Lifting the Taung child

SIR — The Taung child, *Australopithecus africanus*[1], is a key fossil to our understanding of hominid evolution. It is, however, accompanied by an exceptional fossil fauna comprised of mainly relatively small animals. This has led to much analysis and speculation about the possible agent responsible for the accumulation of this fauna[2]. Large carnivores or even the ape-man himself have been proposed as the most likely candidates. Recently, Berger and Clarke[3] suggested that the primary collecting agent of the Taung child and the associated fauna was a large bird of prey. Support for this hypothesis was obtained by comparison of the Taung fauna with that found below nests of large African eagles. The most likely candidate species is the crowned eagle *Stephanoaetus coronatus*[3], which was anecdotally reported to have attacked, and nearly killed, a 7-year-old child of approximately 20 kg. The body mass of the Taung child was probably 10–12 kg (ref. 3).

I used biomechanical information[4,5] about bird load-lifting capacity to test whether a raptor the size of a crowned eagle would be capable of carrying a prey the weight of the Taung hominid. During a short anaerobic sprint exertion, the load-lifting capacity of a crowned eagle is approximately 6.1 kg (ref. 4; assuming a 4.12-kg eagle body mass[6]), well below the body mass of the Taung child. In sustained flapping flight, the fuel load-carrying capacity of an eagle is only about 1.7 kg (ref. 5). However, because fat used as fuel is uniformly distributed around the body, drag is minimized compared with a load of prey held in the talons. Therefore, this represents an upper limit to the sustainable load-carrying capacity. The distance between the hominid savannah habitat and the deposition site was probably substantial[3], and so an eagle could have carried little more than the skull over this distance.

Biomechanics thus show that if a large bird of prey collected the Taung fauna, the Taung child itself must have been dismembered before being brought to the eagle's nest.

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Energetic motion detection

SIR — Motion detection has been widely investigated using random-dot kinematograms (RDKs). Under appropriate conditions, motion may be seen between a random-dot image and its displaced counterpart[1]. Here we attempt to discriminate between the two classes of model that can account for this.

Proponents of energy-based models argue that low-level motion sensors detect motion energy at a range of spatial scales[2]. The directional outputs of the detectors are later combined to indicate the overall direction of movement of an object. Alternatively, edge-based models suggest that the edges in an image are located and then motion is detected at a single scale by forming correspondences between displaced edges[3]. Both models can account for the observation that the maximum displacement for motion detection ($d_{\max}$) increases when a RDK is low-pass filtered. For energy-based models, this is because low-spatial-frequency detectors have larger receptive fields and tolerate larger spatial displacements. For edge-based models the increase is because low-pass filtering increases the separation between edges.

$d_{\max}$ is surprisingly small for white noise, given the presence of low spatial frequencies[1], while the absence of an effect on $d_{\max}$ of initial low-pass filtering is unexpected[4]. Proponents of energy-based models must resort to special pleading to explain these effects (that is, that high spatial frequencies mask low[4]). In edge-based models, direction discrimination is based on the edges in the pattern after initial blurring by the visual system. The low-pass filtering of the stimulus must exceed that of the visual system before there is any noticeable effect. A cornerstone of the argument supporting edge-based models is the recent finding that observers could not see motion between a binary noise image and some of its low-pass-filtered counterparts[5]. In these images, there is little correspondence between the location of the edges in the two frames, so edge-based models predict that motion would not be detected. There is motion energy at common (low) spatial frequencies, however, so energy-based models predict that motion would be seen.

White-noise patterns in RDKs generally contain equal energy at all spatial frequencies. It has been suggested that the spatial characteristics of cortical cells are matched to the spectra of natural images, thus providing an efficient representation of the natural environment[6,7]. Both simple and complex cortical cells have frequency bandwidths that are approximately constant in octaves[8,9]. Thus, white-noise patterns produce activity skewed towards high spatial frequencies because the frequency bandwidth of cortical cells increases with peak frequency; cells tuned to high spatial frequencies respond the most. To provide a more appropriate test, noise patterns were filtered to the 1/*f* magnitude spectrum characteristic of natural images, where magnitude scales inversely with spatial frequency. The response of visual cortex cells to 1/*f* patterns is therefore equal across spatial scales and the neural representation is broad and flat.

We measured $d_{\max}$ using 1/*f* noise patterns which were subsequently low-pass filtered or high-pass filtered (Fig. 1, top row). The observer reported the direction of displacement in each trial. Direction

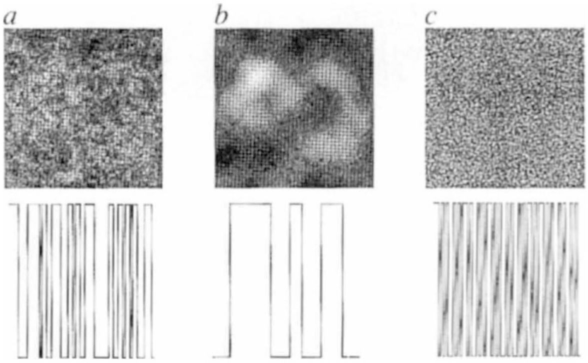

FIG. 1 The top row illustrates stimuli used. *a*, An 8-bit (gaussian) white-noise field, filtered to have a 1/*f* relationship between spatial frequency and amplitude; *b*, low-pass-filtered version of *a*; *c*, high-pass-filtered version of *a*. Contrast has been normalized for illustrative purposes, but in the experiment contrast was not normalized. The second row shows the edges in a one-dimensional section through each noise sample after low-pass filtering to simulate visual blurring. The edges were located at the zero crossings in the second spatial derivative of the blurred luminance profiles[12]. There is little correlation between the edges in each pattern, and any edge-matching algorithm would be unable to identify correct matches for motion detection between filtered and unfiltered 1/*f* patterns. It may be possible to match the peaks between the 1/*f* and the low-pass image, but it would not be possible to match them between the 1/*f* and the high-pass image. Four main conditions were examined: both images were filtered in the same cut-off (low- or high-pass); one image was 1/*f* noise and the other was filtered (low- or high-pass). The order in which the images were presented was examined separately (full experimental details are available on request). Direction discrimination was possible between broad-band 1/*f* noise and filtered 1/*f* noise, despite the absence of correlation between the edges in these images.