of that model, including Helvenston and Bahn (2002, 2003, 2004, 2005, 2006a, 2006b, 2007). None of this literature was reviewed by Froese et al. in their 2013 paper. Like earlier supporters of Lewis-Williams and Dowson, Froese et al. frequently ignore all data that does not support the theory, or they distort it, take it out of context and gloss over important details to present a superficial summary, omitting important facts.

Froese et al. (2014a)

These tactics are even more clearly evidenced in Froese et al.'s recently published 2014 paper, entitled 'Are altered states of consciousness detrimental, useful or helpful for the origins of symbolic cognition? A response to Hodgson and Lewis-Williams'. In this paper they make false claims about Helvenston and Bahn, take sentences out of context and make neuropsychological errors. Moreover, they distort some of the literature they cite and discuss new evidence about psilocybin-containing mushrooms and rock art in Europe about 6000 years ago, from a highly simplified standpoint. I addressed some of these issues in a paper entitled 'Are

altered states of consciousness detrimental, useful or helpful for the origins of symbolic cognition? A response to Hodgson and Lewis-Williams, critiqued by Patricia A. Helvenston' which is currently in press in *Adaptive Behavior*. I will now summarise the points I made in that paper. Next I will discuss in detail new evidence for psilocybin-containing mushrooms depicted in the Selva Pascuala mural found at the Villar Humo Cultural Site in Cuenca, Spain, dated at 4000–6000 years before present, that Froese et al. (2014a) cited in their paper.

As mentioned previously Froese et al. (2013) failed to cite any references critical of the neuropsychological model, claiming in their 2014 paper that Bahn and I were the first to criticise the model. That was false as shown earlier in the current paper. Next, they claimed that we tried to demonstrate that ASCs *could not* have played a role for pre-Historic art in Europe. This is an old charge by Lewis-Williams and his follower, David Wilson, and we addressed it in our 2004 *CAJ* paper. For example, on p. 91 we stated, 'mythic culture would have been characterized by the telling of stories and creation myths, reenactments of myth through ritual, and singing, dancing and shaking rattles and/or beating drums around the communal hearth. All of these activities are known to facilitate a hypnotic trance'. On p. 93 we wrote 'A mythic culture might have used plant substances to induce and/or enhance trance (Siberian shamanism is clearly associated with the hallucinogenic mushroom, *Amanita muscaria*) although in Europe, especially where caves containing Upper Palaeolithic cave art are located, the evidence for hallucinogenic substances is very sparse'.

Helvenston and Hodgson (2010) discussed the possibility of ASCs in animistic rituals in the Upper Palaeolithic. These were informed speculations, not empirically demonstrated facts, but they clearly show that we do consider ASCs to be a *theoretical possibility* for persons living in the Upper Palaeolithic; but the issue of whether or not they inspired the cave paintings is a completely different matter. Indeed many (most notably Julian Jaynes, 1976, and his follower Kuijsten 2006) have suggested that ASCs may have played a major role in human evolution and ritual until about a thousand years ago. Jaynes maintained that consciousness was different before writing made the left hemisphere so dominant and that people frequently experienced auditory and visual hallucinations originating from the right hemisphere that they attributed to gods communicating with them.

I completely agree with the reviewer of this paper who suggested that it is likely ASCs have played a large role in hominin evolution for far longer than 40 000 years. Additionally, Walter Ong (1982) demonstrated that Greek thought was profoundly changed by the introduction of writing which he suggested was about 800 BCE; see Helvenston (2013) for a detailed analysis of the differences in preliterate thought and the thinking of literate societies. Literate cultures simply think differently than non-literate cultures and ASCs assume a larger role in non-literate societies, although they are certainly ubiquitous in modern life even today. Helvenston and Bahn (2002, 2003, 2004, 2005) emphasised that rather than one Ur-ASC, there had been actually some 70 different trance states described by Ludwig (1968), including some by hallucination-inducing substances, facts that followers of Lewis-Williams ignore.

Neither Paul Bahn nor I are invested one way or the other as to whether ASCs were involved in Upper Palaeolithic cave paintings. Maybe they were and maybe they were not, but we simply said that there was no empirical evidence from the Upper Palaeolithic supporting that *theory*. We follow the evidence; we do not try to search for facts that support a preordained theory. What we have always objected to was Lewis-Williams and his acolytes presenting a theory as if it were established empirical fact, especially when that theory contained numerous errors, distortions and misunderstandings of neuropsychological phenomena. As one reviewer of this paper noted, Bahn and I 'have always objected to the use of conjecture and assumptions which are not based on scientific evidence and the misuse and inappropriate application of very old experimental data to validate a new theory'.

We specifically criticised Lewis-Williams and Dowson for many factual errors contained in the neuropsychological model (Helvenston and Bahn 2002, 2003, 2004, 2005, 2006a and 2006b), including their presentation of one Ur-Trance consisting of three stages. The *pattern* of hallucinations occurring in this trance was based upon Rouhier's (1927) and Kluver's (1928, 1942, 1996) studies with mescaline and included three phases of trance. (Kluver did not describe three stages; that was Rouhier's contribution, as elaborated by Helvenston and Bahn 2005). The first stage consisted of hallucinations of geometric figures, followed by the second stage which consisted of geometric figures and some 'iconic images'; and the third stage consisted of iconic images such as humans, animals, complex architectural schemes, landscapes and therianthropes. Subsequent research indicated that a similar *pattern* of trance could be produced by psilocybin and LSD. We have never said that no other substances stimulate geometric images for we know that *ayahuasca* does. We do challenge Froese et al. to produce a list of such substances. What we have emphasised is that the specific *pattern* of trance described in the neuropsychological model, consisting of three stages, could only be induced by ingestion of psilocybin, mescaline and LSD. The experimental data cited by Lewis-Williams and Dowson was from the 1920s to the 1970s and most of his sources interpreted their findings with Klüver's work in mind; see Helvenston and Bahn (2005) for a detailed discussion of these outdated sources.

Lewis-Williams and Dowson (1988) also cited the work of Reichel-Dolmatoff with Indians of the Amazon who experienced hallucinations after taking *ayahuasca*, commonly called *yagè*. This brew produces

hallucinations that are nothing like those of psilocybin, mescaline and LSD and is composed of *Banisteriopsis caapa* vine and the leaves of dimethyltryptamine (DMT)-containing species of a shrub, genus *Psychotria.* Lewis-Williams and Dowson (1988: 5) likened Reichel-Dolmatoff's description of two stages of trance experienced by Tukano Indians to their stage 1 and stage 3 trance. However, subsequently, in his book, *The forest within: the world view of the Tukano Amazonian Indians* (1996: 160–172), Reichel-Dolmatoff describes a stage one that consists of geometric figures and a second stage that consists of moving blobs of colour and sounds; both stages *require* shamans to provide cultural interpretations, or otherwise the images and sounds experienced in the hallucinations are meaningless. The shaman helps the participant 'project' on the moving colours, shapes and sounds various mythic landscapes and beings, otherwise the participant would not have a clue what he is seeing. Lewis-Williams distorted this work by claiming that the second stage was similar to the third stage of the neuropsychological model even though that was clearly untrue, imposing that model even though the raw data did not support it. Thus, Lewis-Williams, in constructing the neuropsychological model, conflates the hallucinatory trance produced with mescaline, psilocybin and LSD with the very different trance produced by *ayahuasca* and writes as if they are the same ACS. He also conflated the trance states induced naturally, with those induced by various hallucinogenic substances. Both of these errors distort clinical and experimental research.

Proponents of the neuropsychological model have assumed that early sensory deprivation experiments are analogous to the environment speleologists encounter in caves, and have shown great interest in the ASCs which occurred in the early sensory deprivation experiments when subjects were restrained for several days at a time. However, speleologists' experiences in caves are not analogous to sensory deprivation since they carry lights in dark, cold, damp caves with bad air, packing large quantities of supplies and equipment. Bahn (2010: 87–91) summarises in detail the fact that Jean Clottes, a proponent of the neuropsychological model, has long held that caves, in and of themselves, stimulate hallucinations, just like the sensory deprivation experiments.

Speleologists, who spend days in caves, do not describe more than the occasional flashing light as a visual hallucinatory phenomenon. One speleologist reported seeing complex buildings but attributed it to physical exhaustion and sleep deprivation. Froese et al. (2014a) argue that modern speleologists use caves very differently than did Palaeolithic peoples, but if caves are, in and of themselves, hallucinogen-inducing environments, then people who spend days and weeks in modern caves should report hallucinations. They rarely do, and never in the same pattern of trance as described for the neuropsychological model. Bahn refutes this claim as did Helvenston and Bahn (2005: 45–46, and 2007). Proponents of the neuropsychological model have also claimed that CO_2 and potassium manganate also stimulated ASCs in the artists of the Upper Palaeolithic. Both of these claims have been refuted by Helvenston and Bahn (2005:45–47); Delluc, a physician, (2006: 68–104); and Bahn (2010: 90–93).

Froese et al., in both papers, suggest that the use of the three stages of trance *theory* (unsubstantiated) explains the presence of geometric imagery in European Palaeolithic rock art and focus almost exclusively on geometric figures, a position which is unsupported by valid scientific data. For example, Froese et al. (2014a: 93) state that [in]'a recent review (Sacks 2013: 34–44), sensory deprivation regularly produces all kinds of visual hallucinations, including geometric patterns that are followed by more complex visual imagery'. Presumably they are referring to the discussion of the findings of William Bexton and his colleagues (1954) and John Zubeck et al. (1961). In Bexton et al. (1954), twenty-two male students participated in a sensory deprivation experiment. Only 14 students were interviewed as to visual images. Only three of the subjects reported seeing anything remotely similar to three stages of trance (see Helvenston 2014 for more detail). It seems an overreach of the data to state that 'sensory deprivation regularly produces all kinds of visual hallucinations, including geometric patterns that are followed by more complex visual imagery' because this pattern only occurred in three of the subjects. This is an extremely small sample upon which to base such a generalised statement.

I was only able to obtain an abstract for Zubeck et al.'s (1961) experiment where it was indicated that 11 of 16 subjects experienced hallucinations. No details of the type of hallucinations were available from that abstract. Given the variability of Bexton's actual results, not a summary of the findings, Froese et al. (2014a) are obliged to describe the nature of these hallucinations in detail since they cited this work as evidence for their claims that it is consistent with the neuropsychological model.

Froese et al. (2014a) cite extensively from Oliver Sacks' book *Hallucinations* (2013). When Sacks (p. 39) discussed a total visual sensory deprivation experiment by Merabet et al. (2004: 110) he referred to geometric figures. He described flashing lights, geometric and more complex visual hallucinations. However, in the original experiment reported by Merabet et al. (2004: 110), rather than cascades of geometric figures during this study, 'one subject, no. 4, reported seeing a triangle', and this was apparently stimulated while he was trying to learn the Braille sign for an X, cognitive behaviour that could have led to the visualisation of a triangle. This is hardly an example of a complete deprivation of visual stimulation leading to multiple hallucinations of geometric figures. Moreover, Merabet et al. (ibid.) stated that only two of the subjects reported a pattern of simple to complex hallucinations. No subjects reported animals. Clearly the various subjects saw

differing patterns of hallucinations, only two of which were remotely consistent with the neuropsychological model. Again, this is an experiment with a very small sample size (N = 10 subjects whose hallucinations were described in detail).

Furthermore, Froese et al. (2014a) confuse the hallucinations experienced during this complete blockage of visual stimuli with an ASC. However, Sacks' summary and Merabet et al.'s original paper stress the fact that the subjects of this experiment, while hallucinating, carried on normal activities of daily living. Persons suffering from Charles Bonnet syndrome hallucinate geometric patterns (Sacks 2013: 22), but nowhere does Sacks indicate they are in an ASC.

That the authors conflated hallucinations resulting from sudden and complete deprivation of visual stimuli with an ASC is confirmed by their own words. On p. 93 of Froese et al. (2014a), they state, '[t]hese documented cases of progression from simple to complex hallucinations during days of sensory deprivation support the generality of Lewis-Williams and Dowson's 'neuropsychological model', according to which deepening ASCs often pass through three stages, from geometric patterns (Stage 1), to iconic forms (Stage 2) to complex scenes of animals and self-transformations (Stage 3)'.

Such misunderstandings about neuropsychological phenomena and glossing over of details that do not support their theories are typical of Lewis-Williams and his acolytes, including Froese et al. in a new generation of followers. Are Froese et al. really suggesting that a small group of Palaeolithic people blindfolded themselves for several days in a darkened cave, hallucinating spots of light, and more complex scenes, and that this experience stimulated the painting of geometric figures on cave walls? They appear to be, because they claim sensory deprivation over several days' time makes sense if one *assumes* a vision quest. This is another assumption added into the neuropsychological model. Just because North American Indians of some tribes sought vision quests during recent history does not necessarily mean that Palaeolithic peoples were driven to do the same.

Froese et al. (2014: 92) also state that '[c]ountering the universality of Kluver's so-called form constants, Helvenston and Bahn claim that this "pattern of drug-induced-vivid imagery experiences is only produced by three substances: mescaline, psilocybin and LSD".' We have never questioned the universality of Kluver's form constants. They are evidenced by electrical stimulation of the visual cortex, migraine headaches, partial-complex seizure disorders, hypnagogic and hypnopompic states, mescaline, psilocybin and LSD, as we elaborated in our book *Waking the trance fixed* in 2005, and earlier in 2002. This is also an old claim of Lewis-Williams and his acolytes. Again, we have never disputed the fact that form constants appear to be hardwired in the visual cortex. This view is consistent with Hodgson's neuroresonance theory (2006a, 2006b). We have never stated that no other substances stimulate geometric figures, although we challenge Froese et al. (2014a) to list these substances. We simply stated that the neuropsychological model describes one very specific *pattern* of three-stage trance experience, the first stage of which consists of hallucinations of geometric figures followed by a stage of geometric figures, animals, humans and therianthropes, and a final stage of only iconic figures — a specific pattern that only occurs after the ingestion of these three substances, psilocybin, mescaline and LSD.

Froese et al. (2014a: 92) go on to state that 'geometric patterns are experienced in all forms of ASCs, including naturally occurring alterations, drug-induced alterations and because of brain pathologies as Sacks' (2013) extensive review of hallucinations makes clear'. A careful reading of Sacks reveals that discussion of geometric figures in the hallucinations he describes occur mostly in pathological conditions including Charles Bonnet Syndrome (CBS), Parkinson's disease, migraine headaches and delirium. Geometric images are also seen in hypnopompic or hypnagogic states or some forms of sensory deprivation. Sacks (2013: 27) states that 'people with CBS retain their normal, critical waking consciousness', so their hallucinations are not necessarily an indication of an ASC. Froese et al. (2014a) suggest that geometric figures are common in naturally-induced trance states. I challenge them to cite examples of frequent geometric figures occurring in naturally-induced trance states, such as hypnosis, meditation and starvation, for example. Hallucinations of simple flashing lights and some complex images (as well as of auditory hallucinations) are reported from sleep deprivation experiences and by speleologists (Helvenston and Bahn 2005: 45–47 and Bahn 2010: 87–90). Hallucinations of geometric figures in naturally induced trance states are not as ubiquitous as Froese et al. suggest.

For example, after searching the clinical literature for months in 2002 and 2005, the only references I found to a naturally-induced trance state resulting in what Cardeña (1988, 1996; and pers. comm. 2004) interpreted as images of geometric figures during deep hypnosis was discussed in Helvenston and Bahn (2005: 53–55). His results stated that a few of his subjects reported an occasional geometric image such as a tunnel or a lattice. The *pattern* of the trance in deep hypnosis was not consistent with the neuropsychological model as no animals were reported and they are a sine qua non of that model (Helvenston and Bahn 2004: 92).

Psilocybin-containing mushrooms

Froese et al. (2014a) quote a sentence from Helvenston and Bahn (2004: 94) that states, '[n]either mescaline nor psilocybin has ever been found in Europe'. They take this quote out of context as we were discussing evidence for the presence of mescaline and psilocybin in *Upper Palaeolithic* Europe. To be perfectly clear, the sentence they quote should have read 'neither mescaline nor

psilocybin has ever been found in Europe of the Upper Palaeolithic'. The entire issue of whether or not psilocybin has been found in mushrooms in Europe *since* the Upper Palaeolithic is much more complex than Froese et al. (2014a) imply, and indeed far more complex than Bahn and I realised.

For example, it is well known that psilocybin-containing mushrooms are found in North and South America (Schultes 1972), and reports of their contemporary presence around the world are increasing (Guzmán et al. 1998; Guzmán 2012). In Helvenston and Bahn (2005: 30–33) we discuss the issue of whether psilocybin-containing mushrooms were found in Europe prior to the 1960s, after which time they have naturalised across many areas of Europe. Froese et al. (2014a: 92) state that some mycologists are now claiming psilocybin-containing mushrooms were indigenous to Europe long before the 1960s. It would be useful to have some citations for this assertion in addition to the work of Kosentka et al. (2013) with the *Inocybacae* family, a group of mushrooms which do not appear to have been widely used in Europe, and for which written records of use as a hallucinogen appear to be absent. It is *assumed* that some species of *Inocybe* may be hallucinogenic because of the presence of psilocybin. If there are available written reports of *Inocybe* use in Europe, we would appreciate Froese et al. (2014a) citing them.

We know of one example of a mycologist claiming a deep antiquity for *P. semilanceata* in Europe. For example, in the 1998 (English translation, 2001) edition of Schultes, Hofmann and Rätsch's book *Plants of the gods*, it was mentioned that *P. semilanceata* may have been present in Europe for 12 000 years, without discussing the evidence for this claim. In previous editions of Schultes and Hofmann (1992) there were no psilocybin-containing mushrooms mentioned in Europe. Hofmann was the first to identify psilocybin as the active ingredient in *P. semilanceata* in 1963, yet he did not consider it indigenous to Europe. Indeed, the total absence of descriptions of *P. semilanceata* prior to the early 1900s in written literature from Europe seems very odd if the mushroom was as widespread then as it is now. A search of the internet reveals that many local poisonings have been reported in the past few years in European written literature. Guzmán et al. (1998: 202) stated: 'It is concluded in the distribution of the neurotropic species of *Psilocybe* that these fungi may have their origin in the Southern Hemisphere, mainly in South America, based in the high diversity there and from that region reached the Northern parts (N. America and Europe)'.

When we wrote our book in 2005 there was one report (Gartz 1996: 15) that traced the earliest use of *Psilocybin semilanceata* to a poisoning that occurred in London in 1799, but the author of that report believed that one of the very common species of agaric, some of which resemble *P. semilanceata*,, was responsible, and the experiences described were much more consistent with an agaric poisoning than a psilocybin poisoning. Agaric mushrooms (*Amanita muscaria*) had been known as the fools mushroom in Europe since at least the days of the Roman Empire, having originally been associated with Siberia. Gartz also discussed three reports of poisonings which he attributed to *P. semilanceata* in Europe since the 1900s. Helvenston and Bahn have *speculated* previously that psilocybin-containing mushrooms could have been introduced to Europe following the Spanish Conquest, based upon the fact that an early 16th-century Spanish coin had a mushroom engraved upon it. This debate about various psilocybin-containing mushrooms and where they have been used historically, and whether or not they are indigenous to a region, still rages on with recent comments on the internet over Pollack's paper of 1975 entitled the 'Psilocybin mushroom pandemic'. Full details of this debate are beyond the scope of this paper.

Froese et al. (2014a) cite Kosentka et al. (2013: 7) who conducted a study of muscarinic and psilocybin-containing fungi from around the world. They studied the mushroom family *Inocybacae*, genus *Inocybe*, species: *Inocybe tricolor, I. haemacta, I. corydalina and I. aeruginascens* (all of which they said were only found in Europe and contain psilocybin), as was suggested by Guzmán et al. (1998). We were unaware that some *Inocybacae* fungi contained psilocybin when we wrote our 2005 book. *Inocybe* species must be identified by means of a microscope, and they are not deemed edible. Wikipedia (search under *Inocybe*) says they are eaten by people in undeveloped countries, but provides no citation. The possibility of misidentifications of this mushroom with others in historical times, as well as the present, is high.

Little of *Inocybe* use in Europe now or in Historical periods appears to be known at this time, including the type of hallucinations these species might stimulate (psilocybin-containing mushrooms usually contain other alkaloids too, differing from species to species which can alter the trance experience). They are assumed to be psychedelic because of the presence of psilocybin. As reported by Kosentka et al. (2013), they evolved over a period of some 10–20 million years, so they could be a *theoretical* source of a hallucinogenic mushroom in Europe during pre-History, although no evidence of their use is present from the Upper Palaeolithic at this time. In fact, there are no reported depictions of mushrooms in the *Upper Palaeolithic art* of Europe. As Paul Bahn states (pers. comm. 2014), 'I am not aware of a single image in Ice Age art that could be interpreted as any kind of mushroom. There is one portable engraving of a bear licking what is usually seen as the end of a phallus, and many years ago I consulted a mushroom specialist in case it might be a phallic mushroom, but he found that extremely unlikely. So not one!' Certainly the artists of the Upper Palaeolithic were capable of depicting mushrooms had they wanted to.

On the other hand, Froese et al. (2014a) cite Akers et al.'s (2011) paper suggesting that psilocybin-containing

mushrooms may have been present in Europe from pre-Historic times (also see Guzmán 2012). Akers et al.'s study is based upon the Selva Pascuala mural found at the Villar Humo Cultural Site in Cuenca, Spain, that depicts a number of what have been interpreted as mushrooms thought to be of the species *Psilocybe hispanica*. Considerable uncertainty exists as to the exact dating of this mural, as Akers et al. point out, but they estimate the age at 4000–6000 years. The *P. hispanica* mushroom was discovered high in the hills of Spain, near Huesca in the Pyrenees Mountains (approximately 275 km northeast of the Selva Pascuala mural) in the Aragon region in 1998 by Ignacio Seral. The authors suggest that the mushroom may have been located closer to the mural 4000–6000 years ago but speculate that changing weather conditions may have resulted in localising it to the Aragon area. It was classified by Giorgio Samorini, a well-known Italian mycologist, and described by Guzmán (1998).

Youths in the Aragon region are said to use this mushroom for its psychedelic properties, but Akers et al. (2011) do not describe the pattern of hallucinations, if any, produced by this mushroom, so it is unknown whether it produces a trance consistent with the neuropsychological model. This is an important question and one that could easily be answered by interviewing users from the Aragon region. Moreover, is there any local written tradition for the use of *Psilocybe hispanica* from the Aragon region and how far back into antiquity do the comments reach? While it is a leap of faith to suggest that a mushroom discovered in 1998 may have been indigenous to Europe in antiquity, this paper suggests the plausibility of the use of mushrooms other than *Amanita muscaria* at this rockshelter (note, not a deep cave). Interestingly, *Psilocybe semilanceata* now grows near *P. hispanica,* but has been ruled out as the mushroom depicted in the mural.

By analogy, since horses are now very prevalent in the Americas, it would be easy to suggest that they are indigenous. However, such an assumption would be incorrect since we have historical records documenting their introduction to the Americas during the Spanish Conquest. Similarly, assumptions that because certain hallucinogenic mushrooms appear to have naturalised in Europe over the past 100 years, maybe longer, and increasingly since the 1960s, they are indigenous are fraught with problems. A quick search of the Internet for hallucinogenic mushrooms will quickly confirm how easy it is to buy them anywhere in the world, and this has been true since the 1960s. Again, I remind the reader of Guzmán et al.'s (1998) statement '[i]t is concluded in the distribution of the neurotropic species of *Psilocybe* that these fungi may have their origin in the Southern Hemisphere, mainly in South America, based in the high diversity there, and from that region reached the northern parts (North America and Europe)'.

Conclusion

In conclusion, I have addressed some neuropsychological errors that Froese et al. (2014a) have made, corrected some misrepresentations of the work of Bahn and myself, and discussed recent evidence for the presence of psilocybin-containing mushrooms in Europe during prehistory. But when all is said and done, there is still no empirical demonstration of actual ASCs stimulating the Upper Palaeolithic paintings, whether geometric images or images of animals. We are still left with informed speculation that they *may* have. Indeed, both Bahn and I wonder why there exists this obsession of linking ASCs to artistic production, as opposed to the wonder of modern human consciousness and what is accomplished with it? We agree that this would make an interesting clinical psychological study for some budding PhD in neuropsychology and/or archaeology or the history of science.

There are still no criteria for distinguishing the art created during normal human consciousness from that created during a natural or a drug-induced altered state. Moreover, as stated by Derek Hodgson (pers. comm. 2014a), Froese et al. (2014a) 'do not respond to the fact that similar types of geometrics have been found in the art of indigenous groups that do not practice shamanism or engage in exotic altered states of consciousness'. As stated earlier, we do not care whether ASCs may have stimulated some of the art, but we do ask for solid, empirical evidence to support this theory.

Finally, I would like to quote some thoughts by my colleague, Paul Bahn, an internationally acclaimed expert on rock art worldwide and the art of the Upper Palaeolithic (pers. comm. 2014).

> I am bemused that they [advocates of the neuropsychological model] appear to be totally unaware that Ice Age cave art is turning out to be a really quite marginal phenomenon — even among the 400 or so decorated caves and shelters known at present, only a fraction have paintings in dark recesses, and of course, we now know that the vast majority of Ice Age rock art was almost certainly made out of doors, quite apart from the thousands of portable images. Any theory involving trance and ASCs needs to take that on board, but they always ignore such minor problems. They claim that our work applies modern concepts to prehistoric situations, but they do exactly the same when they simply assume that Palaeolithic people were intent on having visions, and hence spent endless hours in dark caves trying to get them. Pure fantasy.

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The ritualised mind alteration hypothesis of the origins and evolution of the symbolic human mind

By TOM FROESE

Introduction

This article was originally motivated by a couple of critical commentaries about my work (Helvenston 2014, and above). However, I quickly came to realise that, to be able to adequately respond to the specific concerns that were raised, I would have to present some general considerations. It is only with this context in place that it becomes clear why I think that these details are worth arguing over in the first place. Thus, before anything else, the overarching question is: when it comes to the formidable task of understanding human pre-History, why should we care about altered states of consciousness?

To some extent, intentional alterations of normal waking consciousness are so widely prevalent in today's world that it is difficult to think why they should *not* have previously played a role. Throughout Historic times mind alteration has been achieved by an incredible variety of means, be it with the consumption of coffee, beer, tobacco or some stronger substance, or by practising a specialised mind-body technique of mind alteration such as yoga, meditation or repetitive chanting. At this point the precise method used is not as important as the general insight that every notable culture has its own ways of changing consciousness from the normal waking state, with some methods being more potent in their alterations than others. Surely in itself this seemingly universal phenomenon of mind alteration is in need of a scientific explanation. But, and this is where things get more controversial, how far back into pre-History do such practices go?

Every major ancient culture also seems to have had its preferred substances to alter waking consciousness in one way or another. The variety of psychoactive plants and the diversity of their cultural contexts is truly staggering (Schultes et al. 2001; Rätsch 2005). To cite just a few more recent studies, such practices are known for ancient Eurasia (Merlin 2003; Jiang et al. 2006, 2009; Guerra-Doce in press), Australia (Dobkin de Rios and Stachalek 1999), Mesoamerica (Viesca Treviño et al. 1996; Guzmán 2008; De La Garza 2012), South America (Torres 1996; Blanc 2010; Luna 2013), Africa (Sobiecki 2008; Marcus 2009), and North America (Litzinger 1981; Winter 2000; Charlton 2004; Crown et al. 2012). And with improving methods in archaeochemical and archaeobotanical research we can expect that our knowledge of the list of plants used to modulate the mind and their ancient distribution of usage will increase (e.g. Bawaya 2014; Guerra-Doce in press).

Certainly, the widespread popularity of many substances is explainable in terms of their evident functions in daily life, such as increasing physical energy and wakefulness (coffee, tea, coca, cacao etc.) or decreasing inhibition (e.g. alcohol and aphrodisiacs). But there are several categories of plants, typically used in sacred rituals, which do not fit within this scheme because they interrupt the functions of daily life. Depending on the type of plant, these interruptions can range from mild changes in mentation and enhanced suggestibility, to strong perceptual changes, vivid hallucinations and full-blown deliriums (Díaz 2010). Although care must be taken not to conflate these types of plants, for our current purposes it is sufficient if we group them together as psychedelics.

If we believe our current legislation system, such as the UN Convention on Psychotropic Substances, most psychedelics have no value and substantial potential for harm and abuse. If so, then it becomes difficult to explain their widespread use and it may seem plausible that people only became interested in them in more recent times, perhaps as a negative side-effect of the formation of complex societies.

Yet the idea that use of psychedelics is a maladaptation occasioned by complex society is not consistent with the evidence. The first thing to note is that according to some leading drug experts, the desire to occasionally profoundly modify one's state of mind is deeply inherent in human nature, perhaps even comparable to some of the other basic biological and innate drives (Weil 2004; Siegel 2005). What their assessment suggests is that we are not necessarily dealing with an exclusively cultural phenomenon at all.

Indeed, there is a growing recognition that even a wide variety of nonhuman animals will intentionally and repeatedly intoxicate themselves when given the opportunity to do so (Samorini 2002; Siegel 2005). For one well-accepted example we only need to think of cats' obsession with plants that are commonly known as catnip (e.g. the genus *Nepeta)*, which can temporarily cause profound alterations of their behaviour.

Adaptive benefits of altered states of consciousness

Yet if it turns out that such mind alteration is prevalent in the rest of the animal kingdom, then this presents us with another puzzle. Are we dealing with another unfortunate mismatch between animal brains and their botanical environments that evolution by natural selection has been unable to remove from populations? Or could there even be selective advantages conferred by this seemingly unusual behaviour? The idea of pure coincidence can be ruled out by taking a closer look at the chemical substances and neurotransmitter receptors that are involved in the effects of psychoactive plants. On the contrary, the highly specific ways in which these plant substances interfere with animal neurotransmitters is suggestive of a co-evolutionary relationship that is millions of years old. And while part of the explanation is that plants evolved a defensive reaction against animal predation, there is another side to this story.

Sullivan and Hagen (2002) have argued that

consumption of psychedelic plant chemicals could have conferred selective benefits, for example because they could be exploited as externally produced substitutes for metabolically costly endogenous neurotransmitters. Nevertheless, since Sullivan and Hagen's explanation is situated only at the level of metabolism and neurophysiology, it leaves the role of the profound psychological effects rather mysterious. Could mind alteration in itself not also have some selective benefits? At least this is suggested by the positive relationship between altered states of consciousness and improved health in traditional shamanic contexts (Sidky 2009; Blanc 2010), in modern psychiatry (Kupferschmidt 2014), and perhaps even in modern recreational contexts (Krebs and Johansen 2013).

In order to investigate this intriguing possibility, my colleagues and I devised a highly simplified model of mind alteration by making use of an artificial spiking neural network (Woodward et al. in press). We found that if the model 'brain' is subjected to occasional perturbations that profoundly alter its normal state of activity, in this case via the randomisation of its activity, synaptic plasticity spontaneously starts to reshape the network's connectivity in a way that enhances coordination of neural activity. This result is only based on an artificial model, but it is nevertheless suggestive: neuroscientists investigating the psychedelic state have found it to be associated with a similar disruption of normal activity, including cortical desynchronisation (Muthukumaraswamy et al. 2013) and increased disorder of neural activity (Carhart-Harris et al. 2014).

In addition, the model's finding that such disruption can lead to self-optimised coordination of neural activity fits with current psychiatric theories of health benefits. For example, it has been argued that the experience of altered states of consciousness heals by increasing integration between brain areas (Winkelman 2010). Our finding of self-optimised neural coordination is also consistent with existing theories that view psychedelic drugs as instruments that may provide users with functional adaptation of cognition (Müller and Schumann 2011), and as influencing creativity (Dobkin de Rios and Janiger 2003).

Nevertheless, even if we only focused on the potential benefits of psychedelics in the treatment of mental health problems, such as a variety of mood and affective disorders (e.g. Vollenweider and Kometer 2010), it would still lead us to expect a discovery of remains of psychedelic plants associated with burials of pre-Historic medicine men. If psychoactive plants have medicinal value and if they can be found in the environment, we can be relatively sure that hunter-gatherers would have made use of them. In other words, although we emphasise the temporarily disruptive effects of altered states of consciousness, we do so in the context of long-term improved mental functioning, which makes this proposal immune to criticisms targeted at theories of palaeoart based on mental disorders (Bednarik 2013b). We return to the connection between non-pathological altered states of consciousness and enhancement of mental functioning below.

The generality of our model implies that the effects of the psychedelic state are not unique to the modern human brain, which may help to explain why animals are also found to indulge in repeated intoxication with psychedelic plants. For example, wild chimpanzees and wild gorillas are known to engage in consumption of plants that are unrelated to nutrition, including a variety of psychedelic plants. Based on their extensive review of medicinal plants consumed by gorillas, including hallucinogens also employed by local people in ritual contexts, Cousins and Huffman (2002) have suggested that 'Africa may not be so impoverished in psychotropic plants as is widely believed', and that 'it is a tantalising thought too that gorillas might be directly affected by these same properties' (p. 70). Interestingly, chimpanzees are found to engage in unusual-food consumption twice as frequently as gorillas, which can be interpreted as indicating that self-medication may have become accelerated in our ancestors in association with higher social tolerance and lack of herbivorous gut specialisation (Masi et al. 2012). If so, then this too suggests that human practices of psychedelic mind alteration are likely to pre-date the origin of human symbolic culture. But this also means that the practice is so general that it says nothing about whether psychedelic states of consciousness were specifically associated with the origins of symbolic culture. In order to motivate a serious consideration of that connection, I will now turn to arguments that are based on recent developments in the cognitive sciences. And with this we finally start to move into an area of research that is more closely related to the concerns of this journal.

Cognitive benefits of altered states of consciousness

The last couple of decades of interdisciplinary research have profoundly changed the way we think about the mind. The old computational theory of mind is being replaced by an emphasis on biological embodiment, worldly situatedness, and lived experience (Thompson 2007). Mind is conceived of as essentially a living activity of sense-making that constitutes a meaningful point of view, shaped by needs, desires and possibilities of action in the environment, including the social world (Froese and Di Paolo 2009).

One of the main challenges of this new approach is to explain the emergence of abstract 'higher-level' cognition from this concrete 'lower-level' sense-making (Cappuccio and Froese in press). In particular, if mind's default mode of being in the world is to be fully absorbed in coping with whatever is immediately present and meaningful, then how do we account for the origin of cultural signs and symbols, whose meaning is not intrinsic to their appearance while referring to something which is not even immediately present (hence re-presented)? What is needed is a reflective capacity. The beholder of a symbol must be

able to step back from her more immediate worldly preoccupations so as to appreciate the communicative role of the physical substrate underlying the symbol, i.e. serving as a neutral medium of representation, while imbuing that medium's specific content with culturally derived meaning. Arguably, it is the difficulty of having to first adopt such a reflective or 'objective' stance that separates human symbolic capacities from those of nonhuman animals (Froese et al. 2012).

I have elsewhere proposed that ritualised altered states of consciousness could have played a crucial role in originally enabling this unusual cognitive stance in pre-Historic times (Froese 2013a). To see why, it is helpful to consider under what conditions our modern consciousness spontaneously becomes more detached and reflective. Following Heidegger's *Being and time*, a foundational work on existential phenomenology, continental philosophers have noted that most of the time we are engaged in situated smooth coping activities in which the distinction between subject and object is not that clear. As Heidegger argued, under these conditions it is more accurate to describe our existence as one distributed and holistic being-in-the-world (*Dasein*). Yet when something unexpectedly goes wrong and smooth coping is disturbed, a subject-object dualism starts to emerge that with further interruption will develop into a full-blown observer attitude whereby situated coping is replaced by detached reflection (see e.g. Dreyfus 1991: 124–5).

What I suggest is that a similar process may have been operative during *Homo*'s transition from a purely animal kind of life (and mind) to what we would consider as a reflective and symbolic mind. This proposal therefore does not depend on the assumption that the modern human mind is already in existence, but rather tries to explain its original emergence. Nevertheless, having something as useful as the capacity to observe and to reflect could not be left to chance occurrences of interruptions and breakdowns of coping activity, but is something that was likely cultivated in a more and more intentional manner. But how?

Altered states and symbolic culture

Here we return to a theme that we have already discussed earlier, namely how consumption of psychedelics profoundly interrupts normal mental functioning. This is not to say that they are the only way to enact such interruptions, but they are certainly a powerful and for most cultures readily available option. Another factor to consider is that reflective consciousness is less needed by young infants, but becomes increasingly useful and, at least in the context of a highly symbolic culture, even necessary as maturation proceeds. On this view, the traditional prevalence of intense rites of passage during puberty, including taboos, extended periods of seclusion, social isolation, physical hardships, and the ingestion of psychedelic substances, i.e., practices which have little to do with the process of sexual maturation as such (van Gennep 1908/1960), is no longer as bizarre as it may otherwise seem. The rites' original purpose could have been related to the facilitation of the ontogenetic development of young initiates' normally fully situated minds into a more stabilised subject-object dualistic form, one which is more suitable for enculturation into a symbolic culture (Froese 2013a).

Over time this original purpose of socially enhanced mental development would have become less essential as we and our cultural contexts co-evolved to allow individuals to more easily adapt to and reproduce a variety of highly symbolic practices (Froese and Leavens 2014), a co-evolutionary process that has been nicely illustrated by the co-evolution of the human brain and languages (Deacon 1997). Relatedly, this also explains why we should not expect that all traditional cultures still make use of profound mind alteration, because once our propensity and capacity for highly refined imitation of symbolic practices was already in place, existing symbolic content could be preserved and developed without it.

There is another implication of this hypothesis that relates to the particular form of expression of the first symbolic cultures. Neuroscientists have realised that activity in the visual system is normally inhibited so that it can correlate with the external environment (Butler et al. 2012), since abnormally disinhibited activity leads to internally determined forms, i.e. hallucinations. Mathematical models have shown that under such disinhibited conditions activity in the visual system can develop into self-sustaining geometric patterns, which look similar to some of the ones reported by people with altered states of consciousness (Bressloff et al. 2001). My colleagues and I contributed to this research by highlighting two additional properties of self-sustaining neural dynamics that are relevant for explaining the origins of symbolic culture (Froese et al. 2013).

First, the presence of such dynamics in the sensory cortex would simultaneously have the effect of reducing influences from the external environment to other brain regions, and the absence of tight continuous sensorimotor coupling could simultaneously have facilitated the emergence of more detached and reflective cognitive modes. Second, it has been argued that self-sustaining networks of processes embody an intrinsic value related to sustaining their own viability as dynamic structures (Di Paolo et al. 2010), which may have the effect of enhancing the significance that people associated with the seeing of hallucinations caused by such geometric neural patterns.

Taken together, these considerations lead us to expect that the first expressions of symbolic culture took the form of abstract geometric patterns, and this seems to be confirmed by archaeological findings both in the case of modern humans (Henshilwood et al. 2009) and Neanderthals (Rodríguez-Vidal et al. 2014). But they also lead us to hypothesise that these first expressions were made by populations whose

culture included the induction of altered states of consciousness, and who thereby had socially enacted symbolic minds. It matters little if we want to call these practices shamanic or something else[1]. Neither is this hypothesis undermined by indications that Palaeolithic 'art' was mainly produced by children and teenagers (Bednarik 2013b). As I have argued, we should expect a ritualised management of the developmental process of mental maturation, so indications of a focus on younger individuals and of puberty rites is supportive of this theoretical framework (Froese 2013a).

In response to commentaries by Hodgson (2014) and Lewis-Williams (2014), my colleagues and I have clarified that our proposal differs from both of theirs in one crucial respect: we grant an adaptive value to mind alteration as an enabling role in the original emergence of the symbolic mind (Froese et al. 2014a). Lewis-Williams (2002) assumes that the European cave paintings were made by people who essentially had fully developed consciousness like us, such that the role of altered states is basically reduced to that of providing a collection of experiences whose contents are selectively reproduced artistically according to social norms. But if providing content is all there is to it, then Hodgson is right to wonder if appealing to altered states is really necessary. The neural resonance between geometric patterns and the visual system should naturally enhance the salience of those patterns (Hodgson 2006a). But, on our view, that neurovisual resonance is not sufficient to explain the initial appearance of art because it is not limited to the human brain but a general property of animals' visual system. In other words, Hodgson's proposal similarly relies on assuming the existence of a modern human mind to turn neural salience into symbolic representation, and he ignores the essential contributions of cultural context. Our theory, on the other hand, integrates neural, social and phenomenological levels.

In ongoing work I am trying to further demonstrate that the benefits of altered states need not be limited to the self-optimisation of individual brains, but can extend to the spontaneous optimisation of social networks. This is because the general logic of the interruption mechanism we implemented in the model of a neural system (Woodward et al. in press) can in principle be realised by a social system, as long as it has an effective way of temporarily interrupting behaviours associated with normal daily life, such as communal rituals.

In itself this idea of ritualised self-optimisation is not new. In particular, Turner (1977) had already suspected that the liminal phase of rituals benefits societies by increasing the diversity of their behavioural repertoire, thereby making them more adaptable. My colleagues and I have tested this reasoning by implementing a mathematical model of the network of co-rulers of ancient Teotihuacan, central Mexico (Froese et al. 2014a). The results show that periodic, widespread and simultaneous ritualised alteration of normal behaviours can implicitly restructure the social connectivity of the network until the most optimal behavioural configurations are spontaneously found in a consistent manner, even though individuals behave selfishly and no single individual has an explicit intention to adapt their network to the problem domain. Again, the generality of the model should allow us to apply a similar reasoning to other heterarchically organised social groups, such as communities of San hunter-gatherers.[2]

To me these models suggest another intriguing possibility that deserves to be more fully developed: during the initial emergence and development of symbolic culture there may have been a mutually reinforcing feedback cycle of structural self-optimisation spanning both neurobiological and social networks. On the individual level, periodic induction of altered states could have enhanced neural coordination and facilitated abstract cognition, while on the social level that same interruption of normal behaviours could have improved the configuration of relations, leading to more co-ordinated social behaviours, which in turn could have encouraged the development of more complex culture, including more extensive ritual practices of mind alteration. Admittedly, this is a speculative scenario. But it has the virtue of integrating a number of insights into a theoretical framework, which helps us to make sense of the fact that starting from around 300 thousand years ago the pace of cultural development quickened exponentially, suggesting that the changes were increasingly autocatalytic (Ambrose 2001).

Response to criticisms

In response to our article on the implications of self-sustaining neural dynamics in a disinhibited visual system (Froese et al. 2013), Helvenston has above raised several concerns related to our supposedly 'naïve acceptance of the neuropsychological model' (p. 84) of Lewis-Williams and Dowson (1988). By this point I hope it is already clear to the reader that, while we are indeed broadly sympathetic to Lewis-Williams' appeal to the neuroscience of altered states of consciousness, our proposal is not 'based upon the neuropsychological model of Lewis-Williams and Dowson' (p. 84), and

1 In other words, I am not interested in merely terminological disputes regarding the term 'shaman'. Different definitions are possible. Nevertheless, given that it is reasonable to interpret traditional shamanism as a kind of expertise of managing ritualised interruptions of mundane mental life (González in press), it is indeed a convenient label for the practices I am discussing.

2 This is another interesting difference between the ritualised mind alteration hypothesis and the work of Lewis-Williams and colleagues. Whereas the latter have tended to emphasise the role of altered states in producing hierarchical social differentiation (e.g. Lewis-Williams and Pearce 2005), our model suggests that enhanced social co-ordination can also be achieved by ritualised mind alterations in which large parts of the community participate on relatively egalitarian terms.

neither have we 'uncritically accepted the model as originally proposed' (p. 84).

In brief, that model relates some of the Upper Palaeolithic motifs to different classes of hallucinations. It is assumed that the symbolic mind was already put in place via a fortunate mutation of the brain; altered states of consciousness do not serve as more than a source of motifs; and the selection of specific motifs is made purely contingent on social norms. Conversely, our theory assigns a functional role to altered states in the emergence of the symbolic mind, and it provides neuroscientific arguments for why pre-Historic people should have come to value the contents of hallucinations in the first place (Froese et al. 2014a). In other words, the relationship between our proposal and the neuropsychological model is that we provide independent reasons for hypothesising that some palaeoart was indeed inspired by hallucinations.

Unfortunately, Helvenston decided to ignore these differences and the novelty of our proposal. Instead, she focused her concerns on her and Bahn's interpretation of Lewis-Williams' model, which they have termed the 'three stages of trance' model (e.g. Helvenston and Bahn 2003). It is true that Helvenston was not the first to criticise the neuropsychological model, but Bahn (1988) had certainly raised concerns at the time of its publication. Admittedly, it is sometimes confusing to grasp what the main point of contention is. As Helvenston herself states, in her collaborations with Bahn and Hodgson it was acknowledged that altered states were a theoretical possibility for people of the Upper Palaeolithic. In Helvenston's words: 'I completely agree […] that it is likely ASCs have played a large role in hominin evolution for far longer than 40 000 years' (p. 85). If so, then it would have been useful to know her theory of what that 'large role' was in order to be able to evaluate how it differs from existing proposals.

It seems that the dispute arises over some of the specifics of the 'three stages of trance' (TST) interpretation of the neuropsychological model. To evaluate these details, I have to briefly go over concerns that were already published elsewhere (Helvenston 2014), and to which my colleagues and I had already responded (Froese et al. 2014b), but which Helvenston (above) decided to bring up again.

First, she raises a general objection against 'Lewis-Williams and his acolytes [presumably including my colleagues and I] presenting a theory as if it were established empirical fact' (p. 85). I don't think this is the case. Presumably, it is clear to most readers that what is being proposed are hypotheses, theories and models, such as Lewis-Williams' 'neuropsychological *model*'. Helvenston's own interpretation of that model, i.e. her and Bahn's TST model, boils down to the following: 'The first stage consisted of hallucinations of geometric figures, followed by the second stage which consisted of geometric figures and some 'iconic images'; and the third stage consisted of iconic images such as humans, animals, complex architectural schemes, landscapes and therianthropes' (p. 85). She continues: 'What we have emphasised is that the specific *pattern* of trance described in the neuropsychological model, consisting of three stages, could only be induced by ingestion of psilocybin, mescaline and LSD' (p. 85). According to Helvenston this ignores the variety of possible altered states that are possible, and, more worryingly, threatens to completely disqualify the TST model:

> it is only a matter of time before evidence of plants containing mescaline and psilocybin will be found in Europe *if they ever grew there*. […] there is no evidence that any such plants ever grew in Europe and we have simply pointed this out as a serious problem for the empirical basis of the TST model. In our view, this fact refutes the model (Helvenston and Bahn 2004: 94–95).

To summarise the thrust of the argument: (a) if the TST sequential pattern is a necessary aspect of Lewis-Williams' model, and (b) if that pattern can only be experienced if and only if one of those three substances is consumed, and (c) if it can be demonstrated that none of them ever existed in pre-Historic Europe, then the neuropsychological model is certainly in trouble. But, as will become evident, none of these conditions can be taken seriously. Helvenston's strategy is a classic case of building up a straw man just to knock it down.

Regarding point (a), it is best to let Lewis-Williams speak for himself:

> These three stages of the intensified spectrum of consciousness are not ineluctably sequential. Some subjects report being catapulted directly into the third stage, while others do not progress beyond the first. The three stages should be seen as cumulative rather than sequential (Lewis-Williams 2002: 130).

So while his model does build on a general pattern or sequence of hallucinations, that pattern does not always have to be strictly realised. Accordingly, it is not surprising that Lewis-Williams does not 'stipulate any particular method or methods for the induction of altered states of consciousness' (2002: 134), nor does he focus on a specific form of alteration: 'I wish to emphasise the diversity of altered states of consciousness. […] We must beware of stipulating some naively simple altered state of consciousness as the shamanistic state of mind' (2002: 134–5). This nonexclusive stance makes sense because he is mainly interested in hallucinations as a source of motifs.

Points (b) and (c) are already moot points, given that (a) is not justifiable. But for the sake of argument let us assume we happened to always require a strict three-stage sequence. Then (b) must still be rejected because there are other ways of inducing that pattern than by means of those three chemicals. Helvenston may have already suspected this given her cursory dismissal of ayahuasca, since that brew actually produces a rather fitting escalation of hallucinations:

> As noted by many ethnographers, the effects of taking Ayahuasca follow a fairly stereotypical course. Some time after ingesting the drug, drinkers experience severe auditory and visual disorientation: they hear

> loud rushing sounds and see patterns of coloured light. […] This phase is often extremely frightening […]. It is, however, followed by more complex hallucinations, which become clearer and clearer: drinkers see distant and exotic landscapes and people (Gow 1988: 26).

Shanon (2002: 59) quoted this description in his comprehensive study of the phenomenology of ayahuasca as one that captures 'succinctly and accurately the overall flavour of the Ayahuasca experience as I myself have come to know it'. To be sure, this is just one additional example to the three acknowledged substances, which is based on a mixture of DMT and other compounds[3]. But there is no reason to assume that there couldn't be other compounds with similar effects, especially given the incredible variety of psychoactive plants that still await detailed phenomenological study (Rätsch 2005).

And then again, it is not even clear why we must restrict ourselves to only a consideration of chemicals. Couldn't sensory deprivation, such as encountered in deep caves or other situations of profound seclusion, have similar effects? According to Helvenston, the speleological literature does not support this possibility. Yet she herself points out precisely why the relative absence of relevant reports is rather meaningless for the discussion at hand: 'speleologists' experiences in caves are not analogous to sensory deprivation since they carry lights' (p. 86). In other words, to reproduce conditions of sensory deprivation in pre-Historic times, it would have been sufficient to remove light sources while in deep caves (or by putting on blindfolds, as Helvenston ironically suggests, which would in fact have allowed the effects of sensory deprivation to be enacted in external environments as well).

Given the inadequacy of a comparison between modern speleology and sensory deprivation, we need to turn to the relevant scientific literature instead. There the situation is unambiguous. There is no doubt that sensory deprivation can lead to a sequence of hallucinations from simple and geometric shapes to more complex and figurative scenes. Moreover, given the right circumstances, such experiences are not uncommon. For example, as Helvenston is forced to admit, in one such study 3 out of 14 participants reported experiencing a sequence of hallucinations consisting of geometric patterns followed by more complex visual imagery (Bexton et al. 1954). Other studies also occasionally found escalations in hallucinations (e.g. Zubek et al. 1961), as we have already discussed in more detail elsewhere (Froese et al. 2014b).

Here I will just briefly comment again on the more recent study by Merabet et al. (2004), because it is still being misrepresented by Helvenston. In contrast to her assertions, multiple geometric figures and animals (including lions!) were in fact reported. The participant who saw a triangle also experienced other patterns: 'images as well as flashes of light within a few hours of being blindfolded. He saw outlines of puzzle pieces that, while moving, "warped into other amorphous shapes" and transformed in colour from white to orange to red.' (p. 110). Subject 8 saw a fluid sequence of imagery: 'she reported seeing a butterfly that became a sunset, an otter, and finally a flower. She also reported seeing cities, skies, kaleidoscopes, lions, and sunsets so bright she could "barely look at them" ' (p. 111). Figurative images, including animals, were seen morphing into each other. Significantly, in 2 of 13 cases the hallucinations developed from simple patterns to iconic figures and complex scenes.

As we have argued previously (Froese et al. 2014b), Helvenston is right that we must distinguish specific hallucinations from altered states of consciousness, but the sensory deprivation experiments also revealed more general mind alteration. For example, Merabet et al. (2004) observed that the reports of subject 8 were evolving 'much as in a dream', and that 'she stressed the intensity of the hallucinations, commenting "sometimes they were much prettier, I think, than anything I have ever seen" ' (p. 111). This enhanced capacity for mental imagery was also found in another sensory deprivation study:

> The majority of the subjects reported that the images which they conjured up were of unusual vividness, were usually characterised by bright colours, and had considerable detail. All these subjects were unanimous in their opinion that their images were more vivid than anything they had previously experienced (Zubek et al. 1961: 89).

The fact that sensory deprivation has temporarily transformed the abilities of many participants, such that they could visualise fantasies and memories 'with almost picture-like clarity' (Zubek et al. 1961: 89), has direct relevance for explaining the savant-like realism of European cave paintings (e.g. Humphrey 2002). In other words, not only do we find several reports of the specific pattern of hallucinations, transforming from simple and geometric patterns to complex and figurative forms, the general capacities of the imagination can also become significantly enhanced. This is good news for the neuropsychological model.

I agree with Helvenston that larger sample sizes would be desirable, but at the same time it has to be recognised that having a dozen or so participants is not unusual for psychological and neuroscientific studies, such that sample size does not undermine these specific studies. And in any case, what is most important is that different hallucinations are reported in all of these studies, including some that can even be interpreted as variations of the TST pattern. Given that

3 Interestingly, DMT is not exclusive to plants. It is endogenously present in the mammalian nervous system, which means that temporarily elevated levels could have already affected the first humans. It has been suggested that 'naturally occurring altered states of consciousness result from high levels of pineal DMT production' (Strassman 2001: 83). It would be interesting to further investigate under which conditions endogenous levels of DMT can be intentionally manipulated. For example, extreme stress has been put forward as one factor.

Lewis-Williams has never claimed that everyone in a pre-Historic community should be able to experience hallucinations in the same way, rather he assumes that there will be variability with some being more expert than others (2002: 134), even lower percentages of TST patterns would not have been a serious difficulty. Even only one expert in a band of hunter-gatherers would be fine. The more important implication is that even point (b)'s restriction to chemicals, as being the only way to induce the TST pattern, must be rejected.

But this is not all, as I will now show. Even if for some reason we happened to continue to hold on to points (a) and (b), we would still be forced to reject (c). As mentioned, this last point amounts to the claim that no plants containing one of three chemicals, i.e. LSD, mescaline or psilocybin, ever grew in Europe, and that this refutes the TST model (Helvenston and Bahn 2004: 94–5). This is an astonishing claim in several respects. To begin with, it is logically impossible to refute a hypothesis on the basis of absence of evidence (i.e. a lack of evidence for such plants), because that absence could just as well mean that we haven't found that evidence yet (a reasonable assumption, especially due to poor preservation of ancient botanical remains). What would be needed for a refutation is evidence to the contrary (i.e. that such plants could never have existed in principle), and to prove a negative is an extremely difficult undertaking.

What about the positive evidence for such plants? Admittedly, there is currently no reason to assume that mescaline-containing plants ever existed in Europe. In the case of LSD, the situation is a bit more intriguing, since that compound was derived from the ergot fungus, which does exist in Europe and which is known to produce hallucinations, too. But strictly speaking it does not contain LSD, so for the sake of argument we can exclude it as well.

That leaves us with psilocybin, which is known to currently exist in Europe in a variety of psilocybin-containing genus of fungi (Rätsch 2005). In addition to the famous genus *Psilocybe*, discussed by Helvenston, there are other genera of fungi with psilocybin-containing species in Europe, for example the well-known genus *Panaeolus*, whose recreational consumption is prevalent enough to have become a concern for government agencies (Chun-I et al. 2000). But again, for the sake of argument, we will restrict ourselves to a consideration of *Psilocybe* here. Importantly, although recreational usage of at least one such species growing in Europe, *Psilocybe semilanceata*, was already known in the 1970s (e.g. Pollock 1975/76), that important fact was not mentioned in the first critiques by Helvenston and Bahn (2003, 2004). Subsequently, they acknowledged existence of that particular species, but attempted to save their refutation by speculating that 'it may have been imported to the Old World after the conquest of the Americas, […], reaching Spain and Portugal around 1496 at the earliest' (2005: 31)[4]. Helvenston still tries to motivate this same argument: 'By analogy, since horses are now very prevalent in the Americas, it would be easy to suggest that they are indigenous. However, such an assumption would be incorrect since we have historical records documenting their introduction' (p. 89).

Yet the situation is not analogous. Consider the following: if we also knew of several species of horse that were only found in the Americas and nowhere else, then the most reasonable hypothesis is surely not that these species were also introduced but rather that they originated there. And that is precisely the case with the *Psilocybe* genus, of which several species are only known to occur in Europe (Borovička 2008).

But even if some species originated in Europe, what are we to make of the age of that event? Helvenston cites the expert mycologist Guzmán, who theorises that the genus *Psilocybe* may have originated in South America due to that region's greater diversity of species (Guzmán et al. 1998). Yet given that he is talking about an evolutionary timescale, this event is likely to have happened millions of years ago, sufficient time for the new genus to have spontaneously spread around the globe by means of dispersal of spores long before the arrival of humans.[5] This is consistent with the hypothesis that the pre-Historic Selva Pascuala mural, recently discovered in a cave in Spain and dated to about 4000 to 6000 BCE, depicts a species of *Psilocybe* mushroom (Akers et al. 2011).

Finally, if the real problem is just a matter of finding evidence for ancient psilocybin-containing fungi in Europe as such, as originally argued by Helvenston and Bahn (2004: 94–5), then the situation is empirically unambiguous. A genetic study of another family of fungi concluded there were 'a minimum of two independent transitions to a psilocybin-containing state, both of which occurred relatively recently during the Miocene between 10 and 20 million years ago, […]. All of these species are known only from Europe' (Kosentka et al. 2013: 7). We can therefore reject point (c) because psilocybin was present in pre-Historic Europe.

4 Amusingly, Helvenston and Bahn also state that they had been 'unable to find evidence of spoors for this species in data bases of ancient fauna in Europe' (2005: 31). Their likelihood of success would certainly increase if they would search for evidence of *spores* in databases of ancient *fungi*, or at least of *flora*.

5 To confirm whether this interpretation is correct I contacted Prof. Guzmán. He wrote (pers. comm.) that he believes the genus *Psilocybe* with its hallucinogenic species to have first originated in Gondwana (i.e. an ancient southerly supercontinent, which included today's South America and which became part of the supercontinent Pangaea). The genus subsequently evolved new species while it migrated northwards to Pangaea, including to what would later become Europe. He noted that it is difficult to estimate when the genus first arrived in the northern hemisphere, but agreed with me that it may have first appeared in Europe during the Miocene epoch (i.e. roughly between 23 and 5 million years ago).

Conclusions

I have argued that there are several interdependent reasons for taking seriously the ritualised mind alteration hypothesis, i.e. the hypothesis that altered states of consciousness, and the hallucinations that can occur during such states, played a variety of specific facilitating roles in the emergence of the symbolic mind in early human pre-History. Importantly, socially orchestrated mind alteration could have supported the ontogenetic development of more detached and reflective cognitive processing, which in turn would have accelerated cultural evolution.

I have also taken a close look at Helvenston's criticisms and found them mostly unconvincing. Even if we give her the benefit of the doubt and entertain her restrictive interpretation of Lewis-Williams' neuropsychological model as the three stages of trance model, under which she has also tried to subsume my research, there is little to be worried about. Psilocybin-containing fungi existed in pre-Historic Europe since millions of years ago, and in any case the three-stage sequence of hallucinations, i.e., a transition from simple geometric to figurative imagery, could also have been ritually induced using only sensory deprivation techniques. That such techniques can enhance visual imagination is a bonus. In sum, although Helvenston has only built a straw man out of Lewis-Williams' model, she has even failed to undermine that impoverished interpretation. Moreover, in combination with the new ritualised mind alteration hypothesis I have outlined in this article, the general hypothesis that altered states of consciousness played a crucial role in the origins of palaeoart is more compelling than ever.

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Suppositions of psilocybin-mushroom incorporation as the main driver of human cognitive and symbolic evolution

By PATRICIA A. HELVENSTON

Rather than immediately responding to the many challenges and circumscribed issues I raised regarding the neuropsychological model, Tom Froese seems to feel compelled to first present a lengthy, highly speculative model of the ingestion of psychedelic plant use by *Homo sapiens* about 40–50 ka in facilitating the evolution of a larger brain and symbolic abilities in order to explain his obsession with proving that geometric figures in naturally-induced and substance-induced ASCs inspired the geometric figures found in the rock art of the Upper Palaeolithic in France and Spain, and in Africa by Henshilwood and co-workers (Froese 2013a). However, he is basing his entire suppositions on a theory discredited because the 'scientific evidence' upon which it was based was inaccurate, distorted, misleading and fabricated. That theory was the neuropsychological model of Lewis-Williams and Dowson (1988) to which I will return throughout both sections of this paper. The distortions of data go far beyond 'three stages of trance'.

Section I: Helvenston's response to Froese's theory of psychedelic use and the evolution of human symbolic culture

Human cognitive and symbolic evolution is much more complicated than Froese may realise and more plausibly accounted for by other biopsychosocial models to be discussed shortly. There are entire libraries full of books and journals containing papers contesting what symbolic cognition is, how it is defined, when it appeared in hominin or human history, how it might be inherited genetically, etc. Whole disciplines from history, philosophy, psychology, artificial intelligence, evolutionary robotics, sociobiology, neuropsychology and the biological sciences have huge data bases discussing the mind, brain, evolution, the use of psychedelic substances in contemporary and ancient cultures, symbolism in human evolution and so on. Unfortunately, my comments regarding Froese's suppositions will have to be relatively brief because of space constraints.

In his comments, Froese (p. 91) states that:

> The last couple of decades of interdisciplinary research have profoundly changed the way we think about the mind. The old computational theory of mind is being replaced by an emphasis on biological embodiment, worldly situatedness, and lived experience (Thompson 2007). Mind is conceived of as essentially a living activity of sense-making that constitutes a meaningful point of view, shaped by needs, desires and possibilities of action in the environment, including the social world (Froese and Di Paolo 2009).

In case this quote sounds vaguely familiar, but you're wondering from what fields it originates, it is artificial intelligence, computer and/or mathematical models, robotics, philosophy and molecular biology. It does not derive from hominin, human or primate neuroanatomy, biology, comparative primate behaviour, human behaviour etc. (see Footnote 7 for a brief description of Froese's educational background). This is very important because different disciplines may use the same words but with very different meanings or conventions for use. For example, Thompson (2007) writes that people in artificial intelligence believe wherever there is life, there is mind. Biologists and comparative neuroanatomists above the molecular level don't think that amoebas have much of a 'mind' to be considered and indeed few

biologists speak of mind, rather they speak of brain. When the term 'mind' is used by neuropsychologists, it refers to the basic phylogenetically evolved human brain as hardware (a poor analogy) and the ontogenetic experiences of a life-time as software interacting with the brain and *changing* its very structures and functions. They refer to this complex interacting-combinative system as 'mind'. There are estimated to be between 86 and 100 billion neurons in the human brain, with about 10 times that amount of neuroglial cells whose importance is still being debated. Every neuron has up to 10 000 synaptic connections, so the number of interconnections in the human brain is like the stars of the Milky Way, nearly infinite. Moreover, neurons do not die without replacement as was once believed, but continue to develop (Nottebohm 2002). Computer models simply cannot get even close to emulating the neuronal connections in the living human brain, and with ontogenetic experiences altering the brain, and enhancing it, as well as increasing neurons, as shown by environmentally rich environments (Kempermann et al. 1997), the mind is of inestimable complexity.

The neuropsychological definition of mind is not how artificial intelligence defines mind. For example, Froese and Di Paolo (2009) are referring to definitions of mind in cognitive neuroscience, i.e. computer models and artificial intelligence and philosophy. I personally consider Froese's work to be confusing because he often shifts from talking about computer models to human brains and complex behaviour as if there is no difference in the complexity of the systems or the level of observation involved. He seems to assume that the results of computer models of neuronal networks can be applied to complex studies of *in vivo* human brains which is a leap of faith but not science. Computer models are no doubt important in their own way; however, they are no substitute for human and primate brains which we can study *in vivo* with complex imaging and other technologies, as well as after death. Moreover, with the new imaging MRI techniques palaeontologists can image faint details in the skulls of extinct hominins and get a much clearer idea of what major neural landmarks on the brain were developing and offer fairly precise estimates of the time-spans involved.

Froese spends a large portion of his commentary outlining the importance of altered states of consciousness. Let me state unequivocally, as I did in my original comments in this volume and as I have written previously, that I do not dispute that ASCs may have played a role in the lives of hominin ancestors. Further, I do not dispute that many cultures may have used psychoactive and psychedelic substances of assorted kinds in rituals dating back into the Neolithic. Beyond that, there is, as yet, no scientific evidence for their use. Like McKenna, to be discussed presently, Froese finds it necessary to discuss the importance of coffee, tea, tobacco, chocolate, beer, wine etc. I don't dispute the fact that these psychoactive substances have been used for thousands of years in some cases.

I have no argument with Siegel (2005) or Samorini (2002) who suggest that humans have indulged in consciousness-altering activities and the use of psychoactive substances for thousands of years. Indeed, naturally-induced ASCs may be a bi-product of extremely large complex brains. We know that chimpanzees have mourning 'rituals' for the dead, hunting 'rituals', mating 'rituals', parenting 'rituals' and that they become very aroused around waterfalls and act almost intoxicated and then subdued and thoughtful (Goodall 2014, accessed 28/10/14). Finally, Kortland (1975) reported watching a chimpanzee sit and gaze at a sunset for 15 minutes or more, almost as if he were in a trance or having a 'peak experience' (Maslow 1964). Among humans, rituals are sometimes accompanied by ASCs and I don't dispute that rituals, including 'rites of passage' ceremonies in the Upper Palaeolithic, may have been accompanied by naturally-induced trance states. I am also aware that animals, when given the opportunity in laboratory experiments, will consume large amounts of psychoactive substances, alcohol, cocaine etc. (Siegel 2005), or that animals in the wild have been known to consume plants believed to contain psychedelic substances (Samorini 2002). I will return to the topic of gorillas and *Tabernanthe iboga* shortly.

I doubt that readers of *RAR* are ignorant of most of these facts. One important point I wish to make about psychedelic substances is that there are thousands of poisonous plants, including psychedelic substances, that are lethal and no-one knows how many hunter-gatherers may have died before an effective dose-response curve of these toxic substances could be established by traditional societies, if ever. This is hardly a formula for passing on the genes of those who ingest poisonous plants for natural selection to act upon. Froese largely discounts the dangers of psychedelic use (see p. 91) when he states that '[i]f psychoactive plants have medicinal value and if they can be found in the environment, we can be relatively sure that hunter-gatherers would have made use of them'. In order to establish the medicinal as opposed to toxic effects of such substances, many people may have perished.

Let me note that the interest in worldwide religious experience dates back more than two millennia. For example, Herodotus (600 BCE: 319–320 describes the Scythians' use of *Cannabis* around 600 BCE which was believed to originate in central Asia. William James' (1902) book, *The varieties of religious experience: a study in human nature*, has been and remains popular even today. One of the earliest books on religion, human evolution and brain development was published in 1912 (Reichardt), so this topic has been around for a thousand years and more.

More recently, Froese's proposal seems to be an amalgamation of previously elaborated suppositions, the first of which was published by Lewis-Williams and Dowson (1988) as a neuropsychological model. Indeed, they have popularised the belief that shamanism can be dated back to the Upper Palaeolithic without a

shred of scientific evidence for this proposition, aside from analogising the ASCs experienced by users of psychedelic substances like LSD, mescaline and psilocybin to near-contemporaneous San 'shamans' who supposedly entered a healing trance consistent with the neuropsychological model, but without psychedelic substance use. By analogy, Palaeolithic 'shamans' were supposedly inspired by their naturally-induced trance states to paint the figurative and non-figurative (geometric figures) representations found in the caves of France and Spain, although to believe this is foolhardy because Lewis-Williams and Dowson conflated naturally-occurring trance states with trance states induced by LSD, mescaline and psilocybin, for which there is no evidence of *use* in the European Upper Palaeolithic.

There are theoretical possibilities for use in Europe dating back millions of years as I addressed in my earlier comments this volume regarding the work of Kosentka et al. (2013: 7) and we will return to this topic. Indeed, none of the researchers who studied the San from the 1960s to the 1980s much more than Lewis-Williams ever did, and closer to their original culture, believed that the San (known to them as the /Kung and now referred to as the Ju/'hoansi) had any shamans in their society at all. In fact, numerous healing dancers took part in the trance dances, whereas in shamanistic societies such as Siberia and elsewhere in Asia there is only one shaman who often receives her/his calling by developing a serious illness, usually some form of mental illness, epileptic seizures, psychopathy etc., and undergoes a lengthy period of both ecstatic training (which emphasises dreams) and training in shamanic technique, names of spirits, mythology, genealogy of the clan, secret languages etc. (Eliade 1964: 15–50). The term shaman had a precise meaning according to Eliade, prior to its abuse by Lewis-Williams and followers. Now it can virtually mean anything done by a 'healer' and often does. Froese doesn't seem to care much about the precise meaning of words as he reports he can accept many other terms for shamanism, and provides a new definition based upon the work of an unpublished article by Gonzaláz that is so broad as to be largely meaningless.

Those like Lewis-Williams, McKenna, Winkelman and Froese who emphasise contemporary shamanism dating back to the Palaeolithic usually ignore these basic facts and focus on the shaman as a healer, but magician or sorcerer is probably a more appropriate term (Eliade 1964: 13–32). (For references regarding the San see Lee 1966; Katz 1976, 1982; Lee and DeVore 1987). In their work regarding the San, Lewis-Williams and Dowson distorted the work of many psychologists and researchers as Helvenston and Bahn have repeatedly shown (2002, 2003, 2004, 2005, 2006b, 2007). Certainly, nothing in the San healing 'trance dances' is remotely consistent with the neuropsychological model (Helvenston and Bahn 2006a) and Keeney (2003: 152) explicitly states that in trance 'the world of the Bushman "shaman" is not primarily visual'. Katz (1982: 83) quoted a respected healer named Kinachau as stating that 'I saw nothing in trance' and added, 'It's a lie that we healers see anything'.

Lewis-Williams and Dowson (1988) relied heavily upon records from the historical southern San (/Xam from Cape Province and San from the Maluti mountains of Lesotho) to establish their theory of shamanistic trance, but there are few, if any, geometric images located at rock art sites utilised by these peoples. Rather, most of the geometric forms are more common to the north in Zambia and Malawi where Lewis-Williams reports 'they have been associated with the rituals of the Nyau cult' (1983: 32). The Chewa, a Bantu people, not the San Bushmen, formerly practised this secret cult. From the preponderance of evidence it appears that most of the geometric figures that supposedly led to the formulation of the neuropsychological model in South Africa were probably not created by the San as Lewis-Williams and Dowson maintained.

Supporting this conclusion is the fact that geometric figures are not explicated in the ethnography of South Africa and there are no reports in that literature of the San describing geometric figures when they discuss their trance experiences. Rather, they emphasise figures of mythological spirit beings that are manifested as therianthropes, humans or animals (Solomon 1997; 1999; 2001; Le Quellec 2004: 204). Finally, Hromnik disputed that the rock art in the Cape area, consisting mainly of 'iconic shamanistic "trance figures" ' according to Lewis-Williams and Dowson, was created by any San group. Genge (1990: 18) demonstrated that the printed copies of the tracings of rock art that they (Lewis-Williams and Dowson) made did not match the tracings themselves! Rather the 'shamanic rock art' illustrating Lewis-Williams' 'tractates is so stereotypical and emphatic on exactly the points called for by the hallucinatory trance theory that it looks factory made' (Hromnik 1991: 107). Moreover, Lewis-Williams quoted the work of numerous San and /Xam authors and changed their words to substitute shaman for doctor, healer, medicine man, magician, sorcerer etc., completely corrupting the translations of San and /Xam historians.

Despite the fact that the neuropsychological model itself is completely ignored by Lewis Williams in his later writings, especially in a paper entitled *From illustration to social intervention: three nineteenth-century /Xam myths and their implications for understanding San rock art* (2013), Froese (this volume) and his associates (2013; 2014a) utilise it loosely as a means to interpret geometric figures found in Upper Palaeolithic rock art from about 40 ka years ago. Winkelman (2002), following Lewis-Williams and Dowson, also dates human symbolic evolution to about the same time frame, and attributes Palaeolithic rock art images to shamans, topics we will return to shortly. Froese et al. (2013) proposed that Turing instabilities in biology can produce geometric figures in the human brain based

upon *computer models* of simplified neuronal networks[6], but they concluded that no current computer models utilising artificial intelligence methodologies[7] can account for the scientifically demonstrated fact that encoding of geometric figures in the human brain appears to be innately determined by human evolution (see Joseph 1996: 49; Helvenston and Bahn 2002, 2005; Hodgson 2006b: 64–67). I think that it is unlikely that Turing instabilities will be shown to account for neural substrates of geometric figures in the human or other primate brain.

In his 2013 paper (pp. 256–257), Lewis Williams discusses his conviction that *San mythology* is the major influence on South African rock art. He presents all the key elements in the entire corpus of Anne Solomon for the past 17 years (1997, 1999, 2000, 2001, 2006, 2008, 2011 and 2013) as if her ideas were his own and without attribution of her most relevant 2008 paper. Anyone familiar with Solomon's detailed analysis of /Xam and San mythology recognises that Lewis-Williams appears to have incorporated her ideas without citing her work. In this 2013 paper, he essentially replaces the neuropsychological model with the idea that myth inspired the rock art of the extinct /Xam and analogises written records about them to the contemporaneous San in South Africa who do not have a rock art tradition, but do perform a healing dance where traditions and mythology regarding ancestral figures and gods play a large role in determining and interpreting the trance experience.

In short, Lewis-Williams, without specifically formally rejecting the neuropsychological model, has replaced it with an earlier and far more realistic interpretation of rock art in South Africa as being inspired by /Xam and San *mythology* (also see Le Quellec 2004: 212, 2006a, 2006b), not upon unscientific models that conflate naturally-induced ASCs with psychedelic-substance induction in healing 'trance dances'. Even Lewis-Williams has admitted that the San do not use hallucinogenic substances in their healing dances (2002: 141), although they do have access to some mind-altering substances (Mitchell and Hudson 2004: 39–57; Helvenston and Bahn 2006a), a number of which are highly toxic. They have no documented history of using any psilocybin-containing mushrooms at all.

Another major influence upon Froese's speculations appears to be the work of Terrence McKenna (1992–93), although he does not cite McKenna, who proposed the *stoned ape* version of human evolution of symbolic capacities in 1993 in his book, *Food of the gods: the search for the original tree of knowledge: a radical history of plants, drugs and human evolution*. (This book was wildly popular among advocates of the use of psychedelic substances, but ignored by scientists, with the exception of Richard Evans Schultes who gave it a laudatory review (1993: 489). McKenna relies heavily upon the work of R. Gordon Wasson (1968; Wasson et al. 1978), and Mircea Eliade (1964).

In his book, McKenna proposes that *Homo erectus*, sometime between 700 ka and a million years ago, began feeding upon psychedelic mushrooms (*Stropharia cubensis,* aka *Psylocybin cubensis*) in the grass lands of the African savannah. I can find no evidence thus far that this mushroom has been found historically in sub-Saharan Africa nor is there any scientific evidence for its presence there a million years ago. Recently, Froese stated that Guzmán (2014 pers. comm. to Froese who provided me with a copy) *believed* psilocybin mushrooms originated in South America when it

6 Turing instabilities in biology refer to the processes proposed by Turing which are believed to contribute to patterns like stripes on the pelts of zebras, spots on giraffes and leopards etc., and have nothing to do with patterns mediated in the human brain except in mathematical and computer models of reaction-diffusion equations. One of the central issues in developmental biology is the formation of spatial patterns in the embryo. A number of theories have been proposed to account for this phenomenon. The most widely studied is reaction-diffusion theory which proposes that a chemical pre-pattern is first set up due to a system of reacting and diffusing chemicals and cells responding to this pattern by differentiating accordingly. Such patterns, known as Turing structures, were only identified in chemical systems recently (Maini et al. 1997). Froese et al. (2013) tried to show that Turing instabilities based upon computer models were responsible for the hard-wired nature of geometric figures in the human primary visual cortex and deep temporal lobes, but had to conclude that no computer models were sufficient to explain this phenomenon.

7 According to his short biography on the internet (accessed 10/8/14), Froese (2012) has had a life-long interest in biology (he was born in 1985, completed postdoctoral fellowships in 2012) but he does not describe any formal training in the biological sciences. His father taught him about specific ecosystems and fish. He took courses in chemistry (unspecified as to whether he took biochemistry), but he specialised in computer models, artificial intelligence methodologies attempting to explain complex biological systems and organisms by way of computer models, and evolutionary robotics. He has wide-ranging personal interests in psychology, philosophy, psychedelic substances and evolution and an impressive array of publications, but his education in these subjects has apparently been confined to his independent reading. In short, his background is not in the biological sciences, the psychological sciences, anthropology, archaeology, neuropsychology or the social sciences. In my opinion, it is far better to explain biological organisms, the evolution of the primate brain, comparative primate neuroanatomy etc. from a study of actual biological entities or fossil materials, not from a simplified computer model. Indeed, in reviewing some of Froese's publications (2013b; Froese and Leavens 2014) he has a habit of explaining biopsychosocial issues from the perspective of computer models and he enters fields beyond his educational background, based upon his readings of a few papers in a field of interest. In short, he presents the results of his computer models as if they actually applied to living biological systems, an enormous leap of faith, but not science as I know it.

was Gondwana and migrated from there to North America, Europe and Asia during the Miocene epoch, which is dated from 5–23 Ma (Online *Encylopedia Britannica*). Guzmán also believed that there were psilocybin-containing mushrooms that originated in Africa, although I can find no written records of the traditional use of them in African medicine (Helwig 2005; Abdullah 2011) aside from north Africa which we will discuss shortly. I certainly do not dispute that psilocybin-containing mushrooms occur in sub-Saharan Africa today, and indeed all over the world, and there are lists of the species available on the internet. They have been available all over the world for over 50 years as can be widely attested to by the numerous ads on the Internet aggressively selling them. Any claims of their historic use are subject to scientific verification as the fact that they can be found now says nothing about their historical use without written documentation.

It appears that McKenna chose his time frame rather arbitrarily as the increase in the hominin brain is generally believed to be due to increased meat consumption occurring in many primate ancestors for which there is much scientific evidence amassed over the years in numerous papers discussing 'man the hunter theory of evolution' (Aiello and Wheeler 1995; Aiello et al. 2001). Since lithic technology shows tool scrapes on bone from about 2.6 Ma, it has been assumed these mark the time period in which hominins began the serious consumption of meat. However, this ignores the fact that like chimpanzees, our ancestors were likely hunting and killing smaller game that didn't require tool use to dissect the meat for an extensive period of time prior to that (Pobiner 2013: 1–20). Chimpanzees are known to consume the entire colobus monkeys that they kill. Indeed, primitive primates such as tarsiers, lemurs and tree shrews are all insect-consuming and one could say most, if not all of their diet is meat. McPherron et al. (2010: 7308) found evidence that fossilised bones were found in Ethiopia showing clear evidence of stone tool use by *Australopithecus afarensis* dating back to 3.4 Ma, so at least part of their diet was meat.

Preserved animal remains are rare from 1.8 Ma so it is difficult to estimate when hunting of larger animals became routine. A recent study (Ferraro et al. 2013) shows that the persistent eating of animal brains as early as 2 Ma, at three sites in Kanjera, southern Kenya was widespread. Apparently lions and other large predators routinely leave animal heads intact because their teeth and jaws cannot bite through the skull and consume the fatty, rich brain tissue inside. But hominins, with their tools, could and this likely contributed to an early and distributed form of meat-eating. The complex interactions between hominin predators, their prey and huge carnivores that preyed upon hominins is believed to have been one of the factors contributing to the large increase in the hominin brain as they became largely meat eaters (Aiello and Wheeler 1995; Aiello et al. 2001; Hodgson and Helvenston 2006: 3–40). Human use of animals for food and cultural development only accelerated after they controlled fire.

Hart and Sussman's book (2009) purportedly superseded the 'man the hunter model of human evolution' (Lee and deVore 1968 rpt. 1987), but it was over-hyped by an ignorant press and simply detailed the many horrific animals that preyed upon hominins as they in turn preyed upon other game. Other books like *Woman the gatherer* contributed much about hominin females and their important contributions to providing a majority of the food for the social group (Dahlberg 1981; Cummings et al. 2014: 151–176), and the Ju/'hoan females of South Africa have been closely studied for their hunting of small game (these women like meat very much) and for gathering of significant amounts of plant material (Biesele 1993).

The human frontal lobes have been large since the split between the last common ancestor of chimpanzees and humans (estimated at about 7 Ma) and the frontal lobes, thought to be the mediators of complex cognitive and symbolic behaviour, as well as of inhibitory circuits necessary to gain behavioural control so essential to the development of human culture, have been largely the same from 300 ka (Bookstein et al. 1999: 217–224), suggesting the neuroanatomical substrates were well established to mediate symbolic behaviours deep into the hominin past, not 40–50 ka ago. Nevertheless, McKenna proposed that the amazing insights *Homo erectus* supposedly gained while 'high' on psilocybin and experiencing hallucinations, led to increased brain capacities and an expansion of subsequent human consciousness that enabled *Homo erectus* to evolve symbolic capacities[8], and this appears to be what Froese is suggesting too for *Homo sapiens* at a much later time during the Upper Palaeolithic, when presumably they were using psilocybin mushrooms to induce trance. Although there is theoretical evidence of the presence of four *Panaeolus* species dating back millions of years ago in Europe, and these contain psilocybin, there is no evidence of direct *use* by people of the Upper Palaeolithic, but there is some suggestive evidence that naturally-occurring trance states may have been involved in assorted rituals (Helvenston 2013: 59–110).

8 McKenna's comments during an interview indicate that his motives for proposing the *stoned ape hypothesis* were dictated by his Marxist beliefs, not actual scientific conviction or data. For example, he said 'I felt if I could … convince people drugs were responsible for large brain size … get drugs insinuated into a scenario of human origins, I would cast doubt on the whole paradigm of Western civilization', reported on Sam Woolfe's internet blog by an anonymous commentator (accessed 24 Nov. 2013). In other words, McKenna was deliberately trying to propagandise the American public into accepting the contemporary use of psychedelic drugs based upon a hypothesised view of the distant past, because psychedelics supposedly led to a larger brain and the evolution of symbolic culture, an idea Froese seems to be proposing also, although much later in the Upper Palaeolithic.

Bednarik (2008: 1–17) discussed his theory of *human domestication* by means of neotenisation and other biological and cultural processes, which account for the rapid gracilisation of more robust forms of *Homo sapiens* relatively rapidly in the last 40 millennia of the Pleistocene. Human culture (probably already highly developed by this time) began to perceive gracile features in females as sexually preferential to robust features, and through sexual selection and self-domestication changed the morphology of body forms from robust to gracile. In addition to all the evidence Bednarik cites, recent evidence from Siberia supports this view where a 45-ka-old human skeletal DNA sequence shows that humans were interbreeding with Neanderthals between 50 and 60 ka (Fu et al. 2014: 445–449). In a truly seminal pair of papers Bednarik (2012a: 1–53, 2012b: 319–335) criticises and challenges many other tenets of modern archaeology such as *the human revolution*, the *Out of Africa theory*, the *replacement hypothesis* and other shibboleths of current archaeology that do far more to confuse the trajectory of human evolution than they do to clarify it. He revisits the topic again in a direct challenge to the African Eve model (2013c). Truly modern human behaviour, which results from changes in the brain due to the technology of writing, only dates from about 800 BCE, a topic we will return to shortly (Helvenston 2013: 59–110). Bednarik's speculations about the behaviour of hominins include the genera *Homo, Australopithecus, Paranthropus and Ardipithecus*. He (2012b) describes his approach to the problem of the theory of 'modernity' and its ignorance of primate brain evolution when he writes:

> Modernity of behavior is not determined by modern explanations of what are purported to be archaeological traces of ancient behavior, but by the state and operation of the neural structures that are involved in moderating behavioral patterns. Therefore this paper makes no attempt to elucidate specific instances of supposed ancient behavior, but instead considers the general framework giving rise to primate behavior. Modern human behavior is not only determined by the intrinsic neural structures and endocrine systems giving rise to it. These are demonstrably influenced by ontogenetic influences within the individual and their effects upon these neural configurations.

Thus, rather than relying upon archaeological theories that are not supported by scientific evidence from other fields, Bednarik places his confidence in comparative primate and hominin brain neuroanatomy and the neurosubstrates necessary for the development of complex human behaviour. As mentioned previously, modern palaeontological scientific methods of studying ancient skeletal and skull remains with MRI and other imaging devices have contributed a great deal to our understanding of major brain evolutionary developments as marked by landmark imprints of brain cerebral lobes on the skull of ancient hominins. In lengthy, complex discussions of Theory of Mind, consciousness and self-awareness, Bednarik, using multidisciplinary scientific findings, makes a compelling case for these crucial abilities dating back several million years ago and laying the foundation for subsequent cognitive and symbolic evolution. This approach has a great deal of support from comparative neuroanatomy, neuropsychology, ethology, comparative primate behaviour, palaeontology, and human and other primate imaging studies. It certainly demonstrates that the neural substrate was present for the development of symbolic and higher cognitive functions dating to millions of years ago, not just the past 50 ka.

Further evidence supporting the very ancient evolution among primates and hominins of symbolic and higher cognitive functions and language potential is derived from observational and experimental work with chimpanzees who have demonstrated such skills to an extent not thought possible only a decade or so ago. Thus, chimpanzees have latent potential for higher-level thinking and language that they are simply unable to *express* in their natural surroundings. One of the most remarkable examples of this is the bonobo Kanzi, raised by Sue Savage-Rumbaugh et al. (1993, 1994), who as a youngster began to learn human English language by observing his mother in an experimental setting. Kanzi knows over 500 signs for English words, can converse with humans using these signs, and can go on a picnic with his son, light a fire, cook the food and extinguish the fire when he is finished (*The Daily Telegraph* 2011). As Donald (1998: 7–17) explained, literate cultures alter the cognitive capacities of their members and this can be seen even in chimpanzees. For example bonobos, who when raised in an artificial culture (Savage-Rumbaugh 1993) especially designed to facilitate their production, modification and purposeful use of tools; their understanding of sentences of naturally-spoken English; and their acquisition of a large number of visual symbols, 'do not act, think, or communicate like the same species', thus revealing latent cognitive potential. This also applies to humans raised in literate versus oral cultures to be discussed further at the end of Section I.

In a recent publication (Wiessner 2014: 14027–14035) explores the significance of the control of fire for cooking, which dates back to well over 1 Ma (James 1989: 1–26; Beaumont 2011) and claims of its routine use by *Homo erectus* about 400 ka are widely supported. Evidence of widespread use of fire dates to 125 ka. Cooking meat and tubers was accompanied by expansion in the hominin brain, and reduction in tooth and jaw size and the gut as meat-eating became increasingly important in the hominin diet. Little is known about what transpired around the camp fire, but it has long been supposed that telling of stories, dancing, singing and chanting as well as rituals possibly accompanied by some altered states of consciousness were among the activities fostered by the use of fire in extending the daylight hours. Certainly leisurely visiting with members of the group was a common activity leading to group solidarity and enhancement of social skills (Dunbar 2003: 163–181; Helvenston and Bahn 2004:

90–100; Hodgson and Helvenston 2006: 3–40; Gamble et al. 2011: 115–135).

Froese asks, if I think ASCs may have had important roles to play in pre-Historic hominins why don't I propose a model explaining this? I did, years ago. Helvenston and Bahn (2004: 90–95) discussed these issues at length along with the importance of temporal lobe development which preceded the expansion of the frontal lobes and is one of the areas of the limbic system highly implicated in ASCs. Deep electrical stimulation of the inferior temporal lobes leads to mystical, religious feelings, dreamy states and images of faces, circles, crosses, hands etc. (Joseph 1996). It is well known that naturally-induced ASCs facilitate feelings of well-being, closeness to others, understanding, compassion and sympathy for others. It is highly likely that rituals, dancing, singing, story-telling, all practised around a camp-fire at night, facilitated bonding of group members. Such groups might have a small adaptive advantage over groups who did not encourage such activities.

There is no need for the use of substances to produce geometric or other hallucinations, as hypnopompic and hypnagogic hallucinations are one natural way of 'seeing geometric figures' with no risks of adverse effects whatsoever. We know that dream states have been considered highly significant by ancient and modern cultures throughout the world and that many strange beings can inhabit dreams, as well as the fearsome predators that preyed upon hominins during the Pleistocene and earlier. Why not postulate that Upper Palaeolithic peoples were inspired to paint all that cave art from dreams? There is far more evidence for that than there is for the routine, ritual use of psilocybin-containing mushrooms. In fact, many of the mythical images reported by the San occur during dreams when they fall asleep, exhausted from the dance.

Wiessner (2014) conducted a study of the Ju/'hoan hunter-gatherers of southern Africa which shows that daylight talk and firelight talk are substantially different. Day talk involves all the practicalities of life, hunting, eating, making weapons, gathering vegetables, tubers, fruits etc. During the daylight hours gossip is sanctioned. Fire-lit activities centred upon conversations that evoked the imagination, helped people to remember and understand others in their external networks, healed the rifts of the day, perhaps with healing dances, chanting, enthralling stories, religious ceremonies and rituals, and conveyed information about cultural institutions.

Wiessner has compared the results of her study with other hunter-gatherer groups around the world and found the difference between day-lit activities and fire-lit activities to be essentially a universal human trait, and she speculates that when the day was extended by fire, human social, cognitive, symbolic and cultural developments were fostered. Wiessner's theory, along with the 'man the hunter meat-eating theory' and the social brain hypothesis (Dunbar 2003; Gamble et al. 2011) contributing to the evolution of an ever larger brain with enhanced cognitive and symbolic possibilities, is far more plausible and supported by scientific evidence than a theory that mushroom-eating hominins or humans evolved a larger brain because of psychedelic ingestion. As I have suggested, and will re-iterate, such consumption would have been more likely to have killed them or made them very ill. This would not serve as a motivation for others to consume the same substances.

There are two other related problems with the stoned ape theory in the guise of Froese's comments, besides the fact that there is no *evidence* for a psilocybin-containing mushroom in sub-Saharan Africa during historical times, let alone millions of years ago. The first is that psilocybin and other psychedelic substances can be highly toxic, even lethal in large doses, and the second problem is that rather than being mind-expanding, psychedelics actually lead to inhibition of the frontal lobes, one of the key areas involved in higher cognitive and symbolic functions (Carhart-Harris et al. 2012). Psilocybin *inhibits* areas of human brain connectivity in the medial prefrontal cortex, anterior cingulate gyrus, posterior cingulate gyrus and thalamus and lowers cerebral blood flow to these areas, freeing other brain regions such as parietal, temporal and occipital cortex from inhibition, so one might expect complex, vividly coloured images accompanied by deeply 'religious' feelings because of the resulting dis-inhibition of these areas.

The medial frontal lobes are implicated in the processing of risk and fear. They also play a role in the inhibition of emotional responses and in the process of decision making, control of aggression, psychopathy etc. (Boes et al. 2011: 151; Bechara et al. 2000). Losses of function in these areas lead to psychopathic aggression, loss of moral sense, loss of inhibition of impulses etc., as the case of Phineas Gage showed in 1848 (Neylan 1999: 280–281). As Carhart-Harris et al.'s (2014) paper explicates, psilocybin does not expand the capacities of the human brain, it inhibits them and this is made even more clear by the fact that they postulate psilocybin use reveals a much more *primitive brain* than exists in a normal waking state, and it is consistent with Freud's conception of the *id*. Why would anyone want to turn into a Mr Hyde from a Dr Jekyll?

These results strongly imply that the subjective effects of psychedelic drugs are caused by decreased activity and connectivity in the brain's key connector hubs, enabling a state of unconstrained cognition and fostering vivid visual hallucinations that dominate consciousness and make it impossible to perceive and respond to realistic environmental threats. Froese, above, describes the work of his colleagues using a simple computer model of neuronal networks. In this research, perturbations in computer models of neuronal networks profoundly alter the networks' normal state of activity, in this case via the *randomisation* of its activity. In this model 'synaptic plasticity' spontaneously

starts to reshape the network's connectivity in a way that enhances coordination of neural activity. Froese analogises his interpretation of his model to the work of Carhart-Harris et al. (2014). But his computer model bears no resemblence to the research of Carhart-Harris et al. (2012, 2014) with psilocybin in living human brain tissue. Once again, Froese leaps from inferences about research on a simplified computer model to a highly complex biological system like the living human brain as if his model were equivalent in significance and actually told us something that supported *in vivo* results of whole- brain research.

Psilocybin inhibits the frontal lobes, it *stimulates inhibitory* fibres, it dis-inhibits neuronal activity in other brain areas and there is no evidence for enhanced synaptic plasticity reported. Thus, rather than fostering the evolution of symbolic behaviour, psychedelics, at least temporarily, retard it by inhibiting the most evolutionarily advanced areas of frontal cortex and contributing to the deaths of hominins who theoretically may have ingested psilocybin-containing mushrooms. The effects of long-term, habitual use of psychedelic substances are still a matter of great controversy in the U.S. and scientific studies are sparse because of the perceived danger to humans of ingesting these toxic substances. Instead of exciting the entire brain as has long been supposed, psychedelics seem to act by blocking the functioning of the most highly evolved area of the human brain, the frontal lobes, thus depressing executive functions which are essential for long-range planning and execution of hunting and other complex behavioural strategies, as well as for the development of complex culture.

At the microscopic level, psilocybin seems to act as an agonist of 5HT2a receptors (5-hydroxy-tryptophan 2a receptors). Thus it stimulates the synthesis of increased levels of serotonin which diminishes brain activity and connectivity. Psilocybin converts to psilocin which acts upon many neurotransmitter receptors to modulate activity on excitatory long-axoned pyramidal fibres and inhibitory GABA-ergic neurons. Psilocin may act on excitatory or inhibitory receptors to augment or inhibit neurotransmission. Psilocin's net effect is a decrease in neuronal activity and connectivity as measured by fMRI (Lee and Roth 2014: 1820–1821). No evidence of enhanced coordination of key brain activity is indicated (Carhart-Harris 2012 or 2014). Froese's computer model tells us nothing about the activity of living brains as studied by Carhart-Harris and colleagues *in vivo*. These provocative findings are important because they challenge many long-held models regarding hallucinogen actions that have focused mainly on their ability to enhance excitatory neural transmission and overall brain activity.

Furthermore, McKenna and Froese completely ignore the maladaptive influence of psilocybin-containing mushrooms from an evolutionary perspective (National Drug Intelligence Center 2006). Even if we *assume* that it was present on the African savannah 700 ka ago, or in Europe during the Upper Palaeolithic, anyone 'grazing' upon *Stropharia cubensis* would have been a great target for one of the gigantic predators living at that time (Hart and Sussman 2009), because within 20 minutes of ingestion and lasting approximately 6 hours, the user experiences nausea, vomiting, muscle weakness, drowsiness and lack of coordination. Furthermore, the psychological consequences of ingestion include hallucinations and an inability to distinguish fantasy from reality. Extreme panic reactions and psychosis may occur if a user ingests large quantities of the mushroom. Far from being adaptive, these symptoms would almost guarantee the extinction of the user, thus rendering the group in which the user existed more subject to extinction by predation because of the significant weakening of the small band. This is no paradigm for adaptive evolution at the individual or small group genetic level and Froese does not address how one member of a small group who ingested psychedelic substances that theoretically 'expanded symbolic capacities' could pass on genes for natural selection that would not be overwhelmed by the maladaptive effects of the substance's abuse. Froese claims that the 'healing' effect of psychedelic substances is because they desynchronise existing neural patterns in computer models, but this is refuted by the experimental results of Carhart-Harris et al. (2012, 2014), ignoring the fact that if you are dead and consumed by a predator, any such disruptions of the individual's' perception of reality is lethal, not healing nor symbol building.

I do not question the fact that a few gorillas in some small, highly localised groups have been observed to feed on the roots of *Tabernanthe iboga*, supposedly a hallucinogen (Cousins and Huffman 2002: 65–89), or that many animals self-medicate with assorted botanical varieties in their local environment. This has been known for many years. In this case we can reasonably ask, who was imitating who? The gorilla imitating the humans in the area who used the root, or the humans imitating a lone gorilla or two in a local group? I must point out; however, that the dose-response curve for *iboga* indicates that it requires a huge dose (basketfuls of roots) to produce hallucinations and that the natives who use this substance in rituals and hunting use smaller doses that only act as a stimulant to enhance muscular performance and alertness for hunting. The gorillas were not seen carrying around basketfuls of *iboga* root. In other words, it seems like the gorillas and the humans use *iboga* as we might use coffee. In addition to hallucinations, large doses produce convulsions, paralysis and death from respiratory failure. Over the years many deaths from this substance have been reported in human populations among west African cultures. This substance is illegal in the U.S. for good reason. Indeed Froese, like most proponents of psychedelic use, ignores the fact that in the higher doses, such substances are exceedingly toxic and deadly.

Many psychedelic substances are very harmful as

they are consumed by people who are addicted to their use in these contemporary times. Traditional societies carefully controlled the use of these substances and they are considered an integral part of a religious ceremony undertaken by a small number of participants under a knowledgeable healer's supervision, not a recreational drug to be used *ad libitum* or at one's pleasure. That is why research using these substances is largely banned by the National Drug Intelligence Centers and the UN convention on psychotropic substances. People like Froese dismiss these concerns at their peril. In fact, Froese, this volume, rather off-handedly cites the fact that LSD can be found in ergot as if ergot could be deliberately used to induce hallucinations. It is now well known that a fungus, one of the *Claviceps* species that grows on various Loliums and other cereal grasses native to Greece and other parts of Europe, contained Ergot, a fungal growth on some grain. *Claviceps purpura*, the ergot infecting rye, was the active ingredient causing the disease known as St. Anthony's fire that instigated thousands of people to die a hideous death from ergot poisoning in Europe during the Middle Ages. One of the most common forms of ergotism included symptoms of delirium, bizarre visual hallucinations, gangrene and spontaneous abortion. Ergot is an extremely poisonous compound as shown by an epidemic in 1951 (Fuller 1968); see Helvenston and Bahn (2005: 21, 33–34) for more extensive detail on ergot poisoning.

Like McKenna, Froese discusses the widespread use of hallucinogens in contemporary and ancient cultures with which I have been familiar since 1957 when R. Gordon Wasson and V. Wasson (pp. 2–7) first published their paper *Seeking the magic mushroom* in *Life Magazine*. He had personally experienced the hallucinations caused by psilocybin (converted to psilocin, the active ingredient in that mushroom), when on a trip to Mexico in 1955. Why do advocates of psychedelic use and proponents of the neuropsychological model insist that their critics are simply ignorant about the worldwide use of psychedelic substances as if when they learned of such use they would naturally advocate for the routine consumption of such substances? Indeed, I have spent the last 59 years studying and learning about the uses of psychedelic substances worldwide. I don't need to be convinced of their significance in numerous cultures from ancient times and don't dispute their importance. However, having said all this repeatedly, there is still no *scientific evidence* that they were *used* during the Palaeolithic, or that they inspired rock art productions at that time, or any other time for that matter. Even among Native American 'shamans' who David Whitley (1987, 1992, 1994, 1998, 2003a, 2003b) has insisted painted rock art during ASCs the evidence is absent (Helvenston and Bahn 2005: 80–110).

Indeed, in Helvenston and Bahn (2005: 34–43) we discuss the historical uses of psychedelic substances in Europe, as described in written records, dating from the use of *Amanita muscaria* or fly agaric thousands of years ago in Siberia, from whence it was transported to the Indus valley around 3500 years ago (Wasson 1968; Furst 1976) by the Indo-Europeans. Wasson (ibid.) demonstrated that the Indo-Europeans' sacred drink soma contained *Amanita muscaria*. From India it was transported to early Greek and Roman cultures. It was widely known in Europe from the early Middle Ages and was assumed to have been transported to North America by way of Siberia thousands of years ago where aboriginals have used it in religious or shamanistic rituals (Furst 1976b). *Amanita muscaria* produces a state of euphoria, coloured visions (occasionally), macropsia or micropsia, religious fervour and deep sleep (Schultes 1972: 71; Schultes and Hofmann 1992). Wasson (1967) experimented with *Amanita muscaria* on himself and reported his findings thusly: he indicated it was a strong soporific and one could not be roused from a deep sleep for about two hours, but at times would be aware of sounds round about. In this half sleep, one encountered colour visions sometimes and they responded to a certain extent to the desires of the subject. For about 3–4 hours after awakening one felt a very strong sense of elation, much more so than that produced by alcohol intoxication. During this state one was able to perform amazing feats of physical agility and the experience was enjoyable. No mention was made by any subjects of seeing geometric figures. Since *Amanita* was brought to Europe in the early Middle Ages, it is highly unlikely that it was present in France and Spain during the Upper Palaeolithic. Moreover, its actual use is widely documented in historical written and artistic records in Europe, unlike psilocybin-containing mushrooms.

Cannabis was first described from about 600 BCE as used by the Scythians. It produces dreamy states, but rarely are hallucinations reported. We also considered the uses of *Datura* (*D. metel*) which contains scopolamine and is extremely toxic and *Henbane* (*Hyoscyamus niger*) which induces vivid dreams that are not recalled. There are no written records before about 1799 (Gartz 1996: 15) which describe the use of any psilocybin-containing mushroom in Europe, which is confirmed by Rudgley (2000: 206) who stated that 'There is little evidence for the historical use of *Psilocybe* mushrooms in Europe'. As mentioned, Guzmán (pers. comm. to Froese who provided a copy to me) believes these mushrooms originated in South America when it was Gondwana, and in Africa. From South America the mushroom then spread north, and to Europe and Asia sometime during the Miocene epoch. This means that psilocybin mushrooms theoretically could have been in Europe for some 5–23 Ma. If this is true, it is extremely difficult to explain their complete absence in European written historical documents until 1799. Europeans did have a mushroom to use and to worship, it was called *Amanita muscaria*.

However, there may be evidence of psilocybin-containing mushrooms and their use by humans in north Africa dating to 9000 ka. As Guzmán, according to Froese, believes, psilocybe mushrooms originated in Africa and it is difficult to explain why there are no

historical written records, or contemporary records of their use by traditional societies. We may suppose that their *use* is more ancient, but we cannot prove it scientifically and there are no European Upper Palaeolithic depictions of mushrooms in rock art and the creators of the art were certainly capable of having drawn them if they wished to. Indeed, the earliest evidence of what appear to have been psychedelic mushrooms in rock art was reported by Samorini (1992) who described rock art from Tassili-n-Ajjer as depicting mushrooms of either *Amanita muscaria* or a psilocybin variety. Since *Amanita muscaria* didn't reach Europe until the early Middle Ages, it is difficult to explain how it may have migrated to north Africa. I know of no evidence that identifies these mushrooms more specifically. Perhaps mycologists cannot make a more specific identification based upon the generalised nature of the images. There is even a dispute in the literature as to whether or not mushrooms are depicted at all, as other interpretations of the drawings have been proposed (Samorini ibid.).

Like Lewis-Williams and Winkelman (2002), Froese cites symbolic evolution as having taken place about 40 ka years ago, in the Upper Palaeolithic. This model, originally known as the *human revolution*, was effectively rebutted in 2000 (McBrearty and Brooks 2000) and many times by Bednarik (e.g. 2012a, 2012b), and although some archaeologists still subscribe to it today, many (Wadley 2013) are questioning the model, because of the discovery of so many symbolic artefacts from the African Middle Stone Age dating further back into hominin history (Chase and Dibble 1987; Chase 2001). Froese does cite Henshilwood et al. (2002), as pushing the envelope for symbolic behaviour back to 78 ka and subsequent publications (Henshilwood et al. 2004: 404; 2009; 2011) have shown that symbolic behaviour in Africa dates back over 100 ka, which Froese does cite in an earlier paper (2013a). The images reported by Henshilwood bear a striking resemblance to those studied by Marshack who concluded similar appearing incisions marked days, months or years of a calendar (1991).

Indeed, symbolic productions of cupules, which are perfectly formed, reflecting another human trait, perfectionism, and eggshell beads are dated from beyond 200 ka (Bednarik 1993, 2003a; Bednarik et al. 2005; Helvenston 2012) and the use of ochre for body ornamentation dates back to over a million years in Africa (McBrearty 2001; Barham 2002; Beaumont and Bednarik 2013). Seafaring, requiring symbolic and higher cognitive skills, dates back almost a million years (Bednarik 2003b) and human burial is argued by some archaeologists to represent symbolic behaviour (Belfer 1992; Pettitt 2011a; Pettitt 2011b), dating from the lower Middle Palaeolithic. Thus, there are many examples of human symbolic behaviour dating back some 200 or 300 ka to 1 Ma ago.

The third major influence on Froese as related to psychedelic drugs and human symbolic evolution seems to be Michael Winkelman as mentioned, who has been espousing ideas about shamanism since the 1990s. In 2002 he described a theory of *Shamanism and cognitive evolution* that was completely based upon the work of Lewis-Williams and Dowson (1988) and in this paper he dated cognitive breakthroughs in *Homo sapiens'* evolution to the Upper Palaeolithic about 40 ka ago. He is convinced that shamanism was widely practised at that time through ritualised activities and altered states of consciousness which he believes account for the content of the cave art in France and Spain. His scientific evidence for his belief is based upon Lewis-Williams and Dowson's 1988 paper.

Winkelman also relies upon Steven Mithen with his ideas about a modular brain (1998) that he ascribed to modern humans after about 50 ka. In it he developed the idea that consciousness is attentive and self-reflective, a theme that Froese (this volume) echoes and to which we will return shortly. The idea of a modular brain was originally developed by Fodor (1983), a philosopher, and his theories had wide acceptance in cognitive science (including artificial intelligence and computer models, philosophy, archaeology and anthropology) but little to no scientific support in the biological sciences, or primate and human comparative neuroanatomy (see Prinz 2006, accessed 12/10/2014, for a refutation of the modular theory). It is rarely discussed today because it is highly simplistic and ignores the fact that in spite of brain areas highly specialised for some functions, the entire brain is so interconnected that semi-isolated modules are nothing more than overly-simplified models of brain function and don't reflect the overwhelming complexity of actual neuronal interconnections in living higher primates including man.

Froese also cites Winkelman (2010) who pursues his interest in the roots of shamanism, claimed as the world's oldest religion, in spite of the fact that it was not described in writing until the 1600s as reported by the Russians (Eliade 1964), although Siikala (1978) cites an early Greek attribution of shamanism to the Scythians around 500 BCE and reports the writings of a Franciscan Friar, William of Rubrucko (1254) who described a Mongolian magician who supposedly practised shamanism. These are very brief reports and do not contain the highly detailed and hierarchically structured shamanism first described, thus it is difficult to assess their value as documenting full-blown shamanism as reported in the 17th century. In contrast, Egyptian and Mesopotamian religions were known through written documentation as early as 5000 or more years ago.

There is simply no evidence for the complex practice of shamanism in the Upper Palaeolithic except by extrapolation from modern sources. Reports of shamanistic burials dating back to 12 ka in Israel (Grossman et al. 2008) more likely should be interpreted as if the human skeleton and portions of animal skeletons were that of a practitioner of animism (Helvenston and

Hodgson 2010; Helvenston 2013), and even Thomas Dowson (2007) has written that it is time to give up assuming that shamanism was practised in the Upper Palaeolithic, citing rather the probability that a much more generalised and ancient practice such as animism was involved. Winkelman also discusses the evidence for the healing benefits of ASCs which Helvenston and Bahn (2005: 26–27) pointed out some years ago with the research of Lex 1979), although Winkelman devotes a book to the subject. That permission for research into the healing properties of psychedelic substance induction is very rarely given, for any studies in the U.S. attests to the fact that the National Institutes of Health view habitual use of these substances as potentially addictive and dangerous. Indeed, in my view it is extremely irresponsible to openly advocate for their usage and legalisation.

When Froese comments upon the evolution of symbolic behaviour, he uses descriptors such as the development of more abstract, higher level cognition from a previous, more concrete stance. He describes symbolic behaviour as being self-reflective, distanced and objective. However, these characteristics of more distanced, objective thinking were not present in the Upper Palaeolithic as so many neuropsychologists and archaeologists have assumed. They are a product of the technology of writing which Ong (1982 rpt. 1997) has pointed out. The study of the contributions of writing to changes in the human mind is well-known to medievalists who have noted that the culture of the Middle Ages was largely oral and characteristics of the mind then were quite different than in highly literate, Westernised cultures such as ours is today (Huizinga 1996; Helvenston 2013). What Ong describes is the surprising changes in the human mind resulting from the widespread phenomena of literacy dating from about 800 BCE onwards. All assumptions about pre-Historic minds need to be completely re-evaluated because of Ong's work but neuroscience and archaeology have been woefully inadequate in developing even a basic familiarity with his work. For example, in Ong's own words from the introduction to his book he states:

> In recent years, certain basic differences have been discovered between the ways of managing knowledge and verbalization in primary oral cultures (cultures with no knowledge whatsoever of writing) and in cultures deeply affected by the use of writing. The implications of the new discoveries have been startling. Many of the features we have taken for granted in thought and in literature, philosophy and science and even in oral discourse among literates are not directly related to human existence as such, but have come into being because of the resources which the technology of writing makes available to human consciousness. *We have had to revisit our ideas of human identity* (Ong 1982, rpt 1997: 1, my italics).

In other words, what scholars had been assuming to be universal cognitive attributes of modern humans (dating back to the Upper Palaeolithic), including scientific thinking and analysis, abstract thinking, self-reflection and objectivity, distance, logic etc. depended upon whether or not an individual came from an oral versus a literate culture. This is an extremely complex subject, far beyond the scope of this paper. For a detailed description of the differences between oral and literate cultures see Helvenston (2013). One major difference as relates to my comments here is the fact that there is evidence that people in oral cultures may be more highly susceptible to experiencing naturally-induced ASCs, and thus we might assume that people in the Upper Palaeolithic may have been more susceptible to entering trance states than people who live in highly literate, Westernised cultures.

The point is that writing not only changes the brain (after all, one can see the effects of writing in imprints upon the human brain), but it significantly changes the human mind. One can observe the brains of 3rd–4th graders change in the temporal-occipital regions as the children learn to read and calculate (Dehaene 2005, 2009). The importance of writing in changing brains and minds relatively recently in human history cannot be emphasised enough. So Froese's assumptions of the attributes of the symbolic mind do not encompass the humans of the Upper Palaeolithic. No doubt they had many symbolic capacities, but certainly not the same traits of thought and cognition that we in literate cultures have today.

Section II: Helvenston's response to Froese's comments directly relating to the neuropsychological model

As I see it, the most substantive criticism Froese makes in response to my initial comments is that Guzmán provided him with a geological time scale of when he believed psilocybin mushrooms had their origin in the supercontinent Gondwana which included South America, Africa, Arabia, Madagascar, India, Australia and Antarctica. Gondwana began moving towards the north to supercontinent Pangaea some 80 to 100 Ma years ago according to the online dictionary *Encyclopedia Britannica*. Guzmán further estimated that *Psilocybe* may have arrived in Europe, then Asia during the Miocene, which according to the *Encyclopedia Britannica* was on a time scale of some 5–23 Ma. I had always assumed that Guzmán, when speaking of psilocybin-containing mushrooms originating in South America, was speaking in historical time frames. I was mistaken about this, and I say *mea culpa*. Because he is a world-renowned mycologist, I take his *opinion* very, very seriously, although as far as I can learn, there have been no scientific studies along the lines of the work of Kosentka et al. (2013: 7) that could actually confirm or deny this opinion. Nevertheless, I concede that there is a theoretical possibility that psilocybin-containing mushrooms may have been present in Europe for millions of years.

Kosentka et al. had conducted a study of *muscarinic* and *psilocybin*-containing fungi from around the world and concluded that one mushroom family, the

Inocybacae, included four species known only in Europe. These mushrooms contain psilocybin and so they are assumed to be hallucinogenic. However, there are no historical written sources from Europe attesting to the usage of these four species before the present. They could have theoretically been present, but that is only a necessary reason to assume they were used for their psychedelic properties. It is not a sufficient condition, as that would have to include a documented historical use in Europe of these species. Froese constantly states that my position is that if there were no psilocybin-containing mushrooms in Europe that would falsify the neuropsychological model, which it would. However, the mere *presence* of a substance is no guarantee of its *use* and that would have to be verified by written historical documents.

Froese did provide the citation to a paper that had developed DNA tests to identify the presence of *Panaeolus* and *Psilocybe* mushroom spores in the contemporary U.K. (Chun-I Lee et al. 2000: 123–133). The authors of that paper indicated there was *a potential for abuse* of these substances, but did not cite any direct evidence of contemporary use for either genera in the U.K. If they are present now in the U.K., this is not surprising as these substances have been sold around the world at least since the 1960s and very aggressively. Unfortunately, there are always a lot of people willing to purchase these goods in search of a phenomenal 'high'. What Froese doesn't provide is any historical documentation that any of these substances were used in Europe prior to 1799, and that attribution for *Psilocybe* is probably an inaccurate identification (Helvenston and Bahn 2005: 30–33).

I consider Froese's contention that Lewis-Williams didn't really mean what he said in his 1988 paper with Dowson about three stages of trance to be hopelessly uninformed and naive, because after 14 years of criticism he claimed that not everyone experienced all three stages of trance. I don't disagree with Froese who cites quotes from *A mind in the cave* (2002), stating that Lewis-Williams, after a great deal of criticism, tried to weasel his way out of a strict interpretation of his neuropsychological model. Paul Bahn and I have known this for years. As critics of Lewis-Williams since 1988, now 26 years after publication, know full well, it doesn't matter what he says, he and his followers continue to write papers expressing their conviction in the 'three stages of trance model' to explain rock art from contemporary sources back to the Palaeolithic. However, in his 2013 paper, Lewis-Williams appears to revoke that model in favour of the idea that the mythology of the San is determinative in documenting the trance of the San dancers. While Lewis-Williams gives lip service to the idea that not *everyone* will *always* experience three stages of trance in order to broaden his explanatory options, he continued to write as if a strict interpretation of the neuropsychological model was not just a theory, but in actuality a fact. Indeed, the popular press has picked this up and cites it as a fact, quoting assorted 'experts' including some archaeologists. The fact is, when Lewis-Williams and Dowson first presented that model, they stressed the three stage sequence of hallucinations and followers parroted those beliefs, and many still do. I have written in 2002 that I attended a symposium at Northern Arizona University, Flagstaff, Arizona, on 26 October 2001 wherein David Whitley stressed the three stages of trance model. At a Q and A session after the presentation I pointed out that as a neuropsychologist who had practised hypnotism I had never had a patient reporting imaging geometric symbols while in trance. He responded that psychologists were telling him that but that he and Lewis-Williams dismissed these comments. I encourage Froese, who is fundamentally ignorant of all of the critical literature against this model, to read it and learn something. He dismisses years of critical research on the neuropsychological model by many researchers, because he has never read it.

Froese contends that I have misinformed readers when Bahn and I stated that after examining over 70 states of ASCs as cited by Ludwig, and considering the pattern of trance reported from assorted so-called psychedelic substances, we stated that the only substances that produced the full pattern seen in the neuropsychological model were LSD, psilocybin and mescaline (which was specifically chosen by Lewis-Williams and Dowson as they stated in 1988, because these substances produced a combination of geometric figures and mixed geometric and iconic images and iconic images that 'explained' Upper Palaeolithic cave art images). I stand by those comments.

I have challenged Froese to name other substances that induce this same pattern and he has replied that *ayahuasca* does. This substance has never been known in Europe and thus I have not focused upon it. I don't disagree with Froese that subjects experience some geometric images on occasion and experience more complex hallucinations in what may be considered two stages of trance, but I stand by my previous comments that the images are chaotic, disorganised and must be interpreted by a shaman in order to ascribe a coherent, socially acceptable interpretation of the drug experience.

Froese states that there is no reason to *assume* that other substances may not be found that produce the same trance as LSD, psilocybin and mescaline. Let me state categorically that after researching this issue for months, I have not assumed that these are the only substances Lewis-Williams relied upon, I have done the actual research proving it as has been documented in Helvenston and Bahn since 2002. I am not concerned with future substances, only those that we know about today and I have examined most of them, along with most forms of naturally-induced trances. I stand by my statement that those three substances are the only ones producing a trance consistent with the neuropsychological model as originally proposed. I have challenged Froese to cite other substances in

addition to LSD, psilocybin and mescaline that produce *three stages of trance* and he has not. He has not provided evidence of naturally-induced trances that produce three stages of trance either, nor of geometric figures. He has discussed the fact that he believes 'coming of age' ceremonial rituals were performed in the Upper Palaeolithic and I don't dispute that may be possible in a much more rudimentary form than known today, and that they may have been accompanied by naturally-induced ASCs. But, and this is crucial, no matter how many people believe psychedelic substances inspired cave art in the Upper Palaeolithic, there is no scientific evidence supporting that opinion.

Froese contends that I misrepresented Merabet et al.'s findings. I admit, I overlooked the fact that one subject reported seeing a lion, and in full disclosure also saw a butterfly that turned into a sunset, that turned into an otter that turned into a flower. Otherwise I stand by all my original comments regarding those findings. Only one subject reported seeing a geometric figure. I don't dispute that many subjects reported vivid hallucinations, but they were not in an altered state of consciousness nor were their reality functions impaired in any way. I stand by all my comments about the many pathological conditions that can produce geometric images in Sack's book, *Hallucinations.* I consider them all to be evidence of the fact that geometric images are hard-wired into the human brain in visual and deep temporal cortex and I don't think there will ever be a demonstration that they are the product of Turing instabilities.

Froese conflates the visual deprivation described in Merebet et al.'s findings with total sensory deprivation as practised by Bexton et al. and Zubek et al. He confuses total sensory deprivation with the limited, but sufficient environmental stimuli of speleologists. For example, Froese quotes me as stating 'speleologists' experiences in caves are not analogous to sensory deprivation because they carry lights'. This quote stops in mid-sentence. What I actually wrote was that 'speleologists' experiences in caves are not analogous to sensory deprivation since they carry lights in dark, cold, damp caves with bad air, packing large quantities of supplies and equipment'. Bahn (2010: 87–91) summarises in detail the fact that Jean Clottes, a proponent of the neuropsychological model, has long held that caves, in and of themselves, stimulate hallucinations, just like the sensory deprivation experiments. However, speleologists, who spend days in caves, do not describe more than the occasional flashing light as a visual hallucinatory phenomenon. One speleologist reported seeing complex buildings but attributed it to physical exhaustion and sleep deprivation (Helvenston and Bahn 2005: 45–46, and 2007). Froese et al. (2014) argue that modern speleologists use caves very differently than did Palaeolithic peoples, but if caves are, in and of themselves, hallucinogen-inducing environments, then people who spend days and weeks in modern caves should report hallucinations. They rarely do, and never in the same pattern of trance as described for the neuropsychological model. As Bahn, quoted in my original comments, said, much of the Upper Palaeolithic art extant is not found in deep caves, so speleologists' experiences are moot. Bahn completely refutes Clottes claim (Bahn 2010). Froese et al. (2014b) state that they have examined my claims about speleologists and sensory deprivation, as well as my written record about psychoactive compounds and found them questionable. Perhaps if Froese actually read what I have written he could not so cavalierly dismiss years of scientific research because he is unfamiliar with it.

Conclusion

In short in a long, glib and rambling supposition (*theories* at least have to have some scientific evidence in order to be considered), Froese presents his ideas of how human symbolic behaviour evolved because our ancestors ingested psychedelic substances in the Upper Palaeolithic in Europe. When I first read his proposal I wasn't sure whether or not to take it seriously. But, I did and have presented a sober response. It is long and involved, but necessary to show how little substance there is to what he proposes. Finally, I have addressed his response to my original comments which distorted what I said, failed to respond to the challenges I made, or simply re-iterated what I had written, including citing back to me my own source, Ludwig, on the huge variety of naturally-induced ASCs on record. After researching these various ASCs I concluded that none produced a trance consistent with the neuropsychological model, except for the three substances LSD, psilocybin and mescaline. Froese has cited the opinion of G. Guzmán, in a pers. comm., who has speculated, without any scientific evidence, that psilocybin-containing mushrooms were present in Europe from between 5–23 million years ago. In spite of the fact that no European historical records confirm this, Froese insists that because these mushrooms may have been present, they had to have been used in the Upper Palaeolithic. This is mere speculation from a dyed-in-the wool shamanist who will accept no scientific evidence refuting his position but continues to offer multiple guesstimates and speculations to *prove* his untenable thesis.

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