Late Palaeozoic Wrangellian palaeomagnetic directions north or south seeking?

In a recent *Nature* article Panuska and Stone[1] report that they have resolved the polarity ambiguity in the late Palaeozoic palaeomagnetic data for Wrangellia. They have measured magnetic directions from the Lower Permian Hasen Creek Formation and the Lower Permian–Pennsylvanian Station Creek Formation which they conclude would place Wrangellia north of the Equator in the late Palaeozoic. They reason that since the Earth's field was predominately reversed at this time, any directions measured from these rocks would point to the reversed polarity geomagnetic pole, that is, the geographic south pole. However, their interpretation may be at odds with their data. Most palaeomagnetic studies report palaeomagnetic data just as it was measured from the rocks. If the southwest and down directions (Table 1 in ref. 1) are what was measured in the late Palaeozoic Wrangellia rocks, then these reversed directions would suggest that Wrangellia was south of the Equator and not north of the Equator, as Panuska and Stone[1] conclude. Two statements in Panuska and Stone's[1] article suggest that the southwest and down directions reported in Table 1 are not those that were actually measured. Both occur on page 562. "Thus taking into account the reversed geomagnetic polarity, the VGPs corresponding to the mean vectors plotted in Fig. 2 represent an estimate of the location of the north geographical pole for that time."[1] and "The polarity of the tabulated data represent the equivalent of today's Northern Hemisphere pole."[1] Although these statements may imply that the data have been changed to correspond to the authors' polarity interpretation, nowhere do the authors clearly state what directions were actually measured.

The reason for this comment is to point out that it is misleading and confusing if the data are not reported exactly as measured. Interpretations should be made only after the reader has access to the raw data. In this particular case it is important to know if the southwest and down directions were actually measured in the rocks, in which case Panuska and Stone's[1] interpretation is incorrect, or if the opposite polarity were measured.

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Panuska and Stone reply—We welcome the opportunity to clear up the misunderstanding of data that we reported in our 1981 paper. The directions of the north-seeking magnetic vectors that we measured in the Skolai Creek rocks are actually northeasterly and negative (up). Since only summary data (that is, mean directions) were reported in our Table 1, and not the raw data, we inverted the mean directions in the interest of saving space by avoiding the use of separate tables for measured directions and inferred directions and "avoiding confusion" by reporting the probable polarity. The two statements cited by Kodama were intended to indicate that the measured directions were inverted for this paper because of the predominant reversed geomagnetic polarity during deposition of the Skolai Creek rocks. We have apparently failed in our attempt to avoid confusion and we thank Dr Kodama for bringing this to our attention.

To summarize, we measured northeast and negative (up) magnetic directions in the Skolai Creek rocks. These directions were inverted to the southwest and positive (down) directions reported in Table 1 because of the reversed geomagnetic polarity during the Permo-Carboniferous. Thus, we stand by our original interpretation of a Northern Hemisphere location for Wrangellia in late Palaeozoic time.

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Noise and recognizability of coarse quantized images

We are pleased that Morrone *et al.*[1] found it still worthwhile a decade later to elaborate on an experiment by Harmon and Julesz[2], even though they disagree with our conclusions. We comment only because: (1) from Morrone *et al.* the reader might assume that Harmon and Julesz had critical-band masking as their only explanation[2]; (2) they failed, so far, to disprove critical-band masking; and (3) their demonstration does not seem convincing. We comment now in detail along those lines.

(1) Harmon and Julesz[2] offered two possible explanations for the inability to see Abraham Lincoln's face in the block-quantized image. One was discussed by us at length, but not quoted by Morrone *et al.*[1], although they give a similar explanation. We assumed that the visual system was very sensitive to line contours at the boundaries of the quantized blocks and that these contours masked the low-spatial-frequency image. Our alternative explanation was critical-band masking, since we showed that the removal of an annulus-shaped spectrum from the Fourier spectrum of the block-quantized image restored the visibility of Lincoln's face. (This annulus had an inner radius f_0 and outer radius $2f_0$, where f_0 is the highest frequency in the Lincoln image.) Thus the quantization noise of the middle-frequency annulus next to the image spectrum was adequate to mask the image. This restoration of recognition was the more remarkable since some of the line contours around the quantized blocks were still visible. We also demonstrated that by filtering out the high frequencies outside the disk with $2f_0$ radius, the image of Lincoln remained hidden. This filtering removed the sharp contours at the boundaries of the quantized blocks, yet the face remained masked. It was these findings that persuaded us to consider critical band masking as an alternative to the trivial first explanation.

(2) Critical-band masking occurs for one-dimensional gratings and noise as shown by Stromeyer and Julesz[3]. This was recently reconfirmed by Wilson *et al.*[4]. In another study, Phillips and Wilson[5] showed that for 2.5–6 cycles per deg test and masking gratings, the orientational tuning curves (half-amplitude band-widths) are as shallow as 25 arc deg. While Morrone *et al.* did not specify the viewing distances in their experiment, one can assume that much of their 'windmill' noise falls in the above mentioned spatial-frequency range. It is not surprising that the windmill noise only 22.5° away from the axes of the two-dimensional Fourier domain will mask the masking noise; this is where the quantization-noise spectra are concentrated. Such a masking of the masker (disinhibition) was reported by Stromeyer and Julesz[3].

According to our comment, we would like to see a demonstration by Morrone *et al.* with windmill noise restricted to the diagonals (say, between 40 and 50 arc deg.). Only if this noise were to unmask the original image would we regard the idea of critical-band masking as being challenged. Even then many questions would still be left unsettled. For instance, we used concentric filters with circular symmetry that yielded the same 1-octave-wide critical band for two-dimensional stimuli that were found by Blakemore and Campbell[6] for one-dimensional stimuli. Whether asymmetric filtering can be used without causing some nonlinear effects remains to be seen. The finding by Daugman[7] and Phillips and Wilson[5] that two-dimensional spatial frequency channels are inseparable in their polar coordinates should caution us.

(3) In Fig. 1*d* of Morrone *et al.*[1], the Mona Lisa is so poorly perceived that it resembles our Fig. 3*a* in ref. 2, which we called a masked image. We wonder how Morrone *et al.* can regard the image in their Fig. 1*d* "of higher quality than the lowpass filtered version". Since they did not use some objective method to compare the visibility of the *same* images masked by their windmill with our annulus-shaped spectral noise, any inference to critical-band masking appears superficial.

Finally, consider the more general problem that Morrone *et al.* indirectly questioned: the validity of spatial-frequency channels in vision. If critical band masking does not take place in two-dimensional vision, then spatial-frequency-tuned channels have a limited role. That in preattentive vision only local line contours can be detected, and global periodicities are unnoticed, led one of us to a texton theory of texture discrimination and effortless perception[8–10]. However, in attentive vision such as looking for a recognizable face, global processes (including the detection of periodicities) must be important. Whether the detection of these periodicities is undertaken by early analysers (which can be fatigued or masked) or is the result of higher cognitive processes (for which critical-band masking is not expected) remains to be seen.

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MORRONE *ET AL.* REPLY—For us the most intriguing aspect of Harmon and Julesz's[1] ingenious demonstration is that blocking does not merely degrade the image, but renders recognition impossible. Normal masking (such as their Fig. 3*a*[1] or indeed our Fig. 1*d*[2]) degrades the image but leaves it still recognizable.

Measurements in our laboratory show that masking with one-dimensional noise at 22.5° reduces threshold of high spatial frequency gratings by a factor of only 2, compared with a factor of more than 30 for parallel noise[3]. In any event, even if the noise did encroach into the critical band of the spurious high frequencies it would add much more energy than it could have removed by masking.

Finally, both we[2] and Piotrowski and Campbell[4] have demonstrated that recognizability is restored by phase scrambling of the spurious high frequencies, without interfering with their amplitudes, either physically or by masking. This is interesting, as classical masking and summation are phase independent (ref. 5 and M.C.M., D.C.B. and J.R., unpublished).

We do not challenge the notion of critical-band masking. We recognize the importance which it clearly has in visual processes, but we point out that it is not a sufficient explanation here. There is a substantial body of evidence, both from single cell recordings in cat and of evoked potentials in man, for nonlinear inhibitory processes. These processes presumably have some role in visual analysis, which we attempted to elucidate.

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Identification of γ-ray lines observed from SS433

RECENTLY, Lamb *et al.*[1] reported preliminary evidence for γ-ray line emission from the region of SS433. These authors suggested that observed γ-ray line features at 1.2 and 1.5 MeV may be the red- and blue-shifted components of the 1.369-MeV line from the first excited state to ground-state transition in ^{24}Mg. Here we point out some serious difficulties with this interpretation of the observed γ-ray lines.

In their model, Lamb *et al.*[1] propose that fast-moving ^{24}Mg nuclei ($v \approx 0.26c$, that is, 33 MeV per nucleon) undergo inelastic collisions with ambient protons to produce the 1.369-MeV γ ray. The apparent absence of similar inelastic γ-ray lines from normally more abundant isotopes such as ^{12}C and ^{16}O is interpreted as evidence for the absence of these nuclei in SS433. Although such an elemental distribution would be very different from that observed in the Solar System, such a possibility cannot be ruled out on this basis alone. However, there are ways to test this hypothesis.

γ-Ray production cross-sections have been measured by Dyer *et al.*[2] for proton-induced reactions on C, N, O, Ne, Mg, Si and Fe from threshold to $E_p = 23$ MeV. For proton bombardments of ^{24}Mg at $E_p = 23$ MeV, in addition to the 1.369-MeV line, there is a strong doublet near 1.64 MeV from the 1.634-MeV ^{20}Ne line produced via the ^{24}Mg(p, pα)^{20}Ne reaction and the 1.636-MeV ^{23}Na line produced via the ^{24}Mg(p, 2p)^{23}Na reaction. At this bombarding energy, the ratio of the cross-sections for the 1.64-MeV line and the 1.369-MeV line is 0.85. Zobel *et al.*[3] report a ratio of ~ 0.9 at $E_p = 30$ MeV. Thus, if the 1.2- and 1.5-MeV features observed by Lamb *et al.*[1] were due to inelastic scattering of ^{24}Mg on protons, one would expect to observe lines of nearly the same intensity at ~ 1.4 and 1.8 MeV.

The apparent absence of any significant γ-ray lines other than those at 1.2 and 1.5 MeV thus argues strongly against the proposed model of Lamb *et al.*[1]. It is also interesting to note that the presence of ^{24}Mg lines and the absence of other lines not only would make Mg overabundant compared with carbon and oxygen, but would suggest that it is overabundant compared with heavier elements, particularly Fe, in view of the large cross-sections found at $E_p = 23$ MeV for the production of γ rays from Fe at 0.847, 0.931 and 1.317 MeV[2]. Thus, it seems that an alternative explanation must be sought for the intriguing observations made by Lamb *et al.*[1].

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