KEYWORDS: ***Pareidolia – Consciousness – Visual system – Neuropsychology – Rock art***

ROCK ART AND PAREIDOLIA

Robert G. Bednarik

Abstract. The phenomenon of pareidolia, of experiencing meaningful patterns in random stimuli, is explained in neurophysiological and neuropsychological terms, before its roles in rock art interpretation are considered. A case of group pareidolia in Inner Mongolia is reported in detail, and analysed together with other examples of imagined or pareidolically misinterpreted palaeoart and other phenomena. The process of etic interpretation of rock art is explained neurologically and epistemologically. It is described as a function of the lateral geniculate nucleus of the thalamus yielding to the internal model of the visual cortex in the occipital lobe. This strategy favours incorrect causal associations to be made. It is inherent in the visual system, deriving from its efficacy in natural selection, but its application in rock art interpretation is an impediment to veracity in rock art research. Unless ethnographic information about the meaning of rock art is accessible, rock markings created by humans whose mental and cognitive world is entirely unknown cannot be interpreted with scientific credibility. In such endeavours, meaning is created purely within the brain of the 'interpreter'.

Introduction

Consciousness, which is the subjective experience of humans based on sensory input and stored ontogenic experience, can be defined as a transparent representation of the world from a privileged egocentric perspective (Trehub 2009). Despite having been subjected to much philosophical attention over the centuries, it remains very little understood scientifically. Whereas self-awareness focuses on the self, processing both private and 'public' information about selfhood (Gallup 1998; Gallup and Platek 2002; Carver 2002), consciousness is thought to focus attention on processing incoming external stimuli of the organism's environment (Dennett 1991; Farthing 1992), but in effect it is heavily influenced by previous experience. This is noted by Schrödinger (1964: 19; emphasis added) who alludes to the self-referentiality of consciousness when he states 'the reasoning *is part of* the overall phenomenon to be explained, not a tool for any genuine explanation'. Wittgenstein (1982: 42) sees consciousness and perceived reality as equivalent. The aetiology of this self-referential awareness, however, remains fundamentally unknown (Bednarik 2016a). The quest to explain the ability of experiencing reality consciously is one of the hardest tasks of science, precisely because of its self-referentiality. Hofstadter (2007) compares it to finding a self-consistent set of axioms for deducing all of mathematics: as shown by Gödel (1932) this is impossible. For any recursive axiomatic system powerful enough to describe the arithmetic of natural numbers there are true propositions that cannot be proved. Much the same seems to apply to consciousness, and yet most humans are perfectly unaware that the reality they experience is merely an imagined world made real (Plotkin 2002).

The great efforts made to explain the central fact of existence have indeed yielded precious little so far. It seems safe to assume that the brain is the organ hosting consciousness, because consciousness vanishes when the brain is switched off (by whatever agency). More specifically, the cerebral cortex (Goldberg et al. 2006; Frässle et al. 2014) and possibly the claustrum (Crick and Koch 2005; Koubeissi et al. 2014) are involved in consciousness. Although the cerebellum is made up by just over 80% of the brain's 86 billion nerve cells (Herculano-Houzel 2012) and is just as complicated as the cerebral cortex, it is not involved in consciousness. It appears that subcortical white matter, brainstem and thalamus are implicated in it (Fernández-Espejo et al. 2011), while the cortical brain is assumed to be involved in unconsciousness (Velly et al. 2007), and the thalamus is not believed to actually drive consciousness. Human consciousness is also thought to involve gamma activity (Engel and Singer 2001; Imas et al. 2005) and a frontal P300, as during dreaming sleep (Cote et al. 2001; Takahara et al. 2002). The P300 wave is absent in some brain-damaged patients able to communicate (King et al. 2013), and a similar but weaker wave has been detected in small infants (Kouider et al. 2013).

Solutions to the 'hard problems of consciousness' (Chalmers 1995) remain elusive, however. In the global workspace theory (Baars 1997, 2002), a workspace is imagined in the brain where sensory events may compete with each other for consciousness (Robinson 2009). The theory does, however, at best provide an account of cognitive function; it remains mute on the *nature* of consciousness (see also objections by Blackmore 2005). The alternative integrated information theory (Tononi 2008; Barrett and Seth 2011; Oizumi et al. 2014) begins with five phenomenological axioms: intrinsic existence, composition, information, integration and exclusion. It 'provides a principled account of both the quantity and the quality of an individual experience (a quale), and a calculus to evaluate whether or not a particular physical system is conscious and of what' (Tononi and Koch 2015). But it does not tell us how the brain forms consciousness, or the central fact of our existence.

The principal *sensory* input in the formation of consciousness is from the visual system, but it neither determines the outcome nor can it be regarded as particularly reliable. As shown by numerous optical illusions and other phenomena, this is because in arriving at a judgment it relies heavily on previous experience stored in the brain. Visual information arriving through the retina only accounts for about 5% to 10% of the data processed by the visual system; the remainder originates from within the brain, largely reflecting the ontogenic history of that organ. In fact as much as 95% of excitatory, inhibitory or modulatory input in the lateral geniculate nucleus (LGN) derives from the visual cortex, superior colliculus, pretectum, thalamic reticular nuclei, local LGN interneurons and other projections (Guillery and Sherman 2002). The latter include feedback projections from the higher areas of the visual cortex of the inferotemporal cortex, where visual memory/imagery occurs, back to visual cortex (V1, V2 and V4) (Brosch et al. 2015). Significantly, early redirected pathways emanate from the thalamus region to the amygdala before conscious recognition occurs (LeDoux 1994, 1998). Some thalamocortical pathways relay information from ascending pathways (first order thalamic relays) and others relay information from other cortical areas (higher order thalamic relays), thus serving in corticocortical communication.

Traditionally, visual processing was seen as a linear pathway (retina – LNG – V1 – V2 – V4 – inferior temporal area TEO–inferior temporal area–amygdala), with a shortcut via superior colliculus and pulvinar nucleus of the thalamus. An alternative flowchart proposes numerous optional routes and shortcuts, presenting the flow of visual information 'in terms of "multiple waves" of activation that initiate and refine cell responses at a given processing "stage" ' (Pessoa and Adolphs 2010). Importantly, this model implies paths from the retina to the pulvinar, also via the superior colliculus; and from the pulvinar nucleus to the parietal, frontal, cingulate and orbitofrontal cortices as well as the insula, all of which in turn connect to the amygdala.

Essentially, we see what we expect to see, because it is more difficult and time-consuming to see what we do not expect to see. This is where pareidolia comes into play: it is part of the shortcut the visual system takes in order to arrive at decisions of how to respond to visual signals. It takes hundreds of milliseconds to process visual data and what the thalamus sends to the cortex is in effect a hastily drawn approximation. For instance we take 200 milliseconds to react to sound, but 240 ms to react to light, the visual system being larger and more complex. The information streaming from the visual centre to the thalamus is about six times greater than that travelling the opposite direction (Eagleman 2015). Reaction times can be crucial to survival, and paradoxically an ambiguity of perception offered an advantage in the Pleistocene (Bednarik 1986a: 202): it made sense to switch to a flight response even when the perceived cave bear turned out to be just a rock shaped like a bear. Hodgson (2003a, 2003b, 2004, 2008) has discussed the influence of 'self-priming', particularly in detecting animals and human faces that are automatically activated in what he calls 'adaptive conservatism'. In particular, he noted that the subcortical thalamus to amygdala pathway responds rapidly and pre-consciously to potentially threatening stimuli, especially those involving danger (Hodgson 2008). Helvenston and Hodgson report that internally-produced visual imagery can sometimes activate Area 17 of the primary visual cortex, 'which is usually only active when viewing the real world but relatively inactive during subjective imagery. When this occurs, and especially during heightened emotional stimulation, the individual can misconstrue internal *subjective* images for reality' (Helvenston and Hodgson 2010: 69).

Thus pareidolia is an integral part of the visual system's operation, being attributable to the need of identifying visual stimuli much faster than proper discrimination and processing would require: 'first impressions' are matched with information stored in the brain, i.e. data deriving from previous experiences forming what is called an 'internal model': a rendered simulation. In visual pareidolia a figurative pattern is detected where no representation actually exists, be it two-dimensional or three-dimensional. The term is also applied to sounds, for instance when hidden messages are perceived in sound recordings (Vokey and Read 1985; Zusne and Jones 1989). Pareidolia is a form of apophenia (or 'patternicity'; Shermer 2008), the human tendency to perceive meaningful patterns within random data (Brugger 2001). The 'abnormal meaningfulness' defining apophenia is neurologically rooted in the ability of the brain to sift through the mass of sensory information received to detect significant signals. This mental priming effect of the brain and senses to interpret stimuli according to an expected model is not uniquely human; it is fundamental to all animal behaviour. However, in the highly evolved human brain it 'lacks an error-detection governor to modulate the pattern-recognition engine' (Shermer 2008). This has no negative effect on natural selection,

Figure 1. *Two views of the hundreds of salvaged boulders in the Xiaojinggou depot.*

because the cost of seeing a false pattern as real is significantly less than the cost of not detecting a real pattern; hence natural selection will favour patternicity. Thus natural selection can prefer strategies that make incorrect causal associations in order to establish those that are essential for survival and reproduction. This explains both apophenia and the specific form of it, pareidolia.

Therefore pareidolia has been advantageous in human evolution, despite consisting of entirely erroneous beliefs, and it has no doubt contributed to the formation of the false constructs of reality ('consciousness') we subscribe to as a species. Here we are concerned with the specific role of pareidolia in the interpretation of rock art, where the issue of veracity is of paramount importance and cause and effect reasoning needs to be applied instead of associative thinking. The present review has been prompted by observations made in Inner Mongolia, China, in late 2015. Details about them will be followed by a generic consideration of the connection between pareidolia and palaeoart study, with the goal of formulating a general synthesis of the impact of pareidolia in this field of research.

The case of the three emperors

The president of a university college in Inner Mongolia is a keen rock art researcher who discovered a purported major rock art concentration near his summerhouse at Xiaojinggou, in the Daqing mountains north of Hohhot. He has taken extraordinary steps to preserve this 'rock art'. He found much of it among the rubble of road construction activity, or threatened by other development, so he decided to collect endangered blocks bearing 'petroglyphs' and deposit them in a large yard at his summerhouse. At present, there are approximately 350 boulders in his protection (Fig. 1). The logistics of salvaging these blocks, up to 20 tonnes in weight, often from locations of difficult access, were formidable. Not only did he personally pay for these operations, in many cases he compensated the relevant landowners financially, spending hundreds of thousands of dollars in saving the rock art. His dedication therefore seems unparalleled.

In the months leading up to October 2015, about twenty students were engaged in deciphering and recording the 'petroglyphs' in the salvage centre and those hundreds more not under threat and still remaining in situ. The college hosts an extensive exhibition of 'rubbings' of the rock art, which shows that the dominant motifs are face or mask-like figures, often together with small motifs of unknown meaning, or possibly depicting small animals. Based on this iconography, an elaborate interpretation of the Xiaojinggou rock art has been developed. Accordingly, it relates to a cult of three emperors (or three gods), and the presumed small animals represent sacrifices to them. The religion of the three emperors is in the order of 6000 years old, i.e. of the Neolithic, and it is the oldest known religion in the world.

In October 2015 the college invited Professor Tang Huisheng (China), Professor Giriraj Kumar (India) and the author to inspect this discovery, to estimate the age of the petroglyphs, and to advise concerning submission of the extraordinary corpus to UNESCO's World Heritage List. In view of the recent submissions to that list of the Chinese properties of the Zuojiang Huashan Rock Art Cultural Landscape (Bednarik 2016b) and the Helanshan Petroglyphs Monument it was considered appropriate to submit the Xiaojinggou complex also. The three rock art specialists were at first treated to a day of lectures, introducing the new rock art and the interpretative hypotheses, and they conducted a detailed examination of hundreds of full-size 'rubbings' of the 'face petroglyphs'. Their striking vibrancy and stylistic integrity were astonishing, and the three rock art scientists agreed that a major discovery had been made. Despite obvious similarities with 'face/mask' petroglyphs across central Asia, including those of Helanshan and eastern Inner Mongolia (Chifeng region), this was a very distinctive regional corpus: while each design differed in the details, the stylistic integrity of the collection was overwhelming (Fig. 2).

On the following day the three international rock art specialists were taken to Yémá Gōu (Wild Horse valley), a steep side valley to the east of Xiaojinggou in which many similar petroglyphs had survived in situ.

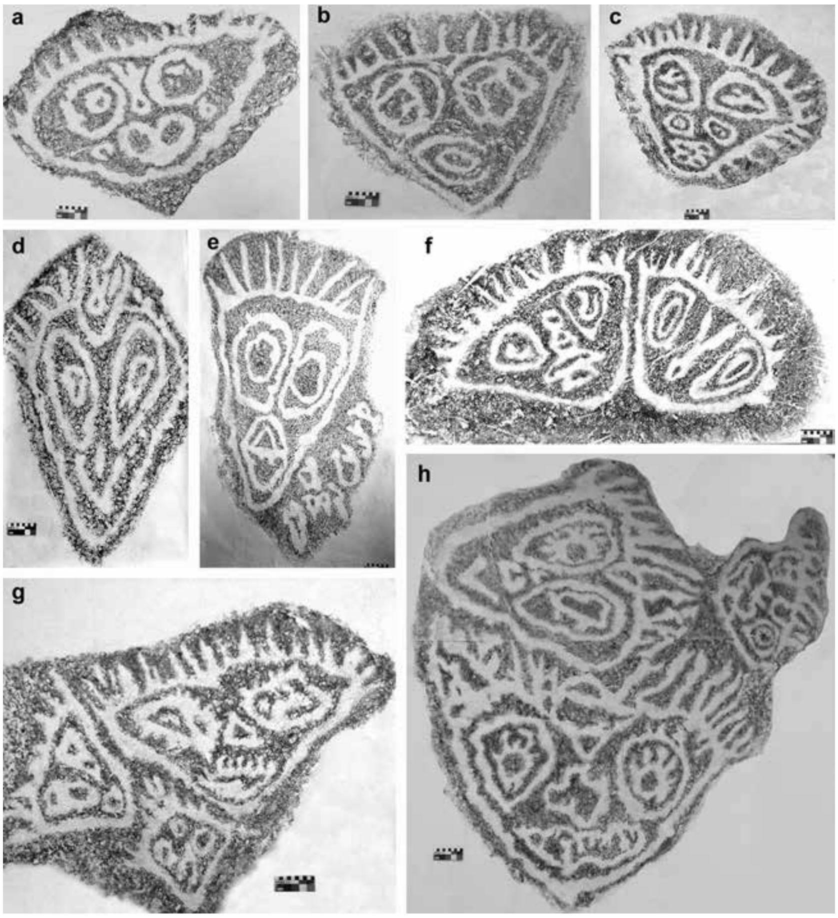

Figure 2. Sample of the hundreds of 'rubbings' made of Xiaojinggou boulders.

The three were led to dozens of large rocks covered by petroglyphs, but they failed to detect any of them. This left them with a quandary: why was it that what everyone else in the large accompanying group saw remained invisible to them? Eventually two cupules were found (more were said to be in the valley) which were determined to have been made with metal tools, almost certainly of steel (Bednarik 2016c: Fig. 4). But no other rock art could be located.

Late in the same afternoon the rock art scientists were taken to the salvage yard and began examining the many hundreds of petroglyphs there. They had been marked out in black colour on most of the boulders, but the further these were examined, the more it became evident that there was no rock art present on them. All the boulders bore extensive taphonomic damage, essentially attributable to either fluvial or glacial transport; or to heavy machinery of roadworks or the recent transport of the blocks. Nearly all of them were of granite and had been transported naturally for many kilometres. For instance Yémá Gōu is located in schist, but the rounded granite boulders derive from sources further up-valley. None of the blocks in the salvage yard bore detectable impact grooves, and grains fractured by impact generally related to random taphonomic damage by other clasts.

At this point the author placed the recording of a large 'face' petroglyph immediately next to the boulder on which it was said to occur, demonstrating step by step that none of the details of the 'rubbing' were visible on the rock surface. For instance the recording showed a detailed double-turn spiral, but in the corresponding place on the rock there were absolutely no impact marks. Similarly, no trace of the surround of the large 'face' in the recording occurred on the panel, nor was there any indication of the 'eyes' or 'hair' (Fig. 3). Among the most readily detectable aspects of a complex petroglyph are sets of repetitive, subparallel grooves, such as those of the 'hair' of the recorded face image; however, none of these occurred on the rock, and not a single trace of deliberate modification could be detected on the entire panel.

Figure 3. Recording taken from one boulder in the Xiaojinggou salvage yard, and view of the same panel in identical orientation.

The complete absence of rock art on these rocks posed a significant problem: taking rubbings of petroglyphs (now discontinued as a recording method in most world regions) is believed to provide relatively objective documentation. How could this method yield copies of petroglyphs that did not exist? To solve this quandary, Tang requested that the recording method be demonstrated. Two members of the recording team immediately obliged. They placed thick paper over the rock, sprayed it lightly with water, covered it with a thick cloth and commenced stamping the papier mâché with stiff brushes (Fig. 4). After the paper had been stamped to take on the surface morphology of the rock, the cloth was removed and the paper allowed to dry.

Figure 4. *Stamping the papier mâché into place with stiff brushes.*

Then stiff smaller brushes, sparsely coated with black paint, were *stamped* on the dried papier mâché, each of the two operators commencing from a different area. In this they seemed to avoid depressions of the surface and following rises they perceived along grooves. In making rubbings, the membrane is placed over the petroglyph and is rubbed energetically with a colouring agent that emphasises protruding aspects. Therefore the method used in this case was stamping, not rubbing, which is rather gentler on the rock markings and thus less objectionable. After several minutes the two students were requested to pause, and the rock art scientists examined the result closely, with the 'recording' still in situ. They agreed that there was no correspondence at all detectable between the blank and black areas and the actual relief details. In some cases slight depressions had been stamped, in others rises had been avoided. It was evident that the operators had imposed their expectations and subconsciously stamped areas in the expectation of a specific pattern. Incredibly, the two students seemed to share the same expectations.

At this stage Kumar asked them to demonstrate on another, unmarked boulder how they had in the past coloured in the perceived petroglyphs in black colour. He observed that they were not tracing any petroglyphs; there were none present. The operators seemed to project mental templates onto the rock and then traced these in black. As block after block was now checked, the author noticed a surprising effect on his own visual system: when he looked at some of the traced 'motifs' of 'faces' from a distance of about 2 m, he seemed to see grooves where the black marks occurred (Fig. 5); but when he examined them closely the grooves disappeared. This suggests that after two days of being subjected to the strenuous need of detecting 'faces', he had himself developed a visual conditioning trying to prompt him to see petroglyphs where there were none.

Figure 5. *Some of the hundreds of 'petroglyphs' traced in black in the Xiaojinggou salvage yard.*

As the entire inventory of the salvage yard was checked it emerged gradually that of the over one thousand petroglyphs supposedly present on the blocks, not a single one existed.

The following morning, the college president remarked that there were hundreds more petroglyphs near his summerhouse, so the author asked him to take the specialists to the best three or four specimens he had encountered. Two slopes of schist exposures were examined, and again there was no trace of petroglyphs on any of them. The only exception was the discovery of a modern inscription on the upper surface of a large transported granite block. Ignoring the finding that there was not a single petroglyph on his collection of hundreds of salvaged granite blocks or at the sites he had shown the specialists, the president then requested that some of his 'petroglyphs' be dated. Three very rough microerosion age estimates were extracted from natural or transport-caused impact damage on three boulders. One was of the current century (no microwane present) and quite probably referred to damage incurred on the transport to the yard; another was of the mid-Holocene, while a third taphonomic damage scar was in the order of 21 ka old. The president rejoiced upon receiving the third estimate, as it suggested to him that his petroglyphs were much older than he had thought. Although he admitted by now that many of his petroglyphs did not exist, he continued to insist that others were authentic. At this stage it also emerged that the director of the rock art institute of his college had in the past often disagreed with his beliefs.

Exploring pareidolia in rock art interpretation

There is no intention here to disparage the college president or any of his staff or students; his dedication to rock art preservation is without equal in the world, his charismatic enthusiasm is boundless and his perseverance and devotion are admirable. But what is needed is a rational, soundly based explanation of what happened here, grounded in robust psychological reasoning. This is not about one person's vision; many others had shared the false belief, and the observation that two recorders would trace parts of the same imaginary image, without communication, certainly needs to be explained. In all, well over one thousand 'face' and thousands of other supposed petroglyphs have been recorded in a matter of months. Let it be clearly stated upfront that the author completely rejects that any form of collusion occurred, or that we were deliberately misled. He is entirely satisfied that all participants of the recording program earnestly believed seeing the petroglyphs, and he is quite certain that they still perceived petroglyph grooves even after we had pointed out that there were none. We observed numerous times that they were astonished that we could not see what was obvious and very tangible to them.

Arguably, what has been described is one of the most dramatic examples of pareidolia observed in rock art interpretation, resulting in a proposal for World Heritage listing of a large corpus of fictitious rock markings. A significant obstruction to understanding the phenomenon would be if we were to explain it away as an idiosyncrasy attributable to a charismatic individual, or as an exceptional occurrence without parallel. This would be a grave mistake: the involvement of pareidolia is an important subject in rock art interpretation (i.e. creative pattern detection) and deserves to be considered more carefully.

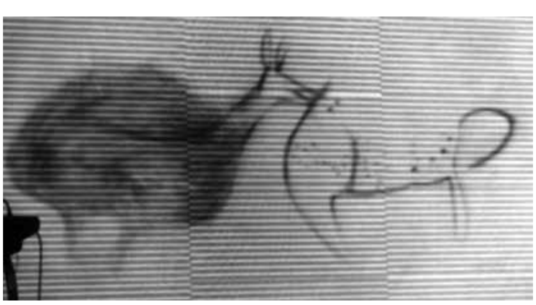

Figure 6. *Pareidolic impressions of depictions in an unintelligible patch of paint residue.*

The first relevant observation is that in the case of rock art, it is particularly easy to transfer an anticipation of seeing a specific design to others, because motifs are often hard to detect, especially due to weathering. When viewing eroded petroglyphs the visual system of the beholder tends to supplement the sensory data 'creatively', i.e. by drawing more than usually on the imagery memorised in the visual centre, allowing it to overrule the information provided from the retina. The differences between the rock art recordings of different observers also illustrate this point. If a researcher who is regarded as more experienced in motif detection asks a less experienced person to find the iconic arrangement the latter is likely to make strenuous efforts to do so. Unable to see the design, the student's visual system will summon images of such petroglyphs from the brain's internal model and search for a match. Trying very hard to please the instructor, the student may detect faint (natural) markings and pareidolia will strive to find a pattern. In this exertion, the internal model is likely to prevail, and once the subject begins to perceive a form, it congeals and he or she is relieved to be able to report seeing the emergent shape. This process is then one of combining psychological anxiety, latent coercion, auto-suggestion and pareidolia, prompting alleviation through concurrence. It would be expected to be particularly effective in subjects of compliant disposition.

Importantly, this effect in the Xiaojinggou case, of the lateral geniculate nucleus of the thalamus being 'overruled' by the visual cortex in the occipital lobe, is not unique. The reported anlage (underlying disposition) of the author, to show the first signs of glimpsing what others believe to see, illustrates the point. In less spectacular forms it underlies all pareidolic interpretation of rock art motifs, of which we have millions of examples in the literature (Bednarik 2014). Another example of such interpretation, coincidentally also from China, is particularly illuminating of the issue because in that case the subject explained in detail how he arrived at his understanding, including the deductions he made. A young archaeologist presented a paper at the 2014 IFRAO Congress, held by the Rock Art Research Association of China (RARAC) in Guyang City, Guizhou Province, presenting a photograph of a smudged and exfoliating patch of red paint residues at a southern Chinese rock art site (Qiao 2014). The present author was completely unable to detect any iconographic elements in the pigment patch, but the presenter, without the use of a method of digital emphasising, believed to see the image of a bird 'biting' a cervid in it (Fig. 6). He then reasoned that the two zoomorphs formed a scene, and therefore the bird must have been very large — large enough to attack a deer. He further deduced that the bird must be carnivorous, aggressive and flightless. Next, he considered three genera of Tertiary flightless birds as potential identifications: *Gastornis* (Palaeocene and Eocene, Europe, China and North America), *Phorusrhacos* (Miocene, Patagonia) and *Titanis* (Pliocene and earliest Pleistocene, North America). Testing each candidate he was not satisfied that they could account for the image his pareidolia had conjured up: two of them are not known to have occurred in China, and two seem to have become extinct before hominins appeared in that country (Fig. 7).

So the subject turned his attention to another candidate, the cassowary (*Casuarius* sp.) of northern Australia and New Guinea. Determined to find a solution to his 'big bird' image, he contradicted his own maxim that the animal had to be a proven native of China, and instead developed a line of reasoning about how a flightless terrestrial species from Sahul might have travelled to China. His solution was that it might have walked over ice sheets that had formed on the oceans during the Pleistocene. Indeed, he then offered the bridging argument that the current absence of cassowary remains from China does not prove that it did not exist there in the past. In other words, the pareidolic interpretation was stronger than the refuting evidence, and the theoretically true adage that absence of evidence is not evidence of absence was cited in its support. This is a classic example of a cumulative body of reasoning applied to buttressing a purely pareidolic proposition, which in various forms is found throughout rock art interpretation.

In this fanciful explanation the massive counter-evidence is simply ignored to preserve an entirely contrived identification, attributable to a failure of the visual system through its lack of an error-detection governor (Shermer 2008). To begin with, the cassowary is not a reasonable candidate in this instance; it is after all mostly herbivorous, although it will on occasion feed on very small vertebrates and invertebrates. Glaciers never existed anywhere in the tropics during the Pleistocene, and if the genus had reached the Sunda plate, it would have been the only Antipodean flightless terrestrial animal to have done so. Moreover, it is extremely unlikely that a flock of such birds would have been able to successfully traverse thousands of kilometres of ice sheets. We can safely exclude the possibility that any justification exists in this case to rationalise a purely pareidolic notion. Besides, a great deal of rock art refers to mythological entities, therefore even if there were a 'big bird' present, it would not prove that such an animal existed.

Very similar circumstances apply to the next example, in which one of two relatively similar aviform pictograms on a sandstone block in western Arnhem Land, Australia, was pareidolically interpreted as the possible image of *Genyornis newtoni* (Gunn et al. 2011). Although here the details of the image are relatively well defined, it is certainly not a naturalistic depiction, which means that the 'identifier' has to arbitrarily select from very numerous variables those that the artist had intended to be diagnostic (Bednarik 2013). The time of extinction is known more securely for *Genyornis* than for most other Australian megafauna species: 50±5 ka ago (Miller et al. 1999; cf. Miller et al. 2016; Bednarik 2013: 203). This would make the Arnhem Land painting the oldest known pictogram in the world as well as the earliest figurative depiction — extraordinary claims that would demand extraordinary evidence.

It was clear from Gunn et al.'s report that the aviform image is of relatively recent antiquity: it suffers from rapid deterioration by rainwater and is associated with other recent rock art, which together with the apparent incipient stylistic x-ray treatment of the bird picture all point to a late Holocene age (Bednarik 2013). In fact there is no evidence that *Genyornis* even existed in northern Australia. The only justification given for this spectacular claim was that the 'head shape, long neck, stubby legs, tail-less rump and large heavy feet' of the figure are diagnostic of *Genyornis* (Gunn et al. 2011: 6). In this bold proposition it was ignored that hundreds of other variables of the motif negated that view (Bednarik 2013), and that the reliable identification of biomorphs in rock art is not possible for cultural aliens (Macintosh 1977). Moreover, the image's head shape is irrelevant (we have no well-preserved remains of the bird's head); while the neck, legs and feet are not diagnostic by any stretch of the imagination; and the tail-less rump is obviously undiagnostic (all extant or recently

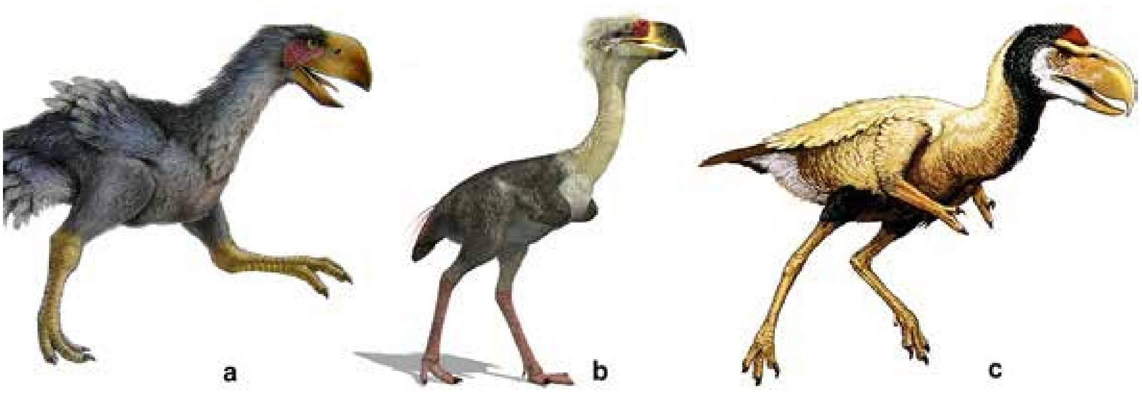

Figure 7. *Artist's impressions of the genera (a)* Gastornis, *(b)* Phorusrhacos *and (c)* Titanis, *not necessarily true likenesses of these birds.*

***Figure 8.** Two aviform pictograms on a poorly protected sandstone panel in western Arnhem Land, Australia (after Gunn et al. 2011).*

extinguished large flightless birds have prominent tail feathers, and we have no idea what those of *Genyornis* may have looked like) (Fig. 8). Two recent reviews of the site and its rock art provided credible evidence that the rock panel on which the paintings occur only came into existence 13 000 years ago (Barker et al. in press); and that the superimposition sequence had been misinterpreted (Chalmin et al. in press). Gunn et al. had assumed that an anthropomorph and a barbed spear had been superimposed over the 'big bird', but the former actually precedes the aviform image while the 'spear' is of the same age and pigment as the 'bird'. The significance of this finding is that if the marking depicts a barbed spear, it has to be very recent as such weapons were introduced only in the late Holocene. Consequently the identification as *Genyornis* now stands squarely refuted.

One contention presented by Gunn et al., concerning the opinions of palaeontologists, has been frequently used by rock art interpreters in support of their opinions. It is, as Schaafsma (2015) notes, 'a futile and often self-serving enterprise'. Translated into scientific language, this argument seems to propose that the lateral geniculate nucleus of persons of palaeontological training is less likely to be overruled by their visual cortex, but without justification for the argument. Knowledge in recognising species or genera of animal specimens confers absolutely no cultural understanding of the iconographic conventions of rock art producers and is in that sense irrelevant to the issue at hand (Helvenston 2013; Thompson 2016).

Another Australian example of this unwarranted practice refers to the 'identification' of a pisciform petroglyph (Bednarik 2010: Fig. 29) at Panaramitee North, South Australia, by a zoologist, cited by Mountford and Edwards (1962) in support of their absurd contention that as a marine creature it demonstrates that the image must date from a time when the sea was close to the site. That would have last been the case in the Late Cretaceous or Early Eocene transgressions, many millions of years before the arrival of humans. This shows again what improbable opinions pareidolic interpretation can prompt, defeating common sense. Similarly, the same authors claim that a zoomorph at the nearby site Yunta Springs depicts a marine turtle, an equally unsupportable notion. Mountford (1929) had much earlier defined a complex Panaramitee North petroglyph as the 'naturalistic' head of a saltwater crocodile (*Crocodylus porosus*), which as Mountford and Edwards (1962: 98) note occurs only much further north today. Actually, no kind of crocodile has been demonstrated to have existed in Australia south of latitude 30° at any time, and with one exception none have been reported south of 18° (Bednarik 2013: 200–201). Therefore the 'identification' of the petroglyph as a crocodile head is unsustainable, and it has been contradicted by informed indigenous commentary in 1942: the pattern depicts a *yarida* magic object (Berndt 1987). This provides another illustration of the merits of pareidolic interpretation of rock art motifs by alien commentators lacking the cognition of the 'rock artist' (Helvenston 2013). Palaeontological support has also been proposed for a series of pareidolic claims concerning extinct megafauna in Arnhem Land (Murray and Chaloupka 1984), all of which have been refuted (Lewis 1986; Bednarik 2013).

Reinforcing interpretations of zoomorphs with the opinions of palaeontologists is of course not a practice limited to Australia (see e.g. Whitley 2009: 102), nor are claims of the depictions of extinct fauna. Indeed, many of those from the United States, for instance, are even more bizarre. There we have not only unsustainable assertions about Pleistocene species depictions in rock art; we even have several purported images of dinosaurs and pterosaurs, i.e. creatures of the Mesozoic era (Bednarik 2015). The perhaps most spectacular of them, which illustrates the operation of pareidolia particularly well, is the misidentification of five separate biomorphs as a pterosaur painting in Black Dragon Canyon, Utah (Barnes and Pendleton 1979: 201). Warner and Warner (1995) have analysed the assemblage and determined that two anthropomorphs and three zoomorphs had been combined as one hypothetical motif. This has been confirmed by Senter (2012). Although these interpretations garner no support from mainstream scholars, they are of relevance because just like Pleistocene proposals, they are based entirely on pareidolic interpretations, leading in both cases to the derivative hypothesis that humans must have seen these extinct animals to be able to depict them. The latter deduction is incorrect, however: humans have depicted numerous biomorphs in rock art that they could not have seen in real life. Some examples are the wonderfully accurate three reconstructions of an ornithopod in Mokhali Cave, Lesotho (Ellenberger et al. 2005; Bednarik 2015: 5), made without the artist having seen this animal. There is no reason why a rock artist/ethnoscientist could not have depicted an extinct creature after seeing its remains frozen in ice, or even from fossilised remains in the same way modern artists reconstruct them in the service of palaeontology. Another example is provided by the numerous zoomorphs we find in rock art that we define as 'fantastical' creatures because our pareidolia fails to produce a 'reasonable interpretation' (Fig. 9). Then there are the thousands of mythological creatures depicted in rock art, which many rock art interpreters have been misled by. Or does anyone believe that therianthropes actually existed in the past, because they are depicted in rock art and portable palaeoart? Clearly the simplistic notion that all rock art depictions are necessarily reflections of reality, e.g. in the form of contemporary fauna, is severely mistaken.

Figure 9. *Palaeolithic zoomorph resisting 'identification', executed over much earlier finger flutings, in Baume Latrone, France. Three different 'identifications' have been proposed for this image (see Bednarik 1986b) (photo 1981).*

Small mimetoliths

A common phenomenon attributable to pareidolia is the perception of objects, especially faces, humans and animals in natural or naturally fractured stones. These rocks can range from pebble sized to cliff or mountain sized; small specimens were collected from alluvial deposits, others may have been fractured by one of several taphonomic processes. The overwhelming majority of the claims in this category of 'figure stones' are that the objects date from Lower or Middle Palaeolithic periods (e.g. Matthes 1969; Benekendorff 2012). In north-western Europe, especially in regions where flint deposits are plentiful, hundreds of people are engaged in collecting figure stones, in northern France, Netherlands, England and northern Germany. Many of them are connected through an international network and they produce a newsletter. However, the phenomenon is not limited to specific parts of Europe; it has also been noted on many occasions in the United States, and in a few cases in Australia and other world regions.

Having met several of these aficionados and examined their painstakingly assembled collections, the author has observed that some of them possess quite good archaeological knowledge and that the majority are receptive to rational argument. However, the author has never been shown such a mimetolith that presents convincing evidence of having been modified by human hand to emphasise a specific shape. Where specimens have been modified, such traces are quite consistent with natural processes, such as kinetic percussion and pressure flaking through glacial or fluvial transport, solifluction, cryoturbation or impact through gravity. Moreover, the majority of these finds have no archaeological context, i.e. they are not from occupation sites or deposits; most are random surface finds or occur in gravel pits. They are generally not of exotic materials, i.e. of minerals that must have been transported to their find sites by humans. And most show very little in the way of iconographic resemblance, although it must be emphasised that susceptibility to pareidolia does differ greatly among individuals.

The issue is further complicated by the subject of pareidolia among hominins. The neural basis of the condition implies strongly that it was experienced by all hominins, and this is confirmed by empirical information. Several finds have been reported of manuports or modified natural stone objects that appear to have attracted the attention of Lower Palaeolithic humans. The oldest of them, the Makapansgat jaspilite cobble, is a manuport carried over a great distance into a dolomite cave because of its outstanding visual characteristics — its bright red colour, smooth roundness, but most of all the face-like markings symmetrically placed on it that give it a particular

***Figure 10.** The Makapansgat jaspilite cobble from South Africa, earliest known evidence of hominin pareidolia (photo 1997).*

resemblance to a head (Bednarik 1998) (Fig. 10). Detecting facial features in non-faces is probably the strongest disposition in pareidolia, prompting pareidoles (those susceptible to strong pareidolia) to detect faces even in building facades, sectioned vegetables, tree bark or burnt toasts, and in several mountains on Mars. Magnetoencephalography has found that objects resembling faces evoke a 165 ms activation in the ventral fusiform gyrus, which actual faces do slightly earlier (i.e. after 130 ms), whereas other common objects fail to evoke such an activation altogether (Hadjikhani et al. 2009). This suggests that face perception of face-like objects is not a later cognitive reinterpretation phenomenon of ambiguous stimuli. Contrary to at least one suggestion (Bahn 1997), the Makapansgat manuport is a completely natural product, bearing no artificial modification (Bednarik 1998). Found in an australopithecine-bearing sediment it was placed in the cave between 2.4 and 2.9 million years ago (McFadden et al. 1979; McFadden 1980: Fig. 2).

More recent manuports of the Lower Palaeolithic that are thought to have attracted hominin pareidolic attention include the Middle Acheulian Tan-Tan proto-figurine from Morocco (Bednarik 2003), the Late Acheulian proto-figurine from Berekhat Ram in Israel (Goren-Inbar 1986) and the Erfoud Site A-84-2 fossil cuttlefish cast from Morocco (Bednarik 2002). The two proto-figurines have both been modified to emphasise their resemblance of human figures, and the Tan-Tan specimen has been coated with haematite. The Erfoud example closely resembles a human penis and has been carried for a great distance, before having been deposited among Late Acheulian artefacts within a windbreak formed by stones.

Therefore the belief of the collectors of thousands of 'figure stones', that such recognition of iconic properties in natural products was possible for people of the Lower Palaeolithic, is indeed justified. However, the great majority of their collected stones were not found in demonstrated occupation sites; therefore no reason exists to assume that they attracted hominin attention. The main justification for these 'figure stones' being artefacts is that they triggered a pareidolic reaction in their finders. But a certain percentage of all river cobbles or naturally broken pieces of flint should be expected to do so, in people who have high susceptibility to pareidolia. Even if the finds came from an occupation deposit, at least one of two further requirements must be met: they must either present forensic evidence of human work traces, or they have to be of a material that cannot occur at the site by purely natural transport. Thousands of mimetoliths examined fail to meet these requirements. Of all the people involved in their study, only Richard Wilson (*http://www.palaeoart.com/*) and Alan Day have endeavoured to introduce scientific reasoning and presentation into the issue.

Over the past 30 years the author has received many dozens of submissions concerning rocks believed to possess iconic properties, in the form of thousands of photographs and sometimes as actual specimens. One Australian pareidole sent us 65 kg of alluvial cobbles and pebbles that were entirely unmodified and included no stones in which the author could recognise whatever they were thought to resemble. Another reported that she found images within small pebbles when she broke them apart, and she proposed that these representations had been placed deliberately by Aborigines. Unable to appreciate what she meant, we invited her to send two or three specimens, eliciting a carton containing many dozens of fractured pebbles. The author saw no images on their fracture surfaces. On another occasion he examined Cedar-by-the-Sea, a petroglyph site on Vancouver Island, on Canada's west coast (Hill and Hill 1974: 99). The owner tried very hard to convince him that, in addition to the site's several excellent petroglyphs, there is also very intricate decoration on the intervening rock surface. Unable to see what she meant it took some time to realise that she perceived the general, sub-millimetre-scale fretwork of patina patterns on the rock pavement as having been created by humans. Our explanation of the phenomenon as natural mineral accretions and their modifications was met with incredulity.

There is an infamous precedent for these examples of pareidolia. The Japanese researcher Chonosuke Okamura discovered thousands of tiny fossils in polished black Silurian limestone from Mount Nagaiwa in Iwate Prefecture in the late 1970s and early 1980s. In a series of reports he published an entire micro-world including plants, fish, reptiles amphibians, birds and mammals, demonstrating that these organisms, all of them between 1 mm and 5 mm in size, existed 425 million years ago in Japan (Okamura 1980, 1983). For instance he noted that humans were then only 3.5 mm tall, but had otherwise been much the same as they are now (Berenbaum 2009). According to his finds, vertebrate life began with today's genera in the Silurian, and he named numerous species, such as *Gorilla gorilla minilorientalis*, *Canis familiaris minilorientalis*, *Homo sapiens minilorientales*, *Pteradactylus spectabilis minilorientalis*, *Brontosaurus excelus minilorientalus* and *Archaeoanas japonica* (a duck) (Spamer 1999). In one example Okamura recognised the severed head of a mini-human in the alimentary canal of a mini-dinosaur. All of the observations he made are attributable to pareidolia; what he observed in the polished limestone slabs were fossilised foraminifera and coral fragments (Fig. 11). In 1996 he was awarded the Ig Nobel Prize in biodiversity (which is a parody of the Nobel Prize and is awarded to outstanding blunders in science).

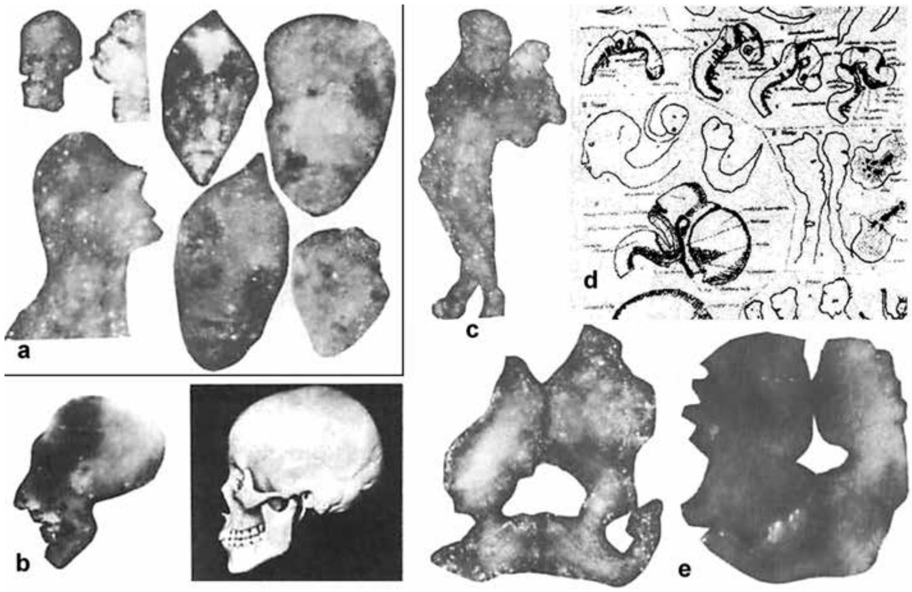

Figure 11. *Some of Okamura's thousands of pareidolic 'identifications' of his Silurian 'mini-world': (a) seven human faces; (b) a 'human mini-head' he compared with a modern skull; (c) 3.5 mm tall 'human mini-person with baby'; (d) some of the 'biomorphs' Okamura observed; (e) two 'fossilised kissing human couples' of 425 million years ago. Note similarity to Rorschach blots.*

Discussion

The question arising from this is whether there is a qualitative difference between the discoveries of Okamura and the pareidolic interpretation of rock art. In both cases there are undeniably markings on the rock surface, and in both cases their discrimination by the visual system is divined through pareidolia: through the imposition of imagery stored in the visual cortex over the signals the lateral geniculate nucleus of the thalamus receives from optic nerve. In Okamura's case, the shapes of tiny fossil casts were detected by the retina and translated into electrochemical signals, and his thalamus sought to identify them from the internal model's previous experiences. His occipital lobe flooded his lateral geniculate complex with strong signals of human and animal images. Once his brain had recognised the biomorphs Okamura exercised little sentient control over the process. In the case of rock art, there are in reality no figures of objects on the rock; there are patches of paint residue or other pigment, or there are anthropogenically produced depressions made by abrasion or impact (not to mention natural features pareidolically seen as rock art; Bednarik 1994). In both cases, Okamura's visions or rock art 'interpretation', the arrangements examined are not random, but adhere to certain morphological rules. Okamura's shapes are determined by the small marine-organisms they represent; the rock art follows *unknown* rules of creating motifs, but again there is limited sentient control over the decision of what appears to be depicted.

Therefore the difference between the two processes of visual 'identifications' is not very great: Okamura's pareidolic explanations can be disproved by an understanding of the nature of the fossils and are therefore scientific. By contrast, the 'interpretations' of rock art decipherers cannot be falsified. They are free-standing 'just-so' claims and are therefore not scientific; to be scientific a proposition has to be testable. In short, Okamura's fantasies were scientific but false; rock art interpretations may be correct but are unscientific. Within particular reference frames, both Okamura's determinations and those of rock art interpreters are quite correct; however, both reference frames can be assumed to be false, the latter because it refers to the visual system of modern, usually Westernised and literate humans. Clearly, *the experiences stored in their internalised models must be dramatically different from those of early humans*, if only for the reasons Helvenston (2013) provides. And, contrary to popular belief, it is these internal models that determine largely what we see.

This is likely to sound unreasonable to those accustomed to interpreting rock art. Wanting to identify its meaning is a common but not necessarily universal human reaction to seeing rock art. However, unless archaeologists or other etic explainers of rock art can demonstrate why they have some special cognitive endowment that enables them to divine the meaning of rock art better than, say, tourists or children, their claims lack justification. For instance the stored ontogenic 'internal model' of the brain, which largely determines what we see, can be assumed to be much richer in previous experiences in a cognitive sophisticate than it is in an infant, hence it could be argued that the latter is in a better position to guess the correct meaning of a motif.

Be that as it may, this topic needs to be approached by first acknowledging that no human has ever seen an event at the moment it occurred, because it takes about half a second for the brain to form an image of it (Eagleman 2015). So we always 'see' the past, not the present. That is precisely the reason for pareidolia being necessary. Most people have never given any thought to how their visual system can scan the environment at will but still stitch the 'footage' together so effortlessly, when in fact what we should see ought to be a sequence of very jerky, almost unrecognisable 'footage' (because of the rapid movements in the direction of our gaze). Similarly, our visual system manages to suppress the fact that we see in the past, by stitching together images from the internal model with most recent sensory input, but presenting us with a flawless imagery entirely created by the brain (Eagleman 2015). Few people realise that colour as such does not exist; it manifests simply a way our brain interprets differences in the wavelengths of reflected electromagnetic waves (Bednarik 1985). Even fewer people know that the world we experience does not exist in the form we see it; it is just the 'imagined world made real' (Plotkin 2002). Many have significant difficulties appreciating this point, which some humans have understood since Plato's simile of the cave. These are matters we need to delve into if we seek to understand how we experience, among other things, rock art. Most especially, we need to appreciate that we have no idea how the brain forms a construct of the external world, how it creates the illusion of consciousness (Bednarik 2016a). This is not a strong position to argue from, but a good reason to be sceptical of finite claims about what we see, and to exercise scholarly humility.

In seeking to comprehend pareidolia it needs to be appreciated that in this instance natural selection has favoured strategies that make incorrect causal associations, outside of sentient control. While these were no doubt useful adaptations in human pre-History and still remain so in navigating our way in the material world, that does not necessarily make them expedient in determining the meaning of rock markings created by humans about whose mental and cognitive world nothing can be known — unless such ethnographic information is accessible. A rock art motif has both emic and etic meanings, the latter deriving from pareidolia; a Rorschach inkblot, by contrast, is also a surface marking that needs to be decoded and by the same processes, but it has no inherent meaning and any meaning imposed on it is the result purely of pareidolia. So the etic interpretation of a rock art motif is not so much different from the determination of a Rorschach figure.

Ultimately the meaning of a rock art motif is divined by our visual system by first deciding whether it is aniconic or iconic. If elements of the figure or its overall form convey the impression of being depictive we consider it iconic; note that other motifs, those we experience as aniconic, may have been iconic for the people who created them. So already at this first level we impose our false framework on the evidence. The decoding of the motif is initially by disambiguation (Davis 1986) of marks and textures on a rock surface. We know that there are problems also at this stage, e.g. from the thousands of documented mistaken identifications of natural rock markings as rock art (Bednarik 1994). The 'production of iconographic forms is simply the cultural and intentional creation of features prompting visual responses to a signifier; it induces visual ambiguity intentionally' (Bednarik 2003). Such features may be colour patches, grooves on rock, or three-dimensional objects. The visual system is 'deceived' into perceiving an object where none exists, through exploiting the visual ambiguity of marks, textures and shapes. This is the basis of all iconographic art: its elements are arranged and rendered in such a way that visual disambiguation experiences them as resembling objects, via pareidolia. Once a beholder has perceived that an arrangement of paint residues or grooves on rock is intended to depict an object, he or she scans the arrangement for confirmation that one of the options the visual cortex presents matches it in adequate detail to pursue the correspondence further. In this murky process any disconfirming visual aspects tend to be disregarded or explained away as not deliberate or as badly executed, as being attributable to awkward materials or deficient skills, or to stylisation, conventionalisation or schematisation. In other words, it is at this stage of the process that science, demanding the full consideration of disconfirming evidence, is discarded in favour of confirmation and autosuggestion. The beholder has latched onto a potential interpretation and now rationalises accordingly. The next crucial error in the process of pareidolic determination is to scan the detected image for diagnostic details: those elements that were 'deliberately' rendered 'naturalistic'. With this endeavour of determining *intention*, without any credible reasoning, any pretension of a scientific process is abandoned. All of this takes place in a matter of a few seconds.

This description of the process of rock art 'interpretation' clarifies that it is attributable to rock art interpreters being unaware of the qualifications that apply to the 'reliability' of the human visual system as well as other cognitive functions. These limitations to its reliability are profound, and the Xiaojinggou experience has been described in some detail here because it illustrates so well that our opinions of what we see are just as unreliable as those of our memory (Loftus 2005; Morris et al. 2006; Laney and Loftus 2008). The phenomenon of 'misinformation false memories' (Zhu et al. 2013) has been investigated in some detail and such findings about the malleability of brain functions are highly relevant to explaining the phenomenon described from Xiaojinggou. Just as false memories are easily implanted in people (Wade et al. 2002; McNally et al. 2004; Geraerts et al. 2007, 2008), false visual information can be subtly transferred to a receptive subject. The underlying common factor is the false belief of human beings that the world is as they experience it, when neuropsychology, neuroscience, cognitive science and epistemology make it perfectly clear that this is unlikely to be the case, because no *direct* link exists between the internalised model of reality in our brain, and the real world that is supposedly out there. Finally, we can only function as human beings in the context of our societies here and now; we have no way of understanding the conceptual world of people thousands of years ago — all of archaeology notwithstanding.

Acknowledgments

The author thanks Professors Tang Huisheng, Giriraj Kumar, Zhou Yushu and Wu Jiacai for their facilitation of an important part of this study. He is also most grateful for the critical comments by the *RAR* referees Dr R. G. (ben) Gunn, Dr Derek Hodgson, Professor Giriraj Kumar, Professor Paul S. C. Taçon, Professor Tang Huisheng and Dr Ben Watson.

Robert G. Bednarik
International Federation of Rock Art Organisations
P.O. Box 216
Caulfield South, VIC 3163
Australia
auraweb@hotmail.com

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RAR 33-1206