Buried by bad decisions

Our brains are hard-wired to make poor choices about harm prevention in today’s world. But we can fight it, says Daniel Gilbert.

The London Association for the Prevention of Premature Burial was founded in 1896 to prevent “premature burial generally, and especially amongst the members”. Because nineteenth-century physicians couldn’t always distinguish the nearly dead from the really most sincerely dead, premature burial was a problem. But not a big problem. The odds of being buried alive in 1896 were, like the odds of being buried alive today, very close to zero. Nonetheless, the good citizens of England formed action committees, wrote editorials and promoted legislation that ultimately led to expensive safeguards against “the horrible doom of being buried alive”. Most of those safeguards — such as the costly requirement that bodies spend time in ‘attractive waiting mortuaries’ before being buried — are still with us today. The frequency with which modern cadavers use this waiting period to demonstrate that they’ve been misdiagnosed is approximately never.

Premature burial isn’t a big problem, but the way we deal with big problems is. When an aeroplane’s fuselage rips open mid-flight, or an offshore oil rig explodes, or a nuclear power plant is crippled by a tsunami, we immediately ask what could have been done differently, blame those who didn’t do it, then allocate funds and pass legislation to make sure it gets done that way the next time. At first blush, this seems sensible. After all, no one is in favour of aviation accidents, reactor meltdowns or oil spills; so when these things happen, why not do everything we can to make sure they don’t happen again?

The answer is that because resources are finite, every sensible thing we do is another sensible thing we don’t. Alas, research shows that when human beings make decisions, they tend to focus on what they are getting and forget about what we are forgoing. For example, people are more likely to buy an item when they are asked to choose...
between buying and not buying it than when they are asked to choose between buying the item and keeping their money "for other purchases". Although "not buying" and "keeping one's money" are the same thing, the latter phrase reminds people of something they know but typically fail to consider: buying one thing means not buying another. So should we do everything in our power to stop global warming? To make sure terrorists don't board aeroplanes? To keep *Escherichia coli* out of the food supply? These seem like simple questions with easy answers only because they describe what we will do without also describing what we won't. When both are made explicit — should we keep hamburgers safe or aeroplanes safe? — these simple questions become vexing. Harm prevention often seems like a moral imperative, but because every yes entails a no, it is actually a practical choice.

How are we to make that choice? In the seventeenth century, Blaise Pascal and Pierre de Fermat derived the optimal strategy for betting on games of chance, and in the process demonstrated that wise choices about harm prevention are always the product of two estimates: an estimate of odds (how likely is the harmful event?) and an estimate of consequences (how much harm will it cause?). If we know which harm is most likely and which harm is most severe, then we know which harm to prevent. We should spend less to prevent a natural disaster that will probably leave 3,000 people homeless than a communicable disease that will certainly leave 3 million people dead, and this is perfectly obvious to everyone.

Except when it isn't.

**ANCIENT MINDS**

The reason it took a pair of mathematical geniuses to develop a formula for rational choice is that humans often don't make choices that way. When left to our own devices, we will pay more to eliminate a small risk of illness than to reduce a large one, and more to insure ourselves against a scary way of dying than against every way of dying. We will save all the members of a five-person group before we will save six members of a ten-person group, and we will save lives by pushing a trolley into a person but not a person into a trolley. Our brains were optimized for finding food and mates on the African savannah and not for estimating the likelihood of a core breach or the impact of overfishing. Nature has installed in each of us a threat-detection system that is exquisitely sensitive to the kinds of threats our ancestors faced — a slithering snake, a romantic rival, a band of men waving sticks — but that is remarkably insensitive to the odds and consequences of the threats we face today.

For example, our brains devote a great deal of time and real estate to processing information about other people — about what they think, know, want and intend. Because we specialize in understanding other minds, we are hypersensitive to the harms those minds produce. When people play economic games, for instance, they tend to reject unfair offers from their opponents — but they are much more likely to do so when their opponent is a person than when their opponent is a computer. When people receive electric shocks, they describe them as considerably more painful when they are intentionally administered by a human agent. It is bad to be harmed, but it is worse to be victimized. And so we worry more about shoe-bombers than influenza, despite the fact that one kills roughly 400,000 people per year and the other kills roughly none. We worry more about our children being kidnapped by strangers than about becoming obese, despite the fact that abduction is rare and diabetes is not. Terrorists and child-molesters are agents, viruses and French fries are objects, and agents threaten us in a way that objects never can.

We are especially concerned when the threats those human agents produce are to our dignity, values and honour. Moral rules bind communities together, enable trust and the division of labour and cause people to behave honestly when no one is watching. Because these rules have such a crucial role in the formation and functioning of human social groups, we are obsessed with their violation, which is why *US* Weekly outsells *The New Yorker*. Unfortunately, when a tribe grows to nearly 7 billion people, threats to its sense of decency are not the most serious threats it faces. Climate change is caused by the burning of fossil fuels, not flags. Because a decision to prevent one kind of harm is always a decision not to prevent another, the irresistible lure of moral violations can distract us from more crucial concerns.

**MORALS TO DIE FOR?**

Our obsession with morality can also discourage us from embracing practical solutions to pressing problems. The taboo against selling our bodies means that people who have money and need a kidney must die so that people who need money and have a spare kidney can starve. Economic models suggest that drug abuse would decline if drugs were taxed rather than banned, but many people have zero tolerance for policies that permit immoral behaviour even if they drastically reduce its frequency. Licensing prostitutes, trading pollution credits and paying students to stay in school may or may not reduce harm, but many would oppose these ideas even if they were proved effective. It is apparently better for people to suffer and die than to get the wrong message.

Our species’ sociality has always been its greatest advantage, but it may also be its undoing. Because we see the world through a lens of friends and enemies, heroes and villains, alliances and betrayals, virtue and vice, credit and blame, we are riveted by the dramas that matter most. We will change our lives to save a child but not our light bulbs to save them all.

"We will change our lives to save a child but not our light bulbs to save them all."
Democratizing clinical research

Keith Lloyd and Jo White commend a way for patients, clinicians and scientists to set priorities jointly.

Research priorities are rarely set democratically. Whereas clinical science is largely about establishing which treatments work best for whom, sadly, the views of those with most to gain or lose — patients — are generally ignored. Academics, industry and other big players with vital roles in developing treatments tend to set the agenda. But their priorities differ from those of patients and clinicians. For example, the outcomes measured in a trial of a drug may not be those of interest to the people who will actually take it.

The inclusion of patient demands is not a panacea. It can divert scarce research resources and delay important treatments. One solution is to try to harmonize the perspectives of patient and clinician. This is what the James Lind Alliance (JLA) Priority Setting Partnerships in Oxford, UK, attempt, perhaps uniquely. Established in 2004 and funded by the UK Medical Research Council and National Institute for Health Research (NIHR), the JLA brings together patients, carers and clinicians to identify and rank questions about the effects of treatments for a given disease. Clinicians and academics — who may never meet patients — find long-held beliefs challenged and sometimes overturned.

The JLA process has recently been applied to schizophrenia — a mental illness affecting about one person in a hundred worldwide. We were involved in this exercise as clinical academics. This, plus our experience as recipients of grants and from within funding bodies, convinces us that money rarely goes to the studies that those with mental illness would choose. We therefore urge funders to adopt this list of top priorities for schizophrenia (see ‘Top ten treatment uncertainties’), and entreat other countries and organizations to use the technique involved in compiling it to steer other clinical research.

Between 2007 and 2009, we and other collaborators from the JLA Partnership collated 489 potential uncertainties about schizophrenia research priorities.

**Top ten treatment uncertainties**

1. What is the best way to treat people with schizophrenia that is unresponsive to treatment?
2. What training is needed to recognize the early signs of recurrence?
3. Should there be compulsory community outpatient treatment for people with severe mental disorders?
4. How can sexual dysfunction due to antipsychotic-drug therapy be managed?
5. What are the benefits of supported employment for people with schizophrenia in terms of quality of life, self esteem, long-term employment prospects and illness outcomes?
6. Do the adverse effects of antipsychotic drugs outweigh the benefits?
7. What are the benefits of hospital treatment compared with home care for psychotic episodes?
8. What are the clinical benefits and cost-effectiveness of monitoring the physical health of people with schizophrenia?
9. What are the clinical, social and economic outcomes — including quality of life and the methods and effects of risk monitoring — of treatment by acute day hospitals, assertive outreach teams, in-patient units, and crisis resolution and home treatment teams?
10. What interventions could reduce weight gain in schizophrenia?

Some treatment uncertainties have been reformulated here as questions.
the treatment of schizophrenia. These came from clinicians, patients and their carers through web- and paper-based questionnaires. We also pulled them from the UK Database of Uncertainties about the Effects of Treatments, which contains instances in which “no up to date systematic reviews exist, or up-to-date systematic reviews show that uncertainty continues”.

These questions were de-duplicated to produce a longlist of 237 issues. Eleven schizophrenia partners — carers, clinicians, patients, funders and voluntary-sector organizations — each ranked their top ten uncertainties. These partners responded either as individuals, or on behalf of an organization, having consulted colleagues and members.

The partnership collated the rankings, recording separate running totals for patient, carer and clinician submissions. This enabled a steering group — a subset of the partners — to examine each individual ranking, as well as the combined ranking, to produce a pooled list of 26 treatment uncertainties.

Finally, this list was discussed at an exhilarating workshop of clinicians, carers, patients, funders and voluntary-sector organizations in January. The JLA facilitated the meeting using a structured variation of small-group discussion called ‘nominal group technique’ (see go.nature.com/xswwtc) to reach moderated consensus on a top ten.

The process prevented one person dominating the discussion and encouraged all group members to participate. The format was rigorous, but flexible enough to allow people to revise their opinions, raise concerns and to reach consensus about any imbalance perceived to have emerged from the interim stages.

Although the purpose of the JLA process is to enable patients and those who treat them to have a say in what gets studied, it can also change clinical practice. For example, sexual dysfunction caused by antipsychotic medication emerged as a key patient priority. This is typically a low priority for clinicians prescribing medication and for companies assessing drug effectiveness.

The week after the JLA workshop, a patient came to see one of us (K.L.) in a clinic, and wanted a change of antipsychotic medication because of sexual dysfunction. Without the experience of the JLA process, it is unlikely that this issue would have been afforded as much weight as it was.

The final top ten for schizophrenia is noteworthy for its divergence from the agenda of the drug industry, and begs many questions. Perhaps most pressing: is it ethical to conduct research, which may include testing new treatments, without considering which outcomes matter most to those who will receive the treatment? And is it, in the long run, to drug companies’ benefit to do so? Such questions are particularly pertinent in conditions such as schizophrenia, in which the balance of power between researcher, clinician and patient is so uneven.

What next? The team will repeat the exercise for depression this year and next. Meanwhile, the JLA is encouraging funders and researchers to act on the top ten rather than to continue with agendas devoid of clinician and patient input. For example, the NIHR is now exploring commissioning research on weight gain and sexual dysfunction in schizophrenia. Assumptions that “researcher knows best” have had their time.

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2. Cowan, K. & Oliver, S. The James Lind Alliance Guidebook (2011); available at go.nature.com/u2cqpcy

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which says that the larger a sample, the more closely the sample characteristics match those of the parent population.

Insurance companies had been limiting the number of policies they sold. As policies are based on probabilities, each policy sold seemed to incur an additional risk, the cumulative effect of which, it was feared, could ruin a company. Beginning in the eighteenth century, companies began their current practice of selling as many policies as possible, because, as Bernoulli’s law of large numbers showed, the bigger the volume, the more likely their predictions are to be accurate.

JULIA COLLINS
From bridges to DNA
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When Leonhard Euler proved to the people of Königsberg in 1735 that they could not traverse all of their seven bridges in one trip, he invented a new kind of mathematics: one in which distances didn’t matter. His solution relied only on knowing the relative arrangements of the bridges, not on how long they were or how big the land masses were. In 1847, Johann Benedict Listing finally coined the term ‘topology’ to describe this new field, and for the next 150 years or so, mathematicians worked to understand the implications of its axioms.

For most of that time, topology was pursued as an intellectual challenge, with no expectation of it being useful. After all, in real life, shape and measurement are important: a doughnut is not the same as a coffee cup. Who would ever care about 5-dimensional holes in abstract 11-dimensional spaces, or whether surfaces had one or two sides? Even practical-sounding parts of topology such as knot theory, which had its origins in attempts to understand the structure of atoms, were thought to be useless for most of the nineteenth and twentieth centuries.

Suddenly, in the 1990s, applications of topology started to appear. Slowly at first, but gaining momentum until now it seems as if there are few areas in which topology is not used. Biologists learn knot theory to understand DNA. Computer scientists are using braids — intertwined strands of material running in the same direction — to build quantum computers, while colleagues down the corridor use the same theory to get robots moving. Engineers use one-sided Möbius strips to make more efficient conveyor belts. Doctors depend on homology theory to do brain scans, and cosmologists use it to understand how galaxies form.

Mobile-phone companies use topology to identify the holes in network coverage; the phones themselves use topology to analyse the photos they take.

It is precisely because topology is free of distance measurements that it is so powerful. The same theorems apply to any knotted DNA, regardless of how long it is or what animal it comes from. We don’t need different brain scanners for people with different-sized brains. When Global Positioning System data about mobile phones are unreliable, topology can still guarantee that those phones will receive a signal. Quantum computing won’t work unless we can build a robust system impervious to noise, so braids are perfect for storing information because they don’t change if you wiggle them. Where will topology turn up next?

CHRIS LINTON
From strings to nuclear power
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Series of sine and cosine functions were used by Leonard Euler and others in the eighteenth century to solve problems, notably in the study of vibrating strings and in celestial mechanics. But it was Joseph Fourier, at the beginning of the nineteenth century, who recognized the great practical utility of these series in heat conduction and began to develop a general theory. Thereafter, the list of areas in which Fourier series were found to be useful grew rapidly to include acoustics, optics and electric circuits. Nowadays, Fourier methods underpin large parts of science and engineering and many modern computational techniques.

However, the mathematics of the early nineteenth century was inadequate for the development of Fourier’s ideas, and the resolution of the numerous problems that arose challenged many of the great minds of the time. This in turn led to new mathematics. For example, in the 1830s, Gustav Lejeune Dirichlet gave the first clear and useful definition of a function, and Bernhard Riemann in the 1850s and Henri Lebesgue in the 1900s created rigorous theories of integration. What it means for an infinite series to converge turned out to be a particularly slippery animal, but this was gradually tamed by theorists such as Augustin-Louis Cauchy and Karl Weierstrass, working in the 1820s and 1850s, respectively. In the 1870s, Georg Cantor’s first steps towards an abstract theory of sets came about through analysing how two functions with the same Fourier series could differ.

The crowning achievement of this mathematical trajectory, formulated in the first decade of the twentieth century, is the concept of a Hilbert space. Named after the German mathematician David Hilbert, this is a set of elements that can be added and multiplied according to a precise set of rules, with special properties that allow many of the tricky questions posed by Fourier series to be answered. Here the power of mathematics lies in the level of abstraction and we seem to have left the real world behind.

Then in the 1920s, Hermann Weyl, Paul Dirac and John von Neumann recognized that this concept was the bedrock of quantum mechanics, since the possible states of a quantum system turn out to be elements of just such a Hilbert space. Arguably, quantum mechanics is the most successful scientific theory of all time. Without it, much of our modern technology — lasers, computers, flat-screen televisions, nuclear power — would not exist.

CORRECTIONS
In the Comment article ‘Buried by bad decisions’ (Nature 474, 275–277), the statement “we will save lives by pushing a trolley into a person but not a person into a trolley” refers to an incorrect reference. The correct one is J. D. Greene et al. Science 293, 2105–2108 (2001).

The Comment article ‘Crowd control in Rwanda’ (Nature 475, 572–573) should have stated that family-planning aid dropped from 30% to 12% of overall health aid, not overall aid.