Ambiguities in stereopsis

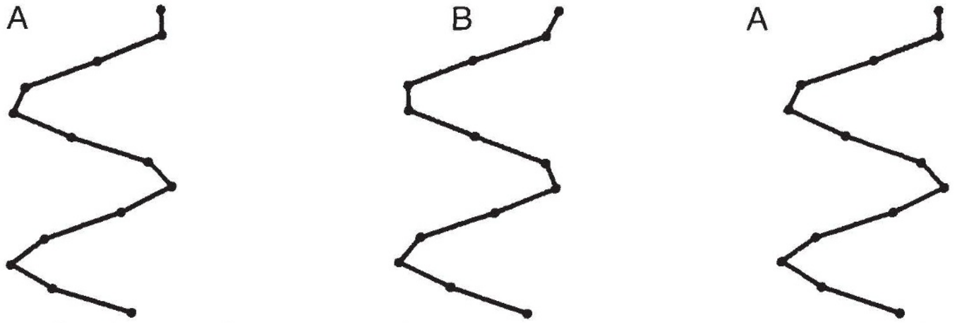
SIR—Stereo-pairs, usually of molecules, are regularly printed in many journals and add a useful third dimension to the traditionally two-dimensional printed page. I wonder, however, how many readers actually see stereo-pairs in three dimensions with correct orientation. An informal poll of my associates reveals that almost no one keeps a stereoscope handy; only about half knew that stereo-pairs could be viewed in three dimensions with the naked eye (direct stereopsis); about a quarter can use direct stereopsis; and only one person knows that a stereo-pair is ambiguous; it does not distinguish between right-handed and left-handed three-dimensional structures.

The ambiguity arises because a stereo-pair can be viewed by two methods[1]. Conventional stereoscopes use the uncrossed visual axes method — lenses, prisms or mirrors cause the right and left eyes to view the right and left members of the pair, respectively. But stereoscopes that use the crossed visual axes method can also be constructed. In these, the right eye views the left member of the pair, and *vice versa*. The depth dimension reverses with a change in viewing method, and the same stereo-pair that gives a right-handed three-dimensional image with one method gives a left-handed image with the other. In effect, the right and left members of the pair are exchanged in position.

Either method can also be used in direct stereopsis[2,3], but the crossed axes method seems easier to learn[2,4]. Therefore, most people who use direct stereopsis will see a reversed image of a printed stereo-pair because the images are usually arranged for conventional stereoscopes, which use the uncrossed visual axes method.

A stereo-triplet (suggested by Bruce Nicklas) consisting of equally spaced members A–B–A, illustrates the reversal (see figure). If A on the right is covered, A and B on the left form a stereo-pair. If A on the left is covered, B and A on the right form the same stereo-pair but with the members exchanged in position. For a given viewing method, the two pairs yield three-dimensional images with reversed depth and handedness. Surprisingly, viewing either pair with all members of the triplet uncovered yields two three-dimensional images side by side, reversed in depth and handedness. In general, a row of n members yields $n-1$ three-dimensional images with a two-dimensional image at each end of the row. This pattern occurs because fusion of the retinal images of any pair shifts the retinal images of the entire row out of register by one member on each retina.

Stereo-pairs as illustrations of three-dimensional objects are now easy to produce with microcomputers and three-dimensional drawing programs. Authors should make such illustrations unambiguous by stating whether they are arranged for viewing with crossed or uncrossed visual axes.



A stereo-triplet of a helical structure. Stereopsis of any two adjacent members yields two three-dimensional images with reversed depth and handedness. With crossed visual axes, the image on the right is right-handed, like a conventional screw thread. With uncrossed axes, it is left-handed.

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Earthquake records

SIR—Roger Bilham[1] has made a powerful case for a global approach to the long-term forecasting of earthquakes and, more specifically, for the use of the techniques of space geodesy to detect premonitory ground deformation. Although strain is a fundamental measure of the energy released by earthquakes, it may not always be recognizable at the surface using geodetic techniques. Therefore, we need also to understand the historic and prehistoric record of earthquakes in much greater detail than we do at present.

Long and well-dated earthquake chronologies[2] bring other benefits: they may reveal seismic zones that are temporarily inactive[3] and they are bound to throw light on the mechanisms responsible for the earthquakes[4].

In any case, the geodetic approach requires information on the strain release of a complete earthquake cycle at the site in question. In other words, it will not pay off until the next earthquake. As Bilham observes, that may be decades or centuries in the future: one of the primary tasks of palaeoseismology is to seek out any periodicity (or its lack) in the local occurrence of earthquakes of different sizes.

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Island occupation

SIR—In his recent News and Views article[1] on the initial human occupation of the islands of the south-west Pacific, Diamond asked the rhetorical question of whether Pleistocene colonists had managed to reach "only the largest visible targets, leaving Bismarck outliers to be discovered tens of thousands of years later by Lapita explorers?" The answer, as far as a south-eastward thrust down the islands of the Solomon chain is concerned, is no.

Wickler and Spriggs last year investigated[2] Kilu cave on Buka Island, just north of Bougainville Island in the northern Solomons (see map in ref. 1), and found late Pleistocene occupation deposits spanning the period from 20 to 28 kyr ago. These levels contain evidence for the exploitation of marine gastropods, fish and, judging from residue analysis of starch grains on some stone flakes, vegetable tubers. Being an oceanic island, the land fauna is depauperate but included some endemic murids which became extinct, probably because of human impact. This pattern of exploitation is similar to that shown[3] in the Pleistocene occupation levels at the coastal cave of Matenkupkum, New Ireland, 33 kyr ago.

Buka is 175 km away from New Ireland and cannot be seen from there. Between the two islands are the small Feni and Nissan groups, but a journey from New Ireland to Buka via the Feni group would still involve a sea crossing of at least 145 km; and a crossing using both Feni and Nissan groups would be not less than 70 km. Nissan is a coral atoll, and it is not