Altered States of Consciousness and Palaeoart: an Alternative Neurovisual Explanation

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There has been much controversy recently regarding Lewis-Williams's assertion that altered states of consciousness and shamanism can explain Palaeolithic art. Evidence now seems to be accumulating that this account is unable to provide a sustainable explanation for Upper Palaeolithic depictions. This proposition will be explored and substantiated by examining further weaknesses contained therein. Additionally, in response to claims by those defending altered states that no alternative explanation for palaeoart has been proposed as a viable alternative, it will be shown that such a description does exist but has not been given the attention it deserves because of a misplaced concern for shamanism.

Preamble

Altered States of Consciousness (ASC), as applied to palaeoart by Lewis-Williams (1991), claims that because the neurophysiology of the visual brain is the same for both modern humans and Upper Palaeolithic people, parallels can be made between the art produced by each group. More specifically, the mind-altering states of shamanism, which might be induced through rituals or the taking of hallucinogens, stimulate regions of the visual brain causing hallucinations to be experienced in the following three stages: 1) various geometric forms; 2) construal of these forms as objects; 3) full-blown iconic objects. The first is neurophysiologically constrained, whereas the third arises out of the cultural importance of the objects concerned. Because the sequence of stages, as well as the geometric forms and structure of hallucinations, are held to be 'hard-wired', they will therefore have a tendency to be experienced in the same way inter and intra-culturally. Owing to their salience in shamanistic ASC, they are further hypothesized to have influenced the art produced therefrom. Finally, because the San of southern Africa have a concern for animals in relation to shamanism, we are advised that, thanks to a shared neurophysiology and interest in fauna, the geometric forms and animals of palaeoart are similarly a consequence of shamanism.

There seem to be four main bodies of evidence on which those promoting ASC base their claim for the occurrence of Upper Palaeolithic cave art, each of which will be reviewed below.

Ethnographic comparisons and cultural traditions

The weakness of ethnographic comparisons is to be found in the fact that Lewis-Williams (2003) proposes that the prevailing cultural tradition will determine the actual objects and things a person in a trance state will experience. A shamanistic account, as Lewis-Williams (2003) defines it, would, it seems, predict a much greater amount of variation than is actually the case and include many kinds of objects other than animals as part of a complex narrative. Shanon (2003), a cognitive psychologist, has lived with, minutely studied, and partaken in the shamanistic rituals of South American Indians involving the personal experience of psychotropic drugs, such as Ayahuasca, some 140 times. The subject matter of Shanon's hallucinations ranged from animals, serpents, monsters, forests, enchanted cities, people, angels, palaces, temples, scenes from other places and times, to ancient and futuristic civilizations and mythological realms as well as objects of art and magic. These were experienced as akin to real things co-existing alongside everyday reality, yet Shanon was able to remain alert to the separateness of each domain. Crucially, local Indians, westerners,

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and people from diverse cultures were found to hallucinate very similar, if not identical, items (Shanon 2002). Kensinger (1973) reports that South American Indians who took Ayahuasca hallucinated a variety of analogous objects. Manifestly, and in contradistinction to Lewis-Williams, culture does not seem to be the dominant factor in deciding what a person will see when experiencing hallucinations. The fact that, as well as animals, a range of scenes and objects figure in hallucinatory episodes suggests that these should also be depicted in palaeoart, especially since the parallel 'reality' reported by Shanon seems to have been so compelling.

Although there are scenes in San art that involve a range of different objects that relate to an obvious narrative, this is completely absent from palaeoart (the few depictions that suggest a scene remain highly questionable). Given that palaeoartists obviously had the technical skill to depict a range of objects (engraving a line of the correct shape is a particularly difficult task), it is significant that animals remained the overriding concern. It should be noted that much of the rock art of southern Africa is also simply of animals drawn as single units in profile e.g. Twyfelfontein, Namibia (Coulson & Campbell 2001), which suggests that shamanism, even where it can be applied to San art, is only applicable to a restricted corpus.

In an effort to support his claims Lewis-Williams (1991) alludes to idiosyncratic examples, such as the horses at Pech Merle. In so doing, he chooses to ignore the overwhelming majority of palaeoart (White 2003, 122) that shows none of the traits cited in this one exceptional case. At best, this example is what might be termed a false positive, at worst a complete misreading of the intended significance — there are no human or shaman-like figures evident (the human-like figure known as the 'wounded man' in the depths of this cave is ambiguous and probably not contemporaneous with the horses). Handprints are so widespread in palaeoart that almost any meaning could be attributed to them. In fact, handprints are not always seen together with animal outlines. In cases where they do occur, this can be accounted for by a fascination at being able to produce a graphic representation of a meaningful object with a comparatively simple technique. The hypothesis is supported by examples from the rock art of Arnhem Land, Australia, thought to be extremely ancient, where the earliest is in the form of handprints precisely because this is a more easily accessible technique than the more sophisticated artistry of the later animal paintings (Chippindale & Taçon 2000, 105). The same sequence occurs at Cosquer, with handprints belonging to an earlier phase dating to about 25,000 BP, whereas the animal depictions do not appear until around 19,000 BP (Clottes 2000).

So, although it may be useful to draw some ethnographic comparisons, in this instance the evidence needs to be set on much firmer ground before any conclusions can be drawn — exceptional claims demand exceptional proofs!

Lewis-Williams cites the therianthropes of palaeoart as one of the mainstays of his argument. Unfortunately, these are extremely rare, and some of those that are thought to be therianthropic are subject to controversy. In any event, if we were to accept shamanism as a viable explanation for palaeoart, we would expect, as in San art, these kind of figures to be much more widespread than is actually the case. What is often ignored are the depictions that adorn portable objects which also betray an absence of therianthropes. If shamanism was such an all-important aspect of the mind set of Cro-Magnons, we would expect to find such figures turning up on these artefacts in abundance, but this is clearly not the case.

Lewis-Williams also seems to take for granted that the isolated and often ambiguous examples of therianthropes automatically prove the case for shamanism, when there are alternative explanations for these figures. For example, they may represent a disguise used to approach animals for the purpose of hunting (Guthrie 1984), in Donald's (1991) terms an example of mythic thinking, or as Helvenston & Bahn (2004) suggest, an example of a nascent religious activity unconnected to shamanism. In fact, there is evidence to support the view that therianthropes may be humans in animal disguise, as such a figure is engraved on a piece of river cobble that seems to show a standing human wearing a mask that dates to the Magdalenian (White 2003).

The neurophysiology of the brain is the same for contemporary humans and Cro-Magnons

It is undoubtedly true that the underlying structure of the brain will have been the same for Cro-Magnons as it is for contemporary humans, and it is generally accepted that the physiology of the early visual cortex is the prime agent that gives rise to the universality of phosphenes (visual hallucinations of flashes of light and geometric shapes). However, although the brain in its underlying form is the same for both groups, the way these forms will have been interpreted by the higher-functioning frontal cortex will have occasioned considerable variation. Indeed, it is the ability to render the 'raw' experience of earlier sensory areas in manifold ways that is a marker of human behaviour

(Donald 2001). So, although there will have been an equivalence in basic neurophysiology, it is the way the higher areas of the brain respond to lower areas that is the key point.

The copying of phosphenes, as experienced, through graphic productions will inevitably have entailed a refashioning of their characteristics, which will have been prone to further transformation thanks to the particular cultural milieu in which they were produced. In fact, because Lewis-Williams's approach is partly based on cultural factors, we would anticipate phosphenes to have been of such a significance that they came to have diverse meanings, and became manifest in a variety of ways, according to particular cultural interpretations. As this does not seem to be the case, this raises the prospect of alternative accounts to altered states for the all-pervasiveness of geometrics in art. In this respect, it has been observed that there is a tradition of geometrics in art amongst people who do not practise shamanism (Dronfield 1996; Bednarik 1988; 1990). Shanon (2002, 326, 327) also states that the connection between hallucinated geometrics and the art of various cultures has been exaggerated by various commentators in order to conform to a western oriented bias.

So, although it may well be valid to hold that some similarities are to be found in the geometrics of various diverse groups because of a common neurophysiological mechanism, this can be more parsimoniously accounted for by alternative theories to that of ASC (see below).

The prevalence of phosphenes in ASC and the three stages of trance

Helvenston & Bahn (2003; 2004) have shown how the way hallucinations are experienced in drug-induced states does not generally involve the three stages to which Lewis-Williams refers. This is further borne out by the first-hand experience of Shanon (2002; 2003, 301, 304, 375). Despite his exhaustive dissection of the phenomenology pertaining under the influence of psychotropic drugs, phosphenes are either not mentioned or are played down (Shanon 2003, 276, 294), while the three stages to which Lewis-Williams refers are viewed as controversial. In fact, quite often the opposite seems to have been the case, in that the hallucinations were experienced as immediate and full-blown.

In the case of Kluver's (1926) study, he states that the subjects undergoing hallucinations said little about simple geometric designs or more complex images as they tended rather to concentrate on the iconic representations. Helvenston & Bahn (2004) emphasize the point by confirming that, with the exception of mescaline, psylocybin and LSD, none of the many other psychotropic substances actually produce the kinds of geometric motifs to which Lewis-Williams refers. With the lack of evidence Helvenston & Bahn cite for any plants containing mescaline or psylocybin existing in Europe during the Upper Palaeolithic and the fact that, in relation to the taking of artificial and natural psychoactive substances, the experience of phosphenes is rare to non-existent, the possibility that phosphenes were a common and immediately engaging experience for palaeo-artists has to be seriously questioned.

Trance states induced by ritual or fasting, it should be added, are not the same or as powerful an ASC experience as when hallucinogens are consumed. In fact, although 'Type 1' phosphenes (flashes, flickers and dim glowing lights) may be experienced in trance episodes 'Type 2' phosphenes (e.g. geometric forms and lattices) are unlikely. As the San, it appears, did not resort to hallucinogens (Lewis-Williams 2002), this has implications in the present context. Even in the case of sensory deprivation, it has been established that, in a controlled study of people undergoing prolonged isolation, the experience of Type 2 phosphenes was found to be infrequent, appearing only after a seven day isolation period (Zubek *et al.* 1970, 355, 356, 359) — an extremely unlikely event for cave artists. Most of the hallucinations were, in fact, of Type 1 that lacked shape and appeared in the peripheral field of vision and were of short duration, occurred infrequently and then only after two days of isolation.

In view of the fact that they are transitory, insubstantial, and not always immediately obvious, even in circumstances where they might be expected to occur, the actual experience of phosphenes seems to be both elusive and obscure. Electing to transpose this experience into a graphic medium makes the connection even more remote. As Lewis-Williams (2002, 207–8) himself admits, only a few of the geometric designs of palaeoart can be said to resemble or derive from 'entoptics'. In sum, although phosphene experience might provide a clue as to the source of the underlying neurophysiological mechanism, from the point of view of ASC they do not provide a solution to the provenance of geometrics in palaeoart. In view of these criticisms, it behoves Lewis-Williams to account for the obvious discrepancies.

An alternative explanation to shamanism and ASC

The geometric forms of palaeoart in relation to the visual brain

The preference for geometric forms may be more deeply rooted in our evolutionary past than Lewis-

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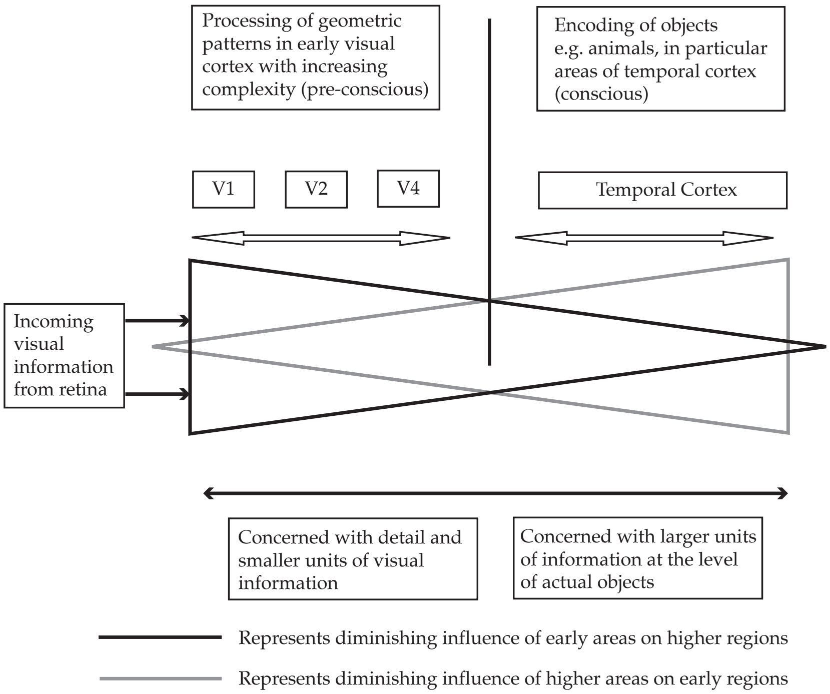

Figure 1. *The organization of the visual cortex showing how incoming visual information is constructed first at the preliminary stages of V1 to V4 involving basic lines and shapes that are fed forward to the later areas of the temporal cortex for recognition of actual objects. The temporal cortex is also thought to call on early areas for scrutiny of detail and when visual memory is invoked through backpropagation. The interlocking triangles show how resonance occurs between the two systems.*

Williams's thesis implies. One has to start from first principles and ask how and why the human visual cortex came to evolve and how this determined its structure. Phosphenes and ASC are regarded as only peripheral to this approach as evidence of how the visual cortex is structured.

In order to understand the relevance of the visual cortex in this respect it is necessary briefly to outline the basic structure and functioning of this part of the brain. In general terms, it is composed of several hierarchical layers, each layer of which is thought to process incoming information beginning with simple components, gradually moving through subsequent levels to accommodate more complex shapes. The first major area involved in this process is V1 (primary visual cortex), an area devoted to dealing with the most rudimentary kinds of visual information (e.g. simple lines, dots). At the next major area, V2, lines are assembled together to make more coherent shapes after which V4 appears to assimilate these to apportion figure and ground. Much of the 'computation' performed at these levels is about constructing the image and is viewer-centred (based on the actual object). From early areas visual information is transferred to the temporal cortex where recognition takes place and is object-centred (based on templates that provide constancy despite change). There is also much feedback from higher to lower areas that serves, amongst other things, to enhance perception (see Fig. 1).[1]

Helvenston & Bahn (2003) make the point that the proclivity to perceive geometric figures was hard-wired into the primate brain millions of years ago. The preference for order, repetition, and geometric patterns in both animals and humans may therefore arise from certain long-standing determinants, relating to their importance for detecting form in various situations, as a means of holding constant the flux of the world so that objects can be reliably perceived. Geometric shapes in patterns embody this kind of scenario in that, as repeated motifs, they remain a stable enduring commodity (see Hodgson 2000a,b; 2004; in press, for a more detailed description of this process). In seeing these kinds of patterns, the early parts of the visual cortex, especially areas V1 and V2, are thought to resonate with greater intensity. In other words, such patterns hyper-stimulate the early visual cortex that is already pre-tuned to be responsive to such lines in the world at large.

This reading of events is supported by many studies that have shown how the processing that takes place in early visual cortex has a tacit influence on later more consciously mediated behaviour (see Hodgson 2003c; 2004 for a summary of some of this research). For example, Zeki (1999) suggests that none of the early visual areas, including V1, merely serve to relay signals to other areas, instead each region actively transforms the incoming signals and may contribute explicitly, if incompletely, to perception (see also Rees *et al*. 2002). This will include later areas of the early visual system such as V4 (implicated in discriminating figure from ground), and an area known as the middle occipital gyrus (MOG) thought to be particularly involved in symmetry extraction (Tyler *et al*. 1998). Tyler makes the further point that the symmetry-specific responses observed in MOG imply the existence of neurons with large receptive fields

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that are *driven* by patterns of activity spread across the mosaic of neurons in earlier visual areas. Furthermore, it has been established that the early visual cortex (V1, V2 & V3) are more active when greater demands are made on the visual system concerning attention to detail (Ress *et al.* 2000), and the sensitivity of neurons in these areas is also known to increase due to training or practice (Li *et al.* 2004; Schoups *et al*. 2001). This suggests the existence of a feedback loop whereby the activity of producing geometric marks helps to fine tune neurons in the early parts of the visual cortex necessary for the rapid discrimination of things in the world. Furthermore, it seems that animals as well as humans (Appelle 1972; Furmanski & Engel 2000) are preferentially tuned to horizontal and vertical lines because the neurons encoding such lines are more widely distributed in the earlier parts of the visual cortex than in subsequent areas. In the later areas, however, oblique lines are represented just as much as horizontal and vertical ones. This has led to the finding that humans are better at resolving and discriminating vertical and horizontal lines in many different kinds of perceptual task (Berkley *et al.* 1975; Essock 1982).

Recent research into visual processes (Ramachandran & Hirstein 1999; Pinker 1997; Shepard 1984) suggests that the pleasing designs found in art and decoration exaggerate these patterns, which tell the brain that the visual system is functioning properly and organizing the world accurately. These contingencies would have been important for discerning shape and therefore tend to produce extensive excitation in neural circuits. Their appeal, therefore, resides in the internalization of certain pervasive properties important for survival that act as powerful guides for segregating figure from ground. These patterns will include well-delineated regions, improbable but informative features such as parallel and perpendicular lines, and axis of symmetry and elongation. The visual brain uses features of this order to carve the visual field into surfaces, group surfaces into objects, and organize such objects for later recall (Pinker 2002).

Thus, it can be said, there has been an evolution of a mesh between cognitive mechanisms and the regularities of the world (Shepard 1984, 434; Tooby & Cosmides 1992, 72). In other words, many statistical and structural relationships that endured across human evolution were 'detected' by natural selection, which designed corresponding computational machinery specialized to use these regularities to generate knowledge and decisions that would have been adaptive in the environment in which humans evolved (Cosmides & Tooby 1994). Indeed, Richards (1971) even went so far as to suggest certain form primitives (geometric motifs), as subjectively experienced, are a consequence of how the neural structure of the visual brain fits together — in hexagonal columns as a means of tightly packing components into a limited space — and this is a product of how nature has 'solved' this problem as exemplified in natural systems of growth. Bressloff *et al.* (2000) have demonstrated how the functional architecture of V1 and V2 can be modelled mathematically to the extent that the same (or similar) forms as phosphenes occur as in real brain counterparts. This study is important because it is an objective demonstration of how the architecture of V1–V2 gives rise to phosphene-like forms.

Palaeoart and resonance

Repeating patterns will therefore tend to evoke extensive excitation in neural circuits because of the very fact they are self-congruent. Massive neuronal resonance to symmetry and pattern may be a function of a deep internalization of the abstract principles of transformational geometry. Such resonant circuits in the early visual cortex may, hence, spontaneously 'reverberate' when presented with particular patterns or forms that approximate early neural centres. These heuristics are probably closely related to how the brain connects things that look alike or are experienced together and seeks to generalize these contingencies to new objects according to their resemblance to known ones. This expresses the tendency of nervous systems in humans and animals to pick up statistical patterns among events in order to achieve generalization. This is realized in neural networks by the well-known principle stating that 'neurons which fire together go together' (Hebb 1949). Stimulation of this function through mark-making *may therefore have been a way of increasing awareness to environmental signals* by helping to sharpen and hone important perceptual skills.

The mind is hence an instrument with a particular preference for simple geometry that is reflected in the architecture of the visual brain (Bando 2000; Cohen & Stewart 1994; Richards 1971). Consequently, when we find simple geometric patterns in nature, then, as a species, we are apt to think something profound has transpired. As Arnheim (1971) proposed, an economical use of shape can establish a bit of order in a world of complexity and what appears at first sight to be a limited vocabulary of units may, in the discovery of similarity, represent a strength. Mach (1943) stated that 'Any figure, no matter how crude or poor, if several times repeated, with repetitions in a line, will produce a tolerable frieze. Also the pleasant effect of symmetry is due to the repetition of sensations.' Correspondingly, Dissanayake (1992) suggests that 'the production and repetition of geometric shapes ... seems to be a fundamental psychobiological propensity in humans that provides pleasurable feelings of mastery, security, and relief from anxiety' (my ellipsis). Such factors may be related to ritualistic behaviour that affords reassurance through repetitive acts.

The contingencies cited by these authors can be readily explained by what I term the 'resonance theory' of mark-making, as it expresses both the way mark-making both simulates and stimulates the process by which the visual system constructs form from primitives and how the two functions are reciprocal (see Fig. 1). A resonating system can have different modes of excitation in that the same tuning response may be activated in various ways. In the present context, this means the system can be activated by external stimulation such as a micro-electrode, drug-induced states, as in shamanism, or, fundamentally, simply through straightforward making or perception of repetitive lines and geometric shapes, as in early art.

Early mark-making, including geometric patterns that predate the Upper Palaeolithic involving repetition, such as those of Blombos (Henshilwood *et al.* 2002), will have embodied this principle in the sense that such marks became a way of representing these processes in an explicit form. Latto (1995) provides a modern example by showing how the abstract geometric art of the twentieth century evokes interest when narrative meaning is absent because it resonates with the earlier, rather than the later, mechanisms of the visual system processing it. A more obvious example of this principle is found in 'op art', which is effective because repetitive lines containing excess redundancy resonate with retinal receptors as well as the visual channels emanating immediately from these areas. Geometric patterns therefore activate more restricted parts of the early visual brain than representational art. In other words, the early visual brain processes the elemental, non-representational 'building blocks' whereas actual representation is carried out at the higher inferotemporal area (Zeki 1999).

The above insights suggest that the geometrics found on the cave walls in Franco-Cantabrian palaeoart can be readily explained by the fact that these forms will have had an intrinsic appeal to their authors through the mechanism of resonance. In fact, the preference for geometrics is probably more closely related to the preference for such things as beads, regular shaped ornaments, fossils and similar items that were also valued during the Palaeolithic. This hypothesis is substantiated by the fact that similar designs are to be found on portable objects which, although they may be decorative in function, may, at the same time, have occasioned specific meaning to do with group affiliation (White 2003). The meaning accorded to these items, however, will have been underwritten by the aforementioned resonance.

Animals in palaeoart and the brain

As to the significance of animals in this context, it is not only the hunter-gatherer who tends to hallucinate animals during ASC; contemporary humans living in modern urban environments also betray a similar preference. Siegal (1977), for example, noted that in a survey of 500 hallucinations induced by LSD, 49 per cent took the form of animals and humans. Kluver (1926) describes how, in his study, animals were also a characteristic of those undergoing hallucinations. These observations reflect Shanon's (2002) findings that animals are by far the commonest item appearing in the hallucinations of people from widely differing cultural groups, including those from highly technological Western societies. Slade & Bentall (1988) additionally report that visions of animals were commonly experienced during the initial phases of progressive eye disease, and one of the most frequently reported items seen in response to the Rorschach test (Rorschach 1942) is animals. Interestingly, night-time long-distance lorry drivers suffering from fatigue often see non-existent animals that they try to avoid (Whitlock 1987). If, as Lewis-Williams suggests, individuals tend to hallucinate those things that have a particular cultural significance, we would expect to find animals to be virtually absent amongst urban populations undergoing hallucinatory experiences, but quite the reverse appears to be the case. This leads to the obvious conclusion that there must be some other reason for the appearance and persistence of animals in such instances other than cultural affinities.

As much as animals were an overriding concern for palaeoartists, what is equally significant is that which they chose to ignore. We do not find caves festooned with, for example, trees, plants and everyday objects, all of which will have figured prominently in the daily lives of Cro-Magnons. The enduring way by which animals were depicted in palaeoart, where the outline is drawn in a particular way (Fritz 1999), informs us that the authors were fixated on animals concerning both the ways in which they continued to loom large in their daily lives and how certain visual areas were moulded by a long-standing interdependence with fauna — the profile view and single unit being the rule (Halverson 1992; Hodgson 2003b).

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Halverson (1992) has additionally shown that this is exactly what comes to mind when one imagines an animal, i.e. the unique profile of mature animal at basic category level lacking hooves. Lewis-Williams (2002) stresses the fact that depicted animals were all about seeming to emerge from cave walls through the mediation of shamans. This being the case, it seems strange that they are nearly all depicted sideways-on rather than from the front. The few that are represented head-on are exceptional and there are good neurovisual reasons as to why they occur (to do with the privileged representation of animals in typical viewing profile in neural circuits compared to frontal views (see Hodgson 2003b).

Seeing an object as a single unit is precisely what occurs when an individual needs to focus attention, especially during episodes of 'fight or flight', in that the visual system becomes blind to all other stimuli except the object which is the cause of concern. This allows the visual brain to focus with greater acumen on the object under scrutiny so immediate action can be taken when and if necessary. Lack of food over a prolonged period, especially such an important source of protein as meat, would have led to a tendency to hallucinate the items in question (Gross 1992, 101; Sandford 1936). In dimly lit caves, this would have been evoked further by both the darkness and the contours of the cave walls that often resembled animal shapes.

As animals came to be of such significance for the survival of hominins during the Pleistocene, the visual architecture for discerning such shapes would have been partially forged by this process. This is supported by the fact that certain parts of the temporal cortex are thought to be dedicated to the analysis of animals (Caramazza & Mahon 2003). More precisely this region seems to be located in the left medial occipito-temporal area of the brain (Moore & Price 1999; Tranel *et al.* 1997), an area that is particularly disposed to processing visual form (Humphreys & Forde 2001).

Recently, this domain-specific view of how the visual brain categorizes objects, such as animals, has proved to be more complex than was first thought, yet, even in a more distributed system, there seems to be distinct 'convergence zones' (Humphreys & Forde 2001). Animals are thought to be preferentially represented in the brain owing to their importance during human evolution (Barrett 2001; Caramazza & Mahon 2003; Hodgson 2003b). Because this area has a privileged place in both yesterday's and today's visual brain, it is almost inevitable that animals should come to the fore during hallucinatory episodes or when normal visual stimulation is lacking. In contrast to Lewis-Williams's approach, this explanation accounts for the many occasions where animals are perceived during ASC, even where they are of little or no significance to a culture and it may be one reason why animals are so widespread in rock art.

The significance of superimpositioning in palaeoart in relation to perception

For Lewis-Williams (2002), superimpositions constitute the residual markings of previous ritualized attempts to break through the 'membrane' of the rock surface. From a neurovisual standpoint, however, superimpositioning can be interpreted as a form of surrogate camouflage that would have been inherently engaging because it stimulates the visual system in particular ways for the ability to discriminate signal from noise. Interestingly, neuroscientists use similar kinds of configurations for assessing brain damage that affects the recognition of objects (Gazzaniga *et al.* 1998, fig. 5.24), and psychologists employ a similar test for demonstrating how the visual system comes to discern figure from ground, e.g. the famous spotted Dalmatian test (the Pech Merle horse that Lewis-Williams refers to is strikingly reminiscent of this). Hodgson (2003c) has demonstrated how superimpositioning in palaeoart may be one technique of many for 'exercising' the visual brain, of which others might include abbreviated outlines and the subdued, changeable illumination of caves that has the effect of lowering thresholds for the perception and recognition of animals *in situ*. The different levels of difficulty for perceiving animal forms in these arrays suggest that this may have indeed been the case.

The ecological relevance of animals to early modern humans

These insights suggest that parietal art was closely related to the ecological environment in which the human perceptual system was embedded to the extent that this art reflected the priorities of this system as it engaged in the world at large. An approach to the subject from this standpoint is not dependent on hunting as an explanation, although this constitutes one strand of a complex dynamic involving many interrelated factors. A key aspect of this dynamic would have been the necessity for knowledge of many kinds of animals that allowed the discrimination of the threatening from the useful and benign. Because of this complex relationship, it may not always appear that the animals depicted were related to hunting, though this will sometimes have been the case.

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	Neurovisual theory	ASC
GEOMETRIC DESIGNS		
Explains geometrics in the art of shamanistic cultures	Partially	Partially
Can account for geometric designs in art of non-shamanistic cultures	Yes	No
Can account for geometric designs where the representation of objects is absent	Yes	No
Explains the appearance of geometric designs before the Upper Palaeolithic	Yes	No
Is based on a non-symbolic account	Yes	Yes
Is related to the ecology of perception and the dynamics of evolution	Yes	No
Accounts for culturally defined aspects of geometric designs	No	No
Explains why geometric forms widespread in art despite infrequency in ASC	Yes	No
Relies on stages (sequential or otherwise)	No	Yes
Offers a mechanism that links the production of geometric marks directly with the normal functioning visual brain	Yes	No
Is refutable	Yes	Yes

	Neurovisual theory	ASC
ANIMALS		
Explains why animals depicted sideway-on as single-units, as well as their predominance in palaeoart	Yes	No
Explains why animals such an all-pervading phenomenon in hallucinations and early art, including shamanic and non-shamanic cultures	Yes	No
Accounts for therianthropes	Partially	Partially
Provides an explanation for superimpositions	Yes	Yes
Depends on ethnographic analogy	No	Yes
Relates to the evolutionary context of humans as a species and how the brain evolved in relation to perception, recognition, visual memory and graphic representation	Yes	No
Depends upon atypical states of consciousness	No	Yes
Regards hand-prints as specific to shamanism	No	Yes
Is refutable	Yes	Yes

Figure 2. *Differences in explanatory scope between Neurovisual and ASC approaches to palaeoart.*

Paradoxically, those who support the shamanistic interpretation of palaeoart make specific reference to such factors but usually ignore these in order to concentrate on evidence that supposedly supports ASC. Clottes (1996), for example, emphasizes how, from Chauvet to Lascaux, there has been a change from a preference for more dangerous animals such as lions, bears, mammoths and the rhinoceros, to more benign species. This may reflect the drop in numbers due to over-hunting by Cro-Magnons similar to the drop in numbers of large dangerous animals in North America owing to the arrival of humans on the continent about 12,000 years ago. Similarly, in relation to Cosquer, Clottes (2000) observes that the species depicted reflect the local biotope. Dowson (Dowson & Porr 2001; see also Hahn 1986), in more explicit terms, shows how animal statuettes of southwest Germany, from about the same period as Chauvet, were of animals, such as lions and bears, that are represented in an aggressive pre-attack posture in a way that emphasizes their power and strength.

Figure 2 summarizes the scope and levels of explanation of both the neurovisual approach and Lewis-Williams's ASC, showing the different ways in which each theory accounts for the various phenomena of palaeoart.

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Conclusion

Taking all the evidence presented in this debate, it seems that shamanism and ASC are unable to provide a coherent and consistent explanation for palaeoart. More seriously, it fails even in those examples that might lend themselves to such an interpretation, such as Pech Merle. This article presents a possible alternative explanation based upon how geometrics are intimately connected with the early visual brain's preferences relating to its functional organization and how the higher brain is particularly primed to be sensitive to animal forms. It thus counteracts the criticism that no credible alternative theory has been proposed. The alternative theory is able to account for the main evidence put forward by those favouring ASC in relation to shamanism by providing a credible explanation for: a) the universality of geometrics; b) the fact that animals were depicted over such a long period in predictable ways; and c) such things as therianthropes, superimpositions and handprints. However, the neurovisual theory does not seek to explain everything about palaeoart, rather it shows how certain aspects of this 'art' can be understood from this perspective and its utility as a tool for discounting theories of a less parsimonious outlook. The approach to palaeoart presented here is what might be termed 'coarse-grained,' leaving the more 'fine-grained' questions pertaining to specific cultural factors to the archaeologist or anthropologist. Uniquely, this explanation is refutable because it predicts that any future discoveries of palaeoart will be exclusively of animals portrayed as described and, to a lesser extent, human-like forms (for an explanation of the significance of the human form see Hodgson 2003b). Secondly, it predicts that geometrics will tend to predate the representation of animals in 2D by a considerable period, thus reflecting the visual brain's ease of processing and preferences for such forms.[2]

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Notes

1. Of course, this is an extremely simplified version of a highly convoluted procedure involving parallel pathways, cross-referencing and back-propagation, much of which is still controversial. However, there appears to be some consensus that the visual system seems first to register information by encoding basic features, after which it is acted upon by higher semantic systems for the purpose of recognition.
2. In fact this latter prediction has already been vindicated as I anticipated (Hodgson 2000a) that any further discoveries of geometric 'art' predating the Upper Palaeolithic would take the form of repetitive designs. As this prediction was made before the 77,000-year-old Blombos designs came to prominence in 2001/2002 (d'Errico *et al.* 2001; Henshilwood *et al.* 2002), this goes some way to substantiating the neurovisual explanation. Similarly with animals, I foresaw (Hodgson 2003a) that any new discoveries of parietal art from the Palaeolithic would consist of single animals in outline profile, a prediction that was recently verified by the discovery of the depictions of animals at Cresswell Crags (Bahn *et al.* 2003).

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