#### letters

collider in 1963. Electron-positron colliders followed at Frascati, Orsay and Novosibirsk." The role of the Princeton-Stanford team in the collidingbeam machine development has indeed been crucial. Nevertheless, it is not fair to say that electron-positron colliders followed at Frascati, Orsay and Novosibirsk. The work done in the latter institutions and the one done at Stanford were simultaneous-in fact. the first beam-beam collisions ever observed were e+e- collisions and not e-e- collisions, and this observation was done by the French-Italian collaboration working on the ring ADA, which was then operated at Orsay. (Nuovo Cimento 34, 1473, 1964).

J. Haissinski Laboratoire de l'Accelerateur Lineaire 4/85 Orsay, France The author replies: J. Haissinski is technically correct. Indeed ADA did observe the first e+e- collisions, although at extremely low intensity. My error stems from recalling that the Princeton-Stanford e-e- machine was started earlier, in 1958, first stored beam and had the full complement of injection, storage and collision devices designed to do physics experiments. I apologize for the error.

LEON M. LEDERMAN Fermi National Accelerator Laboratory

#### SDI non-nuclear?

8/85

In November 1983, PHYSICS TODAY published a letter (page 116) I had written in support of President Reagan's "Directed Energy Weapon" project; it emphasized the following three principles: ▶ Only scientists are capable of discovering methods to technically nullify nuclear weapons; hence it is their responsibility to search for such a method

▶ Beam weapons have practically zero inertial time; hence they can, in principle, defend against nuclear weapons, which require a large inertial time to be transported to a target country

▶ Beam weapons are nonexplosive and are the most benign weapons; they are useful only for defensive purposes.

In the year and a half since this letter was published, there has been a dramatic expansion of effort in the Strategic Defense Initiative. One approach that is being taken in SDI research, and the one that most concerns me, is the development of an x-ray laser driven by nuclear explosives. This approach, although possibly powerful when achieved, not only contradicts President Reagan's repeated claim of "nonnuclear defense," but also could lead to a dangerously unstable situation by making the SDI concept itself ineffec-

tive. Space deployment of nuclear weapons, even for a defensive purpose, would unavoidably lead to space deployment of offensive nuclear weapons, which would nullify the SDI concept. For SDI to succeed, political agreement to keep space free from any nuclear weapon are essential. Scientists should stick to a non-nuclear means of SDI.

A. HASEGAWA
6/84 Summit, New Jersey

#### Math anxiety and physics

The article "Math anxiety and physics: Some thoughts on learning 'difficult' subjects" (June, page 60), clearly outlines some major reasons why education in the US is at present in such a difficult situation. I found "The Learning Bill of Rights" to be particularly distressing with its implication that the less competent and responsible students have "rights" that can lead to dictation of policies for the nation's educational system.

It is all well and good to offer assistance to those who need help in acquiring an education, and in the US this has been common practice since at least 1630. But it is quite another matter to spoon-feed those who are unable or unwilling to fulfill legitimate requirements for learning at the college level. We make a big mistake in assuming that higher education is suitable for all and that it must be provided, at public expense, for everyoneregardless of their intellectual abilities or their willingness to reject responsibilities for their own actions. We need to recognize that each person educates himself or herself, and that in a very real sense, there are no teachers but only learners. When we reach the point, as we have in the US, where remedial courses in colleges are commonplace necessities because the educational foundations at lower levels have been inadequate and ineffective, and where significant numbers of former college students intentionally default on repayment of public loans to enable them to acquire higher education, then we have lost our sense of perspective.

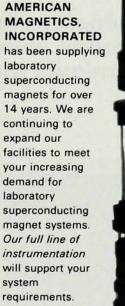
Our emphasis on personal "rights" has been greatly overdone in recent years. It has passed the point of rationality and has given our vocal and radical elements an unjust hold on society at large. We need to recognize that freedom and license are fundamentally different and that for every right we claim, we must accept a concomitant obligation or responsibility. Yet, in all the civil-rights demonstrations since the 1950s, and in all the feminist agitations since the 1960s, I have yet to hear any exponent of

continued on page 108

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continued from page 15

individual rights emphasize the personal obligations that must accompany acceptance of newly sought privileges.

I sincerely hope the publication of this article does not signal a change in editorial policies for PHYSICS TODAY.

> B. DUDLEY New Hartford, Connecticut

6/85

The article by Sheila Tobias (June, page 60) reminded me of my efforts in the late 1970s to increase the female enrollment in high-school physics. After the junior year, in which about half the chemistry students are female, the overall fraction of female science students drops to one quarter. A similarly sharp drop occurs between eleventh- and twelfth-grade mathematics.

Together with a female science teacher, I tried to elicit reasons from the junior class females for their possible avoidance of senior math or physics. We met with the young women in their chemistry classes and found that avoidance was generally based on their perception of advanced math and science as being career-oriented courses for students, usually described as males, who would be embarking upon rigorous professional training. Appalling for the liberated 1970s, many of the females were unashamed to admit that they foresaw themselves as housewives for whom the rigorous preparation would be both unnecessary and academically demanding.

My colleague and I were evidently rather successful in encouraging the female students to explore their motives, because the female enrollments in the next year's physics sections were significantly increased. The effect, however, was not all I had hoped for. The physics classes that year were difficult to motivate and the students frequently expressed distaste for the subject. Not surprisingly, an unusually large number dropped the course during the first semester. Consequently I was not disappointed that we didn't repeat our efforts in subsequent years.

There are several apparent differences between the attitudes of the males and females in my physics classes. Among the students with lower-than-average grade averages, the males generally continue the course while the females generally drop it. Among the higher-average students, the females score as well as, and frequently better than, the males; however, the females say they memorize more and solve fewer problems by reasoning techniques. In view of this, I am not surprised that even the females carrying high grades often say they don't like physics. Yet the males seem

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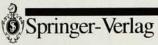
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#### letters

to take pleasure in physics, even the problem-solving aspects of the course. Of course, generalizations such as I am making are dangerous because I can recall many notable exceptions, but the overall pattern is painfully obvious!

What concerns me most about Tobias's article is that she examines the attitudes of females and then ignores these expressed attitudes in considering solutions. She says the females felt compelled to memorize problem solutions because of feelings of helplessness in rigorous thinking. Tobias asserts the unverified aphorism that by giving blocks to their sons and dolls to their daughters, parents are predetermining their children's career opportunities.

Do little boys want to play with dolls? Do girls beg their parents for blocks? In preschools, which children wind up in the doll corner and which segregate themselves into the blocks corner? Despite the feminist urgings of the past decade, liberated mothers are still forced to give their children the toys that make them happy. Why are boys more comfortable with blocks than dolls? Could it be that there is an innate predisposition that determines our most comfortable occupation, and could that predisposition depend upon sex?

The evidence is that females dislike the rigorous, formal thinking of higher math and physics. Males are more often uncomfortable in the more emotive disciplines of language and art, although the pattern is not as obviously one-sided. Until someone points out an advanced civilization in which the above pattern has not occurred, I shall be obliged to suspect that it is an outgrowth of mental differences between the sexes. Indeed, recent studies in prenatal brain development have vaguely indicated gender-specific processes. Why do so many feminists persist in the face of such evidence to hold environmental influences responsible for the math-science anxiety so prevalent in females?

I am hopeful that future research into early brain growth will help us to understand why females tend to choose intuitive reasoning rather than formal logic. The sociobiologist would probably relate the differences to genetic preferences in primitive primates, wherein sex roles required females to nurture and protect their offspring while males engaged in more clannish pursuits. Regardless of its evolutionary origins, the difference is present; it is wasted effort to attempt to minimize its influence. It might be more productive to design different curricula to suit both those comfortable with concrete reasoning and those who prefer formal logic.

Finally we have come full circle. Tobias bemoans the variety of course offerings suited to different learning styles. This is the problem she sets out to solve.

JAMES F. BLAKE
6/85 New Hyde Park, New York

With reference to Sheila Tobias's article "Math anxiety and physics...", one is tempted to wonder what all the fuss is about.

People have been mathematically inclined or not for as long as history records—and the social pressures of our times are not likely to change the ways in which humans think. We either like math and physics and wish to pursue the study of these and related subjects, or our interests lie elsewhere.

There is, as well, the tendency to equate courses in a subject with the subject itself. I have never enjoyed English courses: Lecturers always seemed too fond of dissecting a poem or an essay—somewhat in the way in which a biologist would dissect a flower—and at the end of the dissection we are left with bits and pieces and not much more. However, that has not prevented me from getting great help and sustenance from poetry and prose. Whether or not students take physics courses probably does not prevent them from enjoying the polarized blue of a

sky, the refracted colors of snow crystals, or the products of electronic technology.

Is it not possible that well-meaning practitioners have found a source of rewarding employment in attempting to bring the gospel of physics courses to the heathen? And that the practice has become an end in itself?

Surely the "immersion" that Tobias describes was not physics. The "workout," as it is referred to, resembled nothing so much as a psychological test that could have been applied equally as well to primates as to humans. Or, with equivalent intellectual demands, the apparatus could have been knitting needles and yarn. Object: to use the apparatus to produce a piece of material formed from linked loops. The hoped-for result is the discovery of the property of tension in the wool and a feeling for the density of the material (to paraphrase).

In both Canada and the United States, the standard of our mathematics instruction is below that of some European countries, if performance in international contests may be taken as a guide. In Canada it is certain-and I gather from educational journals that it is true also in the United Statesthat physics undergraduates are far less well-prepared than they should be. both when they enter their studies and when they leave. It is somewhat distressing to find that so much effort is expended on a doubtful need when there are obvious and demanding requirements for skilled instructors.

H. J. HUNTER 7/85 Kanata, Ontario, Canada

THE AUTHOR RESPONDS: The table at left can be interpreted in two ways, and clearly my correspondents and I disagree:

- As demonstration that *only* an elite of males and females (but always more males than females) have the talent and the temperament to do physical science
- ▶ Or, in my view, as demonstration that there is a tragic waste in terms of student-to-subject match, as far as the physical sciences are concerned; and that the loss is as significant for physics as it is for the students who think physics is not for them.

	SHEILA TOBIAS
7/85	Tucson, Arizona

#### Corrections

July, page 48—The subscription fulfillment statistics given in the table are for the calendar year 1984.

August, page 63—The position at IUPAP of John Klauder (AT&T Bell Labs) should have been listed as Associate Secretary-General.

#### Bachelor's degrees in 1981

	Men	Women	% Female
Biological sciences	5.1	4.1	44.2
Business	27.1	15.9	36.7
Education	5.8	18.1	75.0
Engineering and computer sciences	16.5	2.7	14.0
English	3.4	5.1	59.8
Nursing	0.4	11.4	94.8
Mathematical science	1.3	1.0	43.2
Physical science	3.9	1.3	24.6
Social science	12.0	9.5	44.1
Economics	2.8	1.3	30.9

From Digest of Education Statistics, US National Center for Educational Statistics.