expected from sampling only post-glacial basalts. Glacial erosion could also have removed some of the magnetised layer.

Unfortunately, the Ti and Fe concentrations decrease linearly south-westwards, away from Iceland so steeply that there is only a small section of the Reykjanes Ridge deeper than the degassing depth (as defined by reduced S concentrations) but still anomalously high in Ti and Fe. In that small section Ti and Fe are only slightly above the normal levels occurring further south on the Reykjanes Ridge, and any increase in anomaly amplitude in that small section may be within the noise level. The observed increase of amplitude as Iceland is approached from either side seems to be accounted for largely by the changing source depth. We are investigating this.

As degassing should not, in general, affect concentrations of rare earths, trace and minor elements such as Fe and Ti, and as the Reykjanes Ridge is the only geochemically anomalous region for which detailed data exist, we adduced the Reykjanes chemical data[3] in support of our hypothesis, in spite of the absence of high magnetic amplitudes. This absence does not demand a new *ad hoc* hypothesis on our part nor is it an additional latitude as construed by Watkins[9]. In fact, low pressure degassing is a second kind of 'magnetic telechemistry', which reduces J and therefore magnetic amplitudes. It is uncommon because the mid-oceanic spreading axis rarely approaches within 500 m of sea level.

Watkins implies that the differences on magnetic amplitude observed in the Galapagos, Juan de Fuca and Pacific-Antarctic areas[1] are perhaps explained more plausibly by differences in thickness of the magnetised layer, mode of emplacement, oxygen fugacity, degree of quenching, and oxyexsolution. The thickness of the magnetised layer is not measured readily as its meaning in terms of seismically determined crustal structure is still somewhat obscure[11]. In any case, there is no evidence that the crust in the anomalous areas discussed is thicker than elsewhere. We are talking about regional bulges of oceanic crust produced by simple spreading, not about aseismic ridges with thickened crusts. If a thicker layer provides the explanation, deep tow magnetic/seismic profiling would reveal the same apparent magnetisation of minor basement features in both areas. But profiles collected in the Galapagos area show that the high-amplitude region has more intensely magnetised basement irregularities[11], and Fe/Ti basalt also has higher J values in the few dredge samples available[11]. Basement depth is generally continuous across the regional boundary, and both kinds of lavas are exposed to the same physical environment when they erupt. There seems no reason to postulate that the other factors cited by Watkins are necessarily important variables but it is also hard to show that they are not. The advantage our telechemical argument has is that chemical differences have been reported from all hot spots so far studied.

Differences in the mode of emplacement cannot be discounted entirely, especially in the case of the Juan de Fuca Gorda ridges with their different morphologies and different levels of seismicity[12]. If the zone of active igneous activity is broader, anomaly amplitudes fall, and the resolution of short-period reversal events deteriorates[13,14]. It is doubtful, however, whether this mechanism could explain the uniform amplitude difference between the Jaun de Fuca and Gorda ridges. In the Galapagos area, no such deterioration is evident and the width of the 'variable dyke zone' hypothesis seems quite unlikely.

So until a more plausible hypothesis is advanced, we stick with magnetic telechemistry. This does not mean that the two regions (of high and average amplitude respectively) are likely to differ only in their bulk chemistry. Nor does it mean that magnetic amplitudes are necessarily a linear function of Ti and/or Fe. For example, if the rate of increase of magnetisation decreases with increasing iron content, then relatively uniform, high amplitude provinces, within which there is substantial geochemical variation, would result. Should the analysis of rock samples demand such a complex relationship between chemistry and magnetic anomalies—possibly involving additional 'hidden' variables—it would in no way demolish our hypothesis.

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US Naval Oceanographic Office,
Washington, DC, 20373

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The reaction of monkeys to 'fearsome' pictures

THE phenomena a man or animal most needs to know and understand must often be potentially dangerous or discomforting. We report here evidence that monkeys, given the opportunity to look at a picture which excites both interest and fear, choose first to look at it and only later, once their interest has abated, to avoid it.

We have measured the preference for a visual stimulus by allowing the monkeys to choose between looking at the test stimulus and a blank white screen of the same subjective brightness. In earlier experiments[1,2] we found that the response to an informative but affectively neutral stimulus, for example a repetitive loop of cartoon film, was typically an initial strong positive preference which declined within a few hundred seconds to relative indifference. By contrast, the response to an uninformative but unpleasant stimulus, such as a plain field of red light, was a strong and stable aversion. When a stimulus was both informative and unpleasant, for example a black and white film loop projected through a red filter, the monkeys' 'interest' overrode—so long as it lasted—their 'unpleasure'. The purpose of the present study was to find out what would happen with stimuli which now were deliberately chosen to be both informative and 'scaring'.

A television screen was used for displaying the stimuli, which were recorded on video-tape loops so that each action sequence was repeated approximately every 10 s. We made up 15 potentially fear-evoking stimuli, selected partly on the basis of our own hunches and partly on the basis of Hebb's suggestion[3] that 'anomalous' objects give rise to fear in primates. The stimuli included a toy snake, burning paper, a lavatory brush, a mop-head wearing a human mask and

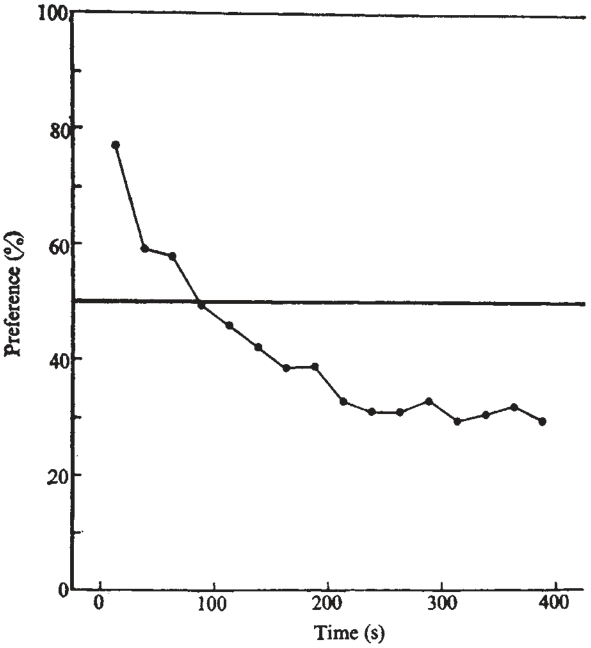

Fig. 1 Preference for 'fearsome' pictures (preference measured as the ratio of the total time spent with the test stimulus to the total time spent with either the test stimulus or the blank white screen).

other objects similarly bizarre. Each object was given some kind of life-like motion.

The method for measuring the monkeys' preferences has been described in detail in earlier papers[1,2]. The monkey sat in a small dark chamber with a television screen (37 cm × 30 cm) at one end, taking up most of the wall. On the screen could be displayed either the test stimulus or a blank white field of the same subjective brightness. The monkey controlled the presentation of the two alternative stimuli by pressing a button: successive presses on the button produced the two stimuli in strict alternation, the stimulus staying on as long as the monkey held the button down. The test was terminated after 400 s exposure (at which point two peanuts were delivered). The monkeys worked eagerly and generally completed the test in under 500 s, alternating rapidly between the two stimuli (on average about 30 alternations per 100 s of exposure).

The subjects were five young male rhesus monkeys (*Macaca mulatta*). All had taken part in previous experiments on preference, in the course of which they had completed several hundred tests and had become thoroughly familiar with the apparatus and with the fact that strange stimuli were likely to be presented to them. They had, however, never before been deliberately exposed to fear-evoking stimuli.

The monkeys were tested with two new stimuli each day over a period of three weeks. It was immediately apparent from the results that it was not so easy to scare the monkeys as we had imagined. In fact in many of the tests there was no sign that the monkeys were anything other than interested in the stimuli. Since our aim was specifically to study the interaction of interest and fear, we needed to select for analysis only those tests in which we could be reasonably sure that the monkeys were indeed afraid. Independent indices of distress (cries, urination and so on) showed that the stimuli which the monkeys found most upsetting were, as might be expected, those to which they showed the greatest overall aversion. We decided therefore to treat any test in which the monkey's preference was predominantly negative as a case of the monkey being scared, and accordingly we defined a stimulus as being 'fearsome' to a particular individual if he chose to look at it for less than 200 s of the 400 s test. By this criterion, 13 of the 15 stimuli turned out to be fearsome to one or more of the monkeys, while the five individual monkeys were scared of eight, seven, seven, three and three of the stimuli, respectively.

Figure 1 shows the typical pattern of preference for 'fearsome' stimuli, as defined above, in each successive 25 s of the test. To obtain this graph we took for each monkey, the mean of his preference for those stimuli which were fearsome to him and then the mean of these means for the five animals. The point to notice is the time course. The characteristic pattern was for aversion to appear only after a short-lived positive preference. This pattern was fully borne out by the data from the individual tests: of the 28 tests in which the stimulus proved fearsome, the preference, taken over each successive 50 s, was positive for the first 50 s in 24 instances and negative for the last 200 s in every instance.

The pattern of preference was very similar, at least in quality, to that obtained with the red film loops in the earlier study[2]. We showed previously that the response to 'red films' could be accurately accounted for by a mathematical model which treats 'interest' and 'pleasure/unpleasure' as two separate factors which interact to determine behavioural preference, subject to a combinatorial rule which gives precedence to 'interest'. Our results suggested that the response to fearsome pictures might likewise be dually determined, and the intriguing possibility arose that we might be able to 'synthesise' the curve of Fig. 1 by using suitably chosen 'compound' stimuli in which we could separately identify components of interest and unpleasure.

To this end we undertook a second experiment in which we presented the monkeys with non-fearsome television pictures to which an unpleasant auditory stimulus ('white noise') was added. The non-fearsome pictures consisted of 10 s video loops of relatively bland material, chosen to be roughly comparable in information content to the fearsome

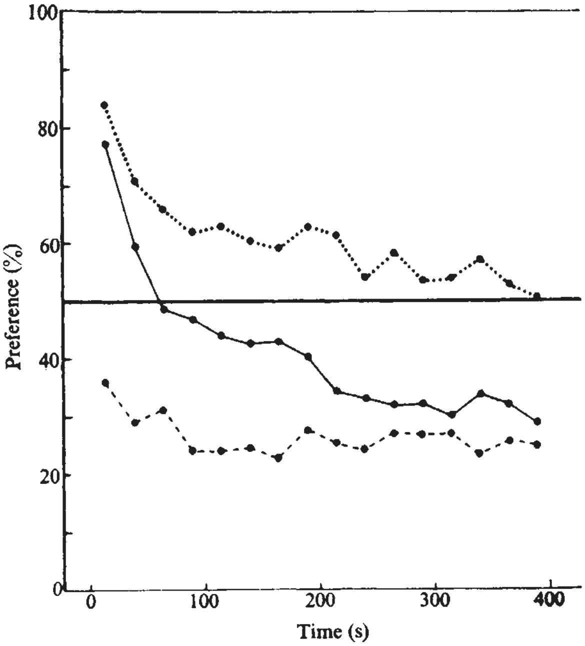

Fig. 2 Preference for, ●····●, 'picture only' (a choice between a non-fearsome, silent, video loop and the blank white screen); ●----●, for 'noise only' (a choice between the blank white screen plus white noise and the blank white screen without the noise); ●——●, for 'picture + noise' (a choice between a non-fearsome video loop plus white noise and the blank white screen without the noise). Monkeys were given 10 tests in each category, taken in rotation. Graphs show the means of the mean preferences of the five animals.

pictures. The white noise was set at an intensity level of 68 db (16 db above the background level of the testing chamber) which preliminary observations indicated would create an appropriate degree of unpleasure.

The monkeys were given three categories of tests: 'picture only', 'noise only' and 'picture plus noise'. As Fig. 2 shows, the response to the pictures only was an initial strong positive preference which declined towards indifference; that to the noise only was a steady aversion (increasing slightly over the first 100 s of the test); that to the pictures plus noise was an initial positive preference which then turned into a marked aversion. In line with the predictions of the mathematical model, the response to pictures plus noise could be almost perfectly fitted by a theoretical curve computed from the separate responses to pictures only and noise only[1].

Comparison of Figs 1 and 2 illustrates the close correspondence between the response to the fearsome pictures and that to the non-fearsome pictures plus noise. It seems fair to say that the 'fearsomeness' of the fearsome pictures had on average the same effect as 68 db of white noise. But we believe there are grounds here for a stronger assertion, namely that at a causal level fearsomeness influences behavioural preference in the same way as noisiness (or redness) through the evocation of a common factor of 'unpleasure', a factor which is strictly subservient to 'interest'.

In functional terms the lesson of these results seems clear: the benefits that come from increased understanding outweigh the immediate rewards of a comfortable life.

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N. K. HUMPHREY
G. R. KEEBLE

University of Cambridge,
Sub-department of Animal Behaviour,
Madingley, Cambridge CB3 8AA, UK

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Behavioural thermoregulation in a wolf spider

LABORATORY studies have shown that wolf spiders (Lycosidae) may prefer temperatures above the ambient air temperature of their normal environment[1,2]. They are commonly active on clear days in winter and may repeatedly move in and out of the sun. In addition, they carry their egg sacs on their spinerettes and apparently incubate them in the sun[3,4]. While the observations suggest that these spiders may exhibit behavioural thermoregulation, it has not been demonstrated.

During a study into the ecological energetics of the large, burrow-inhabiting wolf spider *Geolycosa godeffroyi* (L. Koch 1865) in the Australian Capital Territory[5], continuous temperature records were obtained of both the egg sac temperature and the temperature of the cephalothorax of the spiders.

Egg sac temperature was measured by implanting a temperature transmitter into the egg sac after the removal of about 70% of the eggs. The egg sac was returned to the female in the field and the transmissions monitored during the daylight hours. The resulting magnetic tapes were transcribed at intervals and records obtained from six individuals. The temperature of the spiders was recorded in the field by implanting a fine thermocouple junction into the cephalothorax and recording the temperature with an electric thermometer with an external reference junction at 0° C. The fine thermocouple lead (2.3 mg cm^{-1}) allowed the spider free movement within the burrow and through its normal activity range. The ambient air temperature was recorded from the dry bulb of an aspirated hygrometer placed 1 cm above the ground surface. Temperatures were recorded for 24 h periods from spiders weighing 0.1–1.5 g from February to November 1972.

Figure 1 shows two representative records of the cocoon temperature in summer. Figure 1*b* is the record for an intermittently overcast day showing that the egg sac could achieve a considerable temperature excess[6]. In Fig. 1*a* the spider provided its own control. At A the spider was placed with its 'bugged' cocoon next to its burrow which was partly occluded by debris. The spider began to clear the debris from the burrow but at B dropped the egg sac in full sunlight outside the burrow and continued with its work. The sun was masked by cloud at C and when the spider had cleared the burrow it recovered the egg sac (D) and entered the burrow. Between D and E the sky cleared and the spider began to sun the egg sac at E. The burrow was lightly shaded by trees after 1500h but was bathed in full sunlight at 1800h, just before sunset. The spider maintained a fairly constant egg sac temperature in full sunlight (1200h to 1500h) but the temperature excess potentially reached was considerably greater (A to E in Fig. 1*a*) than that maintained by the behaviour of the spider.

Figure 2 shows three representative records of the cephalothorax temperature of the spiders at different times of the year. Figure 2*b* represents part of the record obtained on a subfemale on March 13, 1972. At 0600h the spider was still benefiting from the thermal lag in the soil temperature profile and by remaining at the bottom of the burrow maintained its temperature 8° C above the ambient air temperature. As the ambient temperature rose in the morning the spider came to the top of the burrow and maintained a temperature close to the ambient temperature until the sun struck the burrow entrance at about 1000h. The body temperature rose rapidly to about 40° C when

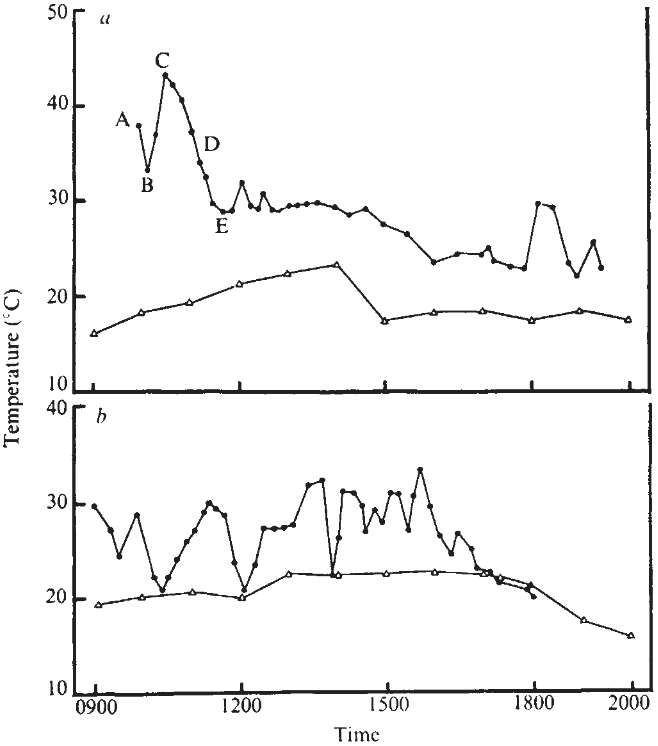

Fig. 1 Egg sac temperatures of *G. godeffroyi* obtained from implanted temperature transmitters (●) and ambient air temperatures (△). The letters A–E are explained in the text.