Recently a colleague asked me for my views on the social and psychological functions of innumeracy. He aptly summarized the heart of the matter:
"I have long-standing research interests in mathematics anxiety and adult numeracy (or, more specifically, innumeracy, including in particular what I term the 'adult numeracy conundrum' – that is, that despite decades of investment in programs to raise adult numeracy rates little, if any, measurable improvements have been achieved. This has led me to now consider the social functions performed by this form of ignorance, as its persistence suggests the presence of underlying mechanisms that provide a more valuable pay-off than that offered by well-meaning educators…)"

This is an interesting deviation from the typical educator's attack on innumeracy. "Innumeracy" apparently was coined by cognitive scientist Douglas Hofstadter but it was popularized by mathematician John Allen Paulos in his 1989 book, Innumeracy: Mathematical Illiteracy and its Consequences. Paulos' book was a (IMO, deserved) bestseller and has gone through a second edition. Most educators' attacks on innumeracy do what Paulos did: Elaborate the costs and dysfunctions of innumeracy, and ask what we can blame for it and how it can be overcome.

Paulos' list of the consequences of innumeracy include:

1. Inaccurate media reporting and inability of the public to detect such inaccuracies
2. Financial mismanagement (e.g., of debts), especially regarding the misunderstanding of compound interest
3. Loss of money on gambling, in particular caused by gambler's fallacy
4. Belief in pseudoscience
5. Distorted assessments of risks
6. Limited job prospects

These are bad consequences indeed, but mainly for the innumerate. Consequences 2 through 6 also are windfalls for those who exploit the innumerate. Banks, retailers, pyramid selling fraudsters, and many others either legitimately or illicitly take advantage of consequence 2. Casinos, bookies, online gambling agencies, investment salespeople and the like milk the punters of their funds on the strength of consequences 3 and 5. Peddlers of various religions, magical and pseudo-scientific beliefs batten on consequence 4, and of course numerous employers can keep the wages and benefits low for those trapped by consequence 6.

Of course, the fact that all these interests are served doesn't imply that innumeracy is created and maintained by a vast conspiracy of bankers, retailers, casino owners, and astrologers. They're just being shrewd and opportunistic. Nevertheless, these benefits do indicate that we should not expect the beneficiaries to be in the vanguard of a campaign to improve, say, public understanding of compound interest or probability.

Now let's turn to Paulos' accounts of the "whodunit" part of innumeracy: What creates and maintains it? A chief culprit is, you guessed it, poor mathematical education. My aforementioned colleague and I would agree: For the most part, mathematics is badly taught, especially at primary and secondary school levels. Paulos, commendably, doesn't beat up the teachers. Instead, he identifies bad curricula and a lack of mathematical education in teacher training as root causes.

On the other hand, he does blame "us," that is, the innumerate and even the numerate. The innumerate are castigated for demanding personal relevance and an absence of anxiety in

their educations. According to Paulos, personalizing the universe yields disinterest in (depersonalized?) mathematics and science generally, and an unhealthy guillibility for pseudosciences such as astrology and numerology. He seems to have skated onto thin ice here. He doesn't present empirical evidence for his main claim, and there are plenty of examples throughout history of numerate or even mathematically sophisticated mystics (the Pythagoreans, for one).

Paulos also accuses a subset of the innumerate of laziness and lack of discipline, but the ignorance of the undisciplined would surely extend beyond innumeracy. If we want instances of apathy that actually sustain innumeracy, let's focus on public institutions that could militate against it but don't. There, we shall encounter social and political forces that help perpetuate innumeracy, not via any conspiracy or even direct benefits, but simply by self-reinforcing feedback loops.

As the Complete Review points out "… the media isn't much interested in combating innumeracy (think of how many people got fired after all the networks prematurely declared first Gore then Bush the winner in Florida in the 2000 American presidential election – none…" Media moguls and their editors are interested in selling stories, and probably will become interested in getting the numbers right only when the paying public starts objecting to numerical errors in the media. An innumerate public is unlikely to object, so the media and the public stagnate in a suboptimal but mutually reinforcing equilibrium.

Likewise, politicians don't want a numerate electorate any more than they want a politically sophisticated one, so elected office-holders also are unlikely to lead the charge to combat innumeracy. Michael Moore, a member of the Australian Capital Territory Legislative Assembly for four terms, observes that governments usually avoid clear, measurable goals for which they can be held accountable (pg. 178, in a chapter he contributed to Gabriele Bammer's and my book on uncertainty). Political uses of numbers are mainly rhetorical or for purposes of control. Again, we have a mutually reinforcing equilibrium: A largely innumerate public elects office-holders who are happy for the public to remain innumerate because that's partly what got them elected.

I've encountered similar feedback-loops in academia, beginning with my experiences as a math graduate doing a PhD in a sociology department. The ideological stances taken by some departments of cultural studies, anthropology, and sociology position education for numeracy as aligned with so-called "positivist" research methods, against which they are opposed. The upshot is that courses with statistical or other numeracy content are devalued and students are discouraged from taking them. A subset of the innumerate graduates forms a succeeding generation of innumerate academics, and on it goes.

Meanwhile, Paulos blames the rest of us for perpetuating romantic stereotypes in which math and science are spoilers of the sublime, and therefore to be abhorred by anyone with artistic or spiritual sensibilities. So, he is simultaneously stereotyping the innumerate and railing against us for indulging another stereotype (No disrespect to Paulos; I've been caught doing this kind of thing often enough).

Lee Dembart, then of the Los Angeles Times, observed that "Paulos is very good at explaining all of this, though sometimes with a hectoring, bitter tone, for which he apologizes at the very end." Unfortunately, hectoring people, focusing attention on their faults, or telling them they need to work harder "for their own good" seldom persuades them. I've taught

basic statistics to students in the human sciences for many years. Many of these students dread a course in stats. They're in it only because it's a required course, telling them it's for their own good isn't going to cut any ice with them, and blaming them for finding statistics difficult or off-putting is a sure-fire way of turning them off entirely.

Now that we all have to be here, I propose to them, let's see how we can make the best of it. I teach them how to lie with or abuse statistics so that they can gain a bit more power to detect when someone is trying to pull the proverbial wool over their eyes. This also opens the way to considering ethical and moral aspects of statistics. Then I try to link the (ab)uses of stats with important issues and debates in psychology. I let them in on some of psychology's statistical malpractices (and there are plenty), so they can start detecting these for themselves and maybe even become convinced that they could do better. I also try to convey the view that data analysis is not self-automating; it requires human judgment and interpretive work.

Does my approach work? Judging from student evaluations, a fair amount of the time, but by no means always. To be sure, I get kudos for putting on a reasonably accessible, well-organized course and my tutors get very positive evaluations from the students in their tutorials. Nevertheless, there are some who, after the best efforts by me and my tutors, still say they don't get it and don't like it. And many of these reluctant students are not poor students—Most have put in the work and some have obtained good marks. Part of their problem may well be cognitive style. There is a lot of evidence that it is difficult for the human mind to become intuitively comfortable with probability, so those who like intuitive understanding might find statistics and probability aversive.

It's also possible that my examples and applications simply aren't motivating enough for these students. Despite the pessimism I share with my colleague, I think there has been a detectable increase in basic statistical literacy both in the public and the media over the past 30 years. It is mainly due to unavoidably statistical aspects of issues that the public and media both deem important (e.g., medical advances or failures, political polls, environmental threats). Acquiring numeracy requires effort and that, in turn, takes motivation. Thank goodness I don't have the job of persuading first-year undergraduates to *voluntarily* sign up for a basic statistics course.