Letters
Anonymous
Science; Mar 19, 1999; 283, 5409; ProQuest
pg. 1849

A group of 73 scientists, 67 of them Nobel laureates, offers support for National Institutes of Health Director Harold Varmus's decision to go forward with stem cell research. "We join with other scientific organizations and patient groups in our belief that [the U.S. Department of Health and Human Services's] current position is both laudable and forward-thinking. It succeeds in protecting the sanctity of human life without impeding biomedical research that could be profoundly important to the understanding and treatment of human disease." **The letter is in reaction to a recent statement signed by 70 members of Congress urging the U.S. government to ban research on stem cells obtained from human embryos. Chinese science and technology are examined. And the question of whether monkeys can count like humans is explored.**

Science Over Politics

Last month, 70 members of the U.S. Congress, including Henry Hyde, Chairman of the House Judiciary Committee, and J. C. Watts Jr., Republican Conference Chairman, signed a letter urging the federal government to ban all research on stem cells obtained from human embryos and fetuses. The letter calls upon the U.S. Department of Health and Human Services (DHHS) to reverse National Institutes of Health (NIH) Director Harold Varmus's decision to allow funding of pluripotent stem cell research. The lawmakers object "in the strongest possible terms" to Varmus's decision, as well as to the memorandum issued in January by DHHS General Counsel Harriet Rabb, which served as the legal basis for Varmus's position. In their letter, the members of Congress state, "Any NIH action to initiate funding of such research would violate both the letter and spirit of the federal law banning federal support for research in which human embryos are harmed or destroyed." Federal laws and regulations, they claim, have protected human embryos and fetuses "from harmful experimentation at the hands of the Federal government" for more than two decades. "This area of law has provided a bulwark against government's misuse and exploitation of human beings in the name of medical progress. It would he a travesty for this Administration to attempt to unravel this accepted ethical standard."

We the undersigned urge the Administration and DHHS to support Varmus's decision to allow federal funds to be used for research using human pluripotent stem cells. NIH fully understands and respects the important ethical and moral issues raised by stem cell research and, indeed, has announced plans "to move forward in a careful and deliberate fashion to develop rigorous guidelines that address the special ethical, legal, and moral issues surrounding this research." Before funding any research using pluripotent stem cells, NIH plans to convene a special oversight-group to review all research grant applications in this area. In addition to two thoughtful sets of guidelines that already exist—the 1994 Report of the Human Embryo Research Panel and the regulations regarding Research on Transplantation of Fetal Tissue (section 498A of the Public Health Services Act)—NIH will consider advice from the National Bioethics Advisory Commission (NBAC), the newly established Council of Public Representatives (COPR), the public, and Congress.

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Human embryonic stem cells differentiated to various cell types, including (clockwise, from upper left) gut, neural, kidney, and striated muscle cells.

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We join with other scientific organizations and patient groups in our belief that DHHS's current position is both laudable and forward-thinking. It succeeds in protecting the sanctity of human life without impeding biomedical research that could be profoundly important to the understanding and treatment of human disease. In addition to helping to unravel processes underlying cell differentiation and biological development (which, in turn, could lead to new ways to prevent and treat birth defects and cancer), the use of human pluripotent stem cells could potentially reduce the number of animal studies and clinical trials required for drug development and testing. The implications of this research for clinical medicine are equally enormous. Stem cells could be used to generate a long list of cells and tissues that could be used for transplantation. Myocardiocytes, for instance, could be injected into the heart, to heal myopathies and scars; neurons could be transplanted into the brains of patients with neurodegenerative disorders such as Parkinson's disease; and insulin-producing beta cells could be used to treat—or perhaps even cure—patients with diabetes. DHHS must remain diligent in allowing pluripotent stem cell research to go forward. If Congress succeeds in reversing Varmus's decision, these tremendous scientific and medical benefits may never become available to the patients who so desperately need them.

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*As of 15 March, joining Advanced Cell Technology.
†Nobel laureate

Editors' note

Stem cell research is one of the areas being pursued by the company Advanced Cell Technology. Another letter supporting stem cell research, led by Paul Berg, representing the American Society for Cell Biology, and signed by 33 Nobel laureates (many of them also signers of the above letter) was sent directly to President Clinton and Congress on 8 March.

Basic Research in China

It is with great pride that I see science and technology in China rapidly moving forward and being one step closer to that in the developed countries (Zhu Lilan, Editorial, 29 Jan., p. 637). The rapid pace of science in China in recent years can be attributed to its outward-looking policy in general. China did, as Zhu, its Minister of Science and Technology points out, contribute greatly to ancient science and technology, but it fell behind in modern times. This may have been largely due to political interference and, sometimes, the lack of understanding by the government. In order to ensure the continued success of science and technology development in China and to move at an accelerating pace, several crucial principles need to be ensured. Scientific researchers and technological innovators must (i) be free of political interference and top-down interference from management; (ii) be free to access information on the Internet; (iii) have no charges for Internet access (especially students); (iv) have easy access to the latest research journals and books (especially young researchers and students); (v) have freedom of selection of research projects; (vi) have a system of merit-based promo-

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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.

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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 ex-

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perimental research, however, Brannon and Terrace should be congratulated for providing a broad and technically sound basis for exploring these and similar questions.

Philip L. Stocklin
439 Blue Jay Lane, Satellite Beach, FL 32937, USA

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.

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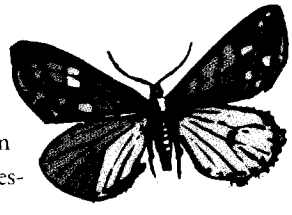

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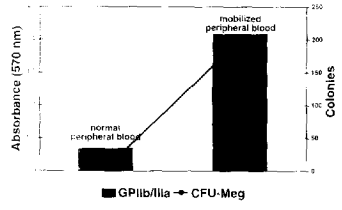

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