NIH Center of Scientific Review, directed by Ellie Ehrenfeld, has established processes to ensure appropriate review of multidisciplinary proposals. Finally, in response to a congressional directive in the fiscal year 2000 NIH Appropriations Act, the NIH is establishing an Office of Bioengineering, Bioimaging, and Bioinformatics (*Science*, 22 Sept., p. 2015).

Through these efforts, the NIH leadership recognized the increasingly central role of imaging and bioengineering in biomedical research. While imaging scientists and bioengineers applauded these initiatives, they also saw the need for an institute to provide permanent support for research in these and related disciplines.

Passage of H.R. 1795 reflects congressional concurrence with that view. In establishing the NIBIB, the director of NIH is authorized to use appropriate physical facilities and to obtain personnel and administrative support from other NIH institutes and centers. In this regard, we should not lose sight of the field's interdisciplinary nature. Certain imaging and bioengineering research efforts must be closely integrated with approaches pursued in other NIH institutes and centers. These institutes/centers, therefore, should retain sufficient resources to continue efforts in imaging and bioengineering that are integral to their missions. The NIBIB, on the other hand, should be devoted primarily to basic and applied biomedical imaging and bioengineering research and training that are likely to have applications to a wide range of disease processes and organ systems. The new institute should strengthen and complement (not subtract from or substitute for) research programs in the other NIH institutes and centers.

The Academy of Radiology Research (*1*) and the American Institute for Medical and Biological Engineering (*2*) are committed to assisting in the creation of the NIBIBE in accordance with these principles. Establishment of the NIBIB is a critical step to develop new concepts, techniques, and technologies for the new century and to integrate the vast amount of biomedical research findings, thus allowing the NIH to accomplish its mission of increasing knowledge to improve people's health and well-being.

SHU CHIEN,[1]* C. DOUGLAS MAYNARD[2]†

[1]Whitaker Institute of Biomedical Engineering, Science Engineering Research Facility, University of California, San Diego, La Jolla, CA 92093–0427, USA; e-mail: shuchien@ucsd.edu. [2]Wake Forest University School of Medicine, Winston-Salem, NC 27157, USA; e-mail: dmaynard@wfubmc.edu

*President, American Institute for Medical and Biological Engineering

†President, Academy of Radiology Research

References and Notes

1. The Academy of Radiology Research is an alliance of 24 professional societies with more than 35,000 members and supporting organizations with more than 87,000 members.
2. The American Institute for Medical and Biological Engineering (AIMBE) is an alliance organization for medical and biological engineering that consists of 15 professional societies (with more than 32,000 members), 69 academic programs (with their faculty and students), 650 Fellows who are leaders in the field, and an Industrial Council. This letter has valuable inputs from members of the AIMBE Board.

Math Melodrama Rings of Reality

CHEERS TO D. F. WALLACE for his spirited, witty, and informative review of the fictional "Math Melodrama" novels by Philibert Schogt (*The Wild Numbers*) and Apostolos Doxiadis (*Uncle Petros & Goldbach's Conjecture*) (*Science*'s Compass, 22 Dec., p. 2263). Cheers also to *Science* itself for conveying at some length and with considerable fidelity, through Wallace, some insights into the joys and anxieties associated with attempted sustained mathematical research.

FIT father Kurt Gödel and friend Albert Einstein in 1950.

In his review, however, Wallace slightly misrepresents the thrust of Kurt Gödel's First Incompleteness Theorem (FIT); further, Wallace uses unduly harsh language in note 17 when he criticizes Doxiadis for allowing his mathematically savvy protagonist Petros to fear that his chosen problem, the Goldbach Conjecture, may be "one of the [FIT's] formally unprovable propositions." "This is so implausible and reductive as to be almost offensive," writes Wallace. And later: "To believe that the [FIT] could apply to actual number-theoretic problems like the Goldbach Conjecture is so crude and confused that there is no way that a professional mathematician of Petros's attainments could possibly entertain [the thought]." FIT asserts that in any sufficiently rich, effectively axiomatizable first-order system (*1*), say first-order Peano Arithmetic, some first-order assertions will be undecidable, in the sense that they are true in some models of that system and false in others. In any given model, any (first-order) statement is true or false; it is the challenge of mathematics to determine in specific cases just which of the two it is, using any legitimate (not necessarily first-order) methods of proof. The character Petros is worried that the Goldbach Conjecture, a first-order statement in the system N of natural numbers (this is the so-called standard model of Peano Arithmetic), might be true in N but not provable by the (permissible, first-order) methods of Peano Arithmetic. We do not know, of course, whether the Conjecture is true in N or false in N (*2*). But Petros's worry strikes us (at the very least) as plausible or reasonable, not as crude or confused.

Furthermore, contrary to Wallace's statement that "the formally unprovable propositions [that FIT] succeeds in deriving are all very special self-reference-type cases," by no means is every statement known to be independent of Peano Arithmetic weird, contrived, or artificial. The combinatorial statement attributed to J. Paris (*3*), as well as the number-theoretic statement of Goodstein's Theorem and the graph/game-theoretic statement of "Hercules and the Hydra" (*4*), are natural mathematical statements that are easy to formulate (in a first-order way), and they are unprovable in Peano Arithmetic but nevertheless true in N. These and other non–self-referential propositions are discussed, for example, in (*5*) and (*6*).

W. WISTAR COMFORT, PHILIPP ROTHMALER

Department of Mathematics, Wesleyan University, Middletown, CT 06459, USA. E-mail: wcomfort@wesleyan.edu; prothmaler@wesleyan.edu

References and Notes

1. Here, first-order refers to number-theoretic statements that are formulated in the logic involving the usual connectives such as "and," "or," and "not," as well as quantifiers; the latter, however, may be applied only to numbers (as opposed to sets of numbers, as in second-order arithmetic).
2. If by chance the Goldbach Conjecture should turn out to be false (in N), it would be false in all models of Peano Arithmetic, and hence, by Gödel's Completeness Theorem, refutable in Peano Arithmetic. Hence, if the Conjecture is independent of Peano Arithmetic, then it is true in N.
3. J. Paris and L. Harrington, in *Handbook of Mathematical Logic*, J. Barwise, Ed. (North-Holland, Amsterdam, 1977), pp. 1133–1142.
4. L. A. S. Kirby and J. Paris, *Bull. London Math. Soc.* **14**, 285 (1982).
5. R. Kaye, *Models of Peano Arithmetic*, vol. 15 of *Oxford Logic Guides* (Clarendon Press, Oxford, 1991).
6. Z. Adamowicz and P. Zbierski, *Logic of Mathematics* (Wiley, New York, 1997).

Response

THE REVIEWER HEREBY WINCINGLY ACKNOWLedges that Comfort and Rothmaler make a good point. It's maybe possible to niggle with them about whether Doxiadis's Petros is actually freaked about the Goldbach Conjecture's undecidability per se or rather just about the possibility that it's "true but independent"—first, because there's no evidence that Petros knows anything about different models of first-order math (the book

makes it clear that he is no logician), and second, because he's too rabidly ambitious to give one fig about the Conjecture's actual truth or falsity; he cares only whether *he* can prove it with first-order deductive tools.

This bit of niggling doesn't affect the really winceworthy point of their letter, though, which is that language like "implausible and reductive" and "crude and confused" that I used to characterize Petros's reaction to the FIT is indeed "unduly harsh" and somewhat misleading. (Worse, my use of the terms "reductive" and "crude" appears itself to have been reductive/crude, so I can understand why it bothered smart readers.)

Though I am grateful that Comfort and Rothmaler have corrected a misleading description of Petros's reaction to the FIT, I believe that what they've actually done here is catch me out in a writing-and-revision error rather than in a mathematical miscue. (This is the inevitable part of the Response where your reviewer tries to offer some kind of explanation/defense for his snafu, but I'll try to keep it maximally brief.) Note 17, which is where the discussion of Petros's horror about the FIT appeared in my book review, was originally longer than it was in *Science*,

"Petros actually goes to Vienna and looks up poor little agoraphobic Kurt Gödel and grabs him by the lapels..."

and the note included stuff about a scene in Doxiadis's novel right after Petros learns about the FIT and bites his wrist in horror. In this scene, Petros actually goes to Vienna and looks up poor little agoraphobic Kurt Gödel and grabs him by the lapels and pretty much demands that K.G. tell him right there on the spot whether the Goldbach Conjecture is one of the Theorem's improvable propositions, Petros saying stuff in the scene like "Damn theory, man!...I have a right to know whether I'm wasting my life!" (*1*). It is one of the worst scenes in the book—incongruous, soap-operaish, unintentionally funny—and in retrospect I see now that it's really more the Petros-Gödel exchange that is "implausible...offensive," or maybe rather that I let my strong readerly dislike of that scene color the way I saw Petros's whole reaction to the FIT. The problems here were intensified when the account in note 17 of the Petros-Gödel scene got cut by the editor (*2*), whereupon harsh language evoked by that scene and (yes, unduly) applied to the FIT itself lost not only its proper referent but any possible indication of its real (if, yes, confused) motivation.

All that said, I still contend that the overwhelming majority of things in the book I said were silly and/or confused really are silly and/or confused. *Quandoque bonus dormitat Homerus.*

DAVID WALLACE
Department of English, Illinois State University, Normal, IL 61790–4240, USA

References and Notes

1. This scene is on pp. 140–142 of Doxiadis's *Uncle Petros & Goldbach's Conjecture* (Bloomsbury USA, New York, 2000).
2. This does not mean that errors/misrepresentations were the editor's fault or just the result of cutting. If the reviewer acquiesces to a cut, he is responsible for cleaning up any errors or incongruities that are created by the cut, and this I clearly failed to do here.

Fundamental Criteria of Nobel Prizes

THE CONTROVERSY CONCERNING WHETHER Oleh Hornykiewicz should have been among those awarded the Nobel Prize for Medicine or Physiology last year, discussed in the News Focus article "Researcher overlooked for 2000 Nobel" by L. Helmuth (26 Jan., p. 567), is not surprising, given that basic science and medicine continue to affect each other's agendas to unprecedented extents. Implicit in the selection process in the past has been the assumption that the Prize be awarded for discoveries of fundamental and generalizable principles that provide the foundations for the understanding of the pathology of disease. As fundamental science and medicine become inextricably joined, the distinction between generalizable and applied principles becomes less clear—genomics/gene therapy, pharmacogenomics/drug development, and structural biology/proteinomics, to name a few examples. In a strict sense, the Nobel committee was correct and consistent in recognizing the fundamental principles discovered by Arvid Carlsson, Paul Greengard, and Eric Kendel. These discoveries form the cornerstone of our current way of thinking about neurotransmission, processing, learning, and memory.

Carlsson's discovery of dopamine as a neurotransmitter provided the opportunity for others to look at pathological states. Hornykiewicz's pioneering work in understanding the pathology of Parkinson's disease warrants much praise and credit, but was only made possible by Carlsson's observation about dopamine. For the committee to have included Hornykiewicz in the award would have invited the kind of criticism generated by the 2000 selections for the Nobel Prize in Physics, where the committee departed from precedent and awarded the prize for the invention of the integrated circuit, clearly an application of fundamental physical principles.

RODNEY E. ULANE
Associate Dean, University of Texas Southwestern Graduate and Medical Schools, Dallas, TX 75390–9033, USA. E-mail: ulane@utsw.swmed.edu

CORRECTIONS AND CLARIFICATIONS

REPORTS: "Backward spreading of memory-retrieval signal in the primate temporal cortex" by Y. Naya *et al.* (26 Jan., p. 661). First, in the equation in note 23, the superscript 2's were misplaced. The equation should have read as follows:

$$\mathrm{PRI}(t) = [\langle \mathbf{Cp}|\mathbf{F}(t)\rangle - \langle \mathbf{C}|\mathbf{Cp}\rangle\langle \mathbf{C}|\mathbf{F}(t)\rangle]/\{[1 - \langle \mathbf{C}|\mathbf{F}(t)\rangle^2][1 - \langle \mathbf{C}|\mathbf{Cp}\rangle^2]\}^{1/2}$$

Also, Fig. 1 (left) printed only partially in color, and in Fig. 2, G and H (right), the two lines within each plot should have been of different thickness. The correct figures are shown here.