Letters

Replication and the Scientific Method

Edward E. Jones, in a footnote to his article "Interpreting interpersonal behavior: The effects of expectancies" (3 Oct., p. 41) tries to explain why the exclusive use of undergraduate college students as subjects in his social psychological experiments should not invalidate his conclusions. His explanation, that "Precise empirical replications are . . . not to be expected, but a conceptual relation that is demonstrated in one context, with one sample of subjects, should be reproducible (with appropriately varied operations) in another context with a different sample," is, at its core, the antithesis of the scientific method. If the report of an experiment performed to test an hypothesis does not describe all the relevant operations, how can another investigator confirm or disconfirm the outcome of the original work? How does one specify the conditions that are necessary for replication of the "conceptual relation"? Does Jones mean that the procedure and methods sections of his research reports are not to be taken literally? When is a replication really a replication?

Probably it is sheer coincidence, but Arthur H. Neufeld's letter ("Reproducing results," p. 11) in the same issue of *Science* as the article by Jones warns us that the "implications of not reproducing experiments are severe." Indeed they are; that's what science is all about.

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Public School Teaching: An Alternative

The Carnegie Forum on Education and the Economy has recently published a report (*1*) on elementary and high school education. Some of the proposals set forth in this report appear quite unrealistic. The argument made in the Carnegie report is that primary and secondary school teachers are grossly underpaid, and therefore, these positions do not attract talented people with adequate interest and background in teaching. This does not appear to be the problem. There are many qualified, talented people who are able to teach and would be happy to teach at current salaries, but who are prevented from teaching in public schools by unrealistic requirements imposed, usually, by state laws. At the elementary school level above the second grade, relatively little background in course content or method is needed. What is needed is the ability to read an elementary textbook and interpret it with imagination and enthusiasm. Mostly one needs the willingness and ability to relate to young people.

At the high school level, only a few college preparatory or advance placement courses such as languages, upper-level science, art, and music require any special knowledge of the field. Even these need only a college graduate who has majored in the subject. Requiring more than a bachelor's degree needlessly increases the already too high cost of teacher training.

In spite of a booming economy, many bright college graduates have difficulty finding their first job. They have no experience to offer, and frequently they want or need a geographical change. Characteristically they have enthusiasm and energy. Many are only a few years removed from jobs as camp counselors or similar jobs where they have had excellent experience in handling children and young adults. Let's make use of them in the educational system, not as underpaid practice teachers, as has been proposed, but as full-time elementary and high school teachers.

The argument about inadequate salaries does not apply to fresh college graduates. Current starting salaries for teachers are in the range of $17,000 to $20,000 a year for a 10-month period and could be higher as school systems are relieved of the high cost of career teachers. This would be a respectable first job salary for most college graduates. These noncareer positions would be offered for 4 or 5 years, with the deliberate intent of rotating personnel to provide starting jobs for the plentiful supply of new graduates.

Other than solving disciplinary problems, which are largely social rather than educational issues, smaller classes would probably be the most effective improvement we could realize in our current system. The lower cost of the noncareer teacher would allow us to have more teachers, smaller classes, and more individual attention.

In each school one or two tenured career teachers could coordinate and help with difficult children and situations where special training and greater experience are a distinct advantage.

One might ask whether bright, able people would take jobs limited to 4 or 5 years. I think they would. The Peace Corps is this type of commitment and it attracts very good people. The permanence of the job is important only after one has invested a subtantial part of one's life in it.

What I am proposing is revolutionary and will draw fire from teachers' unions and other parts of the educational establishment. These institutions have had more than a fair chance to do the job and have failed. Even during the post-Sputnik period, with tremendous pressure and resources being applied to produce better education, the result as judged by colleges and graduate schools has been a progressive decline in college preparation. Change is needed, but it must be change consistent with the society's ability and willingness to pay for it.

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GenBank Status Report

As Roger Lewin reported (Research News, 27 June, p. 1599), GenBank (*1*) has been unable to keep abreast of the rapidly expanding flow of nucleic acid sequences into the literature. In response to continuing inquiries by GenBank users, we should like to offer an updated status report.

The database now contains about three-fourths of the data published in 1985 and one-fourth of that published in 1986. Sequences totaling just over 11 million bases are now entered, of which about 1 million are awaiting full annotation and are available in a new "unannotated" division of the database; we have shifted some effort from annotation to make more of these available rapidly. Data collection is a joint effort of GenBank and the European Molecular Biology Laboratory (EMBL), each group forwarding data collected by it to the other for inclusion in what is effectively a common database.

Although we will continue to improve computational tools for formatting, managing, and checking data and for computer-assisted annotation, investigators are in the best position to provide the annotation. Several thousand investigators have received our request for data and annotation in a standard form that greatly eases entry; responses to these inquiries are given priority for processing into the database. The response rate is below 30 percent, perhaps because we write to authors only after a paper has appeared in print. *The Journal of Biological Chemistry* has taken the initiative and is including our request with acceptance of a sequence paper, with very encouraging results. Data sent at the time of acceptance are available in the database at about the time of publication. We and our colleagues

at EMBL are requesting similar cooperation from other journals that publish sequences, and we earnestly solicit the cooperation of investigators. Since for many purposes sequence data must be accessible to computer processing, we hope that an increasing number of investigators will come to feel that, just as a piece of research is not complete until it has been published, so a sequencing effort is not complete until data are available from the data banks.

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"Toxic Torts"

I appreciated Eliot Marshall's article "Immune system theories on trial" (News & Comment, 19 Dec., p. 1490) since it accurately documented studies supporting the existence of chemically induced immune dysregulation. I must however object to the description of the manner in which I reach my conclusions.

My assessments of immune system damage are based on abnormalities in phenotypic distribution of cells of the immune systems in exposed populations and clinical symptomatology such as recurrent infections, autoimmune diseases, increased incidence of cancers, and organ toxicity in the affected populations. This diagnosis is based on medical history, physical examination, and laboratory analysis. Although literature citations documenting immune system abnormalities associated with such chemicals support these conclusions, clinical manifestations provide the best assessment of immune system function and they are supported by the laboratory data.

My objectives in presenting my data first in the courtroom are to establish a framework within which manufacturers of toxic substances can ensure their safe use as well as to provide an impetus for funding research programs in immunotoxicology. I have placed this in the public record as often as possible. The results of these efforts are gratifying. I have never seen a vehicle of social change work as fast and as effectively as the "toxic tort" arena.

We now have data on clinical symptomatology and immune cell phenotype profiles in several large populations exposed to different immunotoxins. These data support my conclusions. My scientific colleagues should be aware that all of my data on population studies are a matter of public record and are available on request.

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SDI Goals

The negative response to the Strategic Defense Initiative (SDI) in a poll conducted among National Academy of Sciences (NAS) members (News & Comment, 14 Nov., p. 816) was predictable because of how the survey questions were phrased. An effective SDI system need only satisfy two goals: (i) a defense against ballistic missiles aimed at U.S. military assets and (ii) a functional capability that appears credible to a prospective aggressor. The comprehensive Ballistic Missile Defense system envisioned by SDI critics that would "take out more than 99 percent of incoming warheads" is not necessary for the first goal, nor is large-scale empirical testing required for the second goal. In short, the purpose of SDI is not, as the poll stated, to "provide an effective defense of the U.S. civilian population" but instead to preserve a U.S. capability to retaliate in the event of a Soviet nuclear first strike.

The threat of massive U.S. nuclear retaliation has stabilized the world for decades. It is now eroding. The Soviets have installed land-based missiles that can deliver megaton explosions to a target the size of a football field. These missiles are designed to destroy hardened military silos hidden under tons of U.S. earth. This magnitude of explosive power and accuracy presents the nearly 8000 Soviet nuclear missiles as a force for first-strike destruction and not an attack deterrent. The latter goal would have emphasized submarine missiles which, by comparison, are inaccurate but difficult to find (in-flight correction is 7 years off). Since a Soviet first strike can destroy about 95 percent of top-priority U.S. targets, under 12 percent of our 900 Minuteman III missiles would survive to retaliate. Thus only 10 percent of the 4000 top-priority Soviet targets would be at risk from our land-based Mark 12A warheads. As a practical matter, the number is considerably lower due to an extensive Soviet defense system supported by at least 16,000 SAM-2 missiles.

Soviet air defenses are prodigious and no longer penetrable by our B-52 bombers. These numbered 1300 in the early 1960's, but now total under 350. They are older than the pilots who fly them. If we consider how the Strategic Arms Limitation Treaty (SALT) limits the range of Cruise missiles, the sole deterent against a Soviet first strike appears to be U.S. retaliation from nuclear submarines. This means that each new development in submarine detection brings the world closer to nuclear destabilization. Current U.S. nuclear strategy arose from two unthinkable alternatives: mass suicide and surrender. Now SDI offers a third: mass intercept with time to rethink retaliation. More than that, sharing SDI technology would give the Soviets incentive to jointly work toward making a practical umbrella for them as well. The neglect of these and other factors indicates NAS members were polled on a system dissimilar to the one needed to satisfy the goals of SDI.

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Erratum: In the editorial by Philip H. Abelson "The International Geosphere-Biosphere Program" (7 Nov., p. 657), the reference to T. F. Malone's article in *Environment* should have included the month (October 1986).

Erratum: In Table 1 (p. 351) of the report "Structure-activity studies of interleukin-2" by F. E. Cohen *et al.* (17 Oct., p. 349), reference 15 was incorrectly cited for the entries for the 1–29, 30–49, and 100–133 deletion mutants. For all three entries, the reference should have been (*16*).