LETTERS

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Measured success?

Are "valuable research funds" being spent in a "redundant" effort to sequence the genome of the bacterium that causes tuberculosis? How might difficulties in measuring human sexual behavior best be overcome by researchers? Do some types of funding lead to better productivity among graduate students? (And what criteria should be used in seeking to answer this question?) How active should scientists become in "public outreach"? (And how should "scientific contributions" to society be assessed?)

Redundant Genome Sequencing?

I have learned that the U.S. National Institutes of Health (NIH) is to support a program to sequence the genome of *Microbacterium tuberculosis*. While this information is desperately needed to advance studies that could provide essential clues to the pathogenesis and effective treatment of tuberculosis, I am dismayed and disappointed by the decision.

This decision was made with knowledge of an active M. *tuberculosis* genome project in place at the Sanger Centre in Cambridge, United Kingdom. The project has been in place for some time and is now providing up to 40 kilobases of confirmed sequence daily. This information is released immediately into a Website. The United Kingdom group is led by Bart Barrell, who has considerable experience in sequencing; it is expected that the complete M. *tuberculosis* sequence will be available in December 1996.

It appears that valuable research funds are to be spent in a redundant (and apparently competitive) exercise. There is already far too much repetitive effort in bacterial genome sequencing. Because of the interest of pharmaceutical companies in developing new anti-infective targets, at least two (probably three) sequences of the genomes of *Staphylococcus aureus* and *Helicobacter pylori* have been determined privately (they will not be immediately available to the scientific community—a regrettable situation).

As a scientist actively involved in studies of M. *tuberculosis*, I would very much like to know the genomic sequence of this organism, but I don't need two of them! If NIH wishes to make a major contribution to tuberculosis research, I believe that determination of the genome sequence of M. *smegmatis* would be of inestimable value. *Microbacterium smegmatis* is the *only* mycobacterial species for which useful genetic techniques (gene transfer, mapping, gene inactivation, and so forth) have been established; many mutants are available (including temperature sensitives), as well as an ordered cosmid library. There is a great deal of useful information on this microbe. In addition, the sequence of a fast-growing mycorbacterial species would be of great value in comparative studies with M. *tuberculosis*, to identify potential virulence genes. Such a combined set of information would advance studies on all mycobacterial diseases.

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Electrons and Sex

Measuring electrons is not easy. They are small, nearly massless, and stubbornly obey Heisenberg's Uncertainty Principle, which places an immutable limit on the precision with which an electron's momentum and position can be simultaneously determined. Indeed, measuring electrons is so difficult that these subatomic particles were quite well integrated into the theory of physics long before any of their physical properties had been accurately measured.

Measuring sexual behavior is also not easy, which has led some AIDS researchers to study monkeys rather than people (*1*). People lie about their sexuality, both intentionally and unintentionally. Sexuality research is plagued by methodological challenges, including sampling and response bias, mnemonic distortions, and interview effects. How best can these problems be confronted and surmounted, much as phys-

icists overcame difficulties in measuring electrons? The basic issues follow.

Can people accurately recall their recent sexual behavior? The evidence suggests that sexual memory is often fallible, especially when the behaviors being remembered are temporally distant or occur relatively frequently. Thus, it becomes critically important to rigorously characterize and quantify the error rates and various biases inherent in sexual behavior data (*2*).

Similarly, researchers need to recognize the interpersonal nature of the survey procedure. Survey respondents *react* to the questioner, often in nonobvious ways. Interviewer characteristics, and especially interviewer-respondent similarities and differences, can affect the veracity of the responses obtained. Gender, age, and ethnic characteristics can each play a role in eliciting valid data. The very act of measurement disturbs the system being measured, whether that of electrons or of the sexual behavior of humans.

Sex is an intensely private matter. It is also emotionally charged, can be socially stigmatizing, and, depending on the particular act and surrounding circumstances, can even violate criminal statutes. Researchers need to devise methods to minimize distortion and to provide estimates of residual bias.

Sampling and generalizability are also problematic. Exhaustive sampling of a target population is seldom feasible, and it is often difficult to ensure the representativeness (hence, generalizability) of a restricted sample, even if it is randomly selected. Care must therefore be exercised both in generalizing results to disparate populations and in designing studies to ensure that generalization is possible.

There is also the complex issue of culture, which provides the proximal environment in which sexual behavior unfolds; it is the structure that gives meaning to sex and legitimates alternative forms of sexuality (*3*, *4*). Research tools (including survey instruments and interviewing techniques) should be culturally sensitive and linguistically appropriate, and data must be interpreted in culturally meaningful ways (*5*).

Finally, the theoretical underpinnings of sex research must be better explicated. Sexual measurement should derive from, and adhere to, theoretical foundations. There is no shortage of sexual theories, ranging from the distal focus of evolutionary psychology (*6*) to proximal theories in which sexual pleasure or intimacy take center stage (*3*). These seemingly different (although not irreconcilably divergent) theoretical foci suggest somewhat different approaches to the measurement and interpretation of human sexuality. Regardless of the theory selected, the collection of sexual behavior data should be informed by *some* theory.

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Predicting Career Success

We were intrigued by the 10 May article by Jeffrey Mervis about ongoing studies by the U.S. National Science Foundation (NSF)