tion and funding, not promotion based on seniority or political connections; (vii) have generous provision of state-of-the-art equipment and training; (viii) have rapid provision of necessary materials for research; and (x) have free exchange of ideas, so as to attract other researchers to form productive collaborations.

China's achievements in some areas of science in the 1960s were significant. Biomedical research made big strides, improving health for a large segment of the population. All that changed overnight because of oppressive political interference.

Building the foundation of a national science and technology program takes decades, but it can be destroyed in a few months. I sincerely hope that China's leadership will ensure the continued success of science and technology by safeguarding its precious scientific base and allocating sufficient funding where the rhetoric says it will go.

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Free Electrons?

Equation (1) in the Perspective "Biological hydrogen production: Not so elementary" by Michael W. W. Adams and Edward I. Stiefel (*Science*'s Compass, 4 Dec., p. 1842) almost certainly should have read

$$2H^+ + 2e^- \leftrightarrows H_2$$

The journal text was

$$2H^+ + 2 \leftrightarrows H^2$$

There is some humor in this error, as the authors assert that "Electrons are not 'free,' as implied in Eq. 1." Nevertheless, two of them were able to escape their equation. Or is it possible that someone at *Science* has been lifting electrons?

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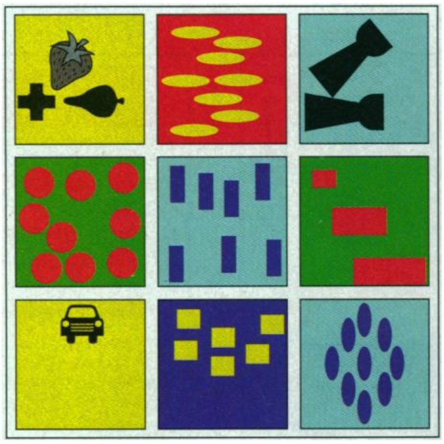
Editors' note

Indeed, the electrons were "lifted" at *Science* during the production process. We regret the error.

Monkey Numeration

E. M. Brannon and H. S. Terrace (Reports, 23 Oct., p. 746) conclude that "rhesus monkeys represent the numerosities 1 to 9 on an ordinal scale." Numerosity is defined as the number of discriminable elements a stimulus contains and is related in the report to the number of visually separate images (for example, that of rectangles, ovals, or bananas) appearing in a single group. A stimulus consisting of a number of groups, each of different numerosity, was shown on a touch-sensitive screen to a monkey, whose task was to touch the groups in order of increasing numerosity.

Although the results elegantly establish that a consistent behavior pattern can be learned and extended to novel stimuli, imputing numerical capability such as ordinal representation may not be justified. Two major unresolved areas arise from the fact, mentioned in the report, that the mental process or processes that a monkey uses remain to be determined. First, it could be argued that these experiments demonstrate solely the monkeys' ability to recognize systematic differences in complexity, which is a more general concept that may be strongly, or weakly, or even inversely related to humanly defined numerosity, depending on the stimuli used. As an example of complexity, one approach to mammalian brain functioning (*1*) posits the generation through the central nervous system of three-dimensional electromagnetic standing wave patterns in the brain by either aural or visual stimuli. For certain stimuli, stimulus numerosity may be related to the resulting pattern complexity in a monotonic increasing manner, leading to experimental results such as those observed. Potentially, such complexity could be defined numerically, but this does not appear possible with our current state of knowledge.



Samples of stimuli used to investigate how rhesus monkeys view numerical representation.

CREDIT: E. BRANNON

Second, a discriminable element for a human may differ from a discriminable element for a monkey. While a strong argument can be made for the physiologically similar visual apparatus of monkey and human, the operative brain mechanism is perception, not quantitively well understood at present. When one considers the many innate difficulties in this type of experimental research, however, Brannon and Terrace should be congratulated for providing a broad and technically sound basis for exploring these and similar questions.

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References and Notes

1. P. L. Stocklin and B. F. Stocklin, *T.-I.-T. (Tower Int. Technomed.) J. Life Sci.* **9**, 29 (1979); measurements establishing the existence of such waves were made in the mid-1980s.

Response

In our report, we reasoned that rhesus monkeys used the numerosity of each stimulus to determine its order in a four- or two-response sequence. We showed that monkeys trained to order the numerosities 1 to 4 could extrapolate that rule and order pairs of the novel numerosities 5 through 9 when tested with trial-unique exemplars in unreinforced trials. We concluded that their ability to order numerosities in which they have no experimental history provides evidence that they represent numerosity on an ordinal scale.

Stocklin states that the rhesus monkeys may in fact recognize systematic differences in complexity rather than numerosity per se. He suggests that some variable other than numerosity might vary in complexity and increase monotonically, allowing an alternative basis for ordering the stimuli.

It is impossible for us to refute this possibility entirely. There are an infinite number of alternative dimensions that would each need to be tested empirically. A particular definition for complexity would need to be embraced, and stimuli that dissociated number and complexity would need to be created and tested. We did, however, conduct a post hoc analysis of our data and did not find any performance difference for stimulus sets that had particularly complex elements in the exemplars of the numerosity 1 as compared with the larger numerosities.

Since our report was published, we have conducted the parallel experiment with human adults using the same task and stimuli. We instructed the human subjects to choose the smaller of two numerosity stimuli and to respond as rapidly as possible while completing most of the trials correctly. The results indicated that, although the human subjects' mean accuracy was considerably higher than that of the monkeys, the accuracy and latency of responding for human subjects varied as a function of the numerical disparity between the two stimuli, just as it did for the monkeys. In fact, the reaction time functions were completely overlapping for humans and monkeys, which suggests that humans and monkeys are using a similar or identical numerical comparison process.

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CORRECTIONS AND CLARIFICATIONS

Figure 1B (p. 544) in the report "Prevention of constitutive TNF receptor 1 signaling by silencer of death domains" by Y. Jiang *et al.* (22 Jan., p. 543) was incorrect. The correct figure appears below.

B