Risk: swimming with sharks, driving to the office or betting your shirt

Herbert E Huppert for Ockham's razor

Are you scared of sharks while swimming in the ocean? I am. But there has been approximately one shark fatality in Australia each year for the last fifty years, compared to the just over a thousand road fatalities each year at the moment. But I do not feel scared driving.

We all make decisions and take risks, either large or small, at every stage of our life. But how should one evaluate which risks are acceptable and which are too large? Are hard, quantitative facts more useful than one's qualitative perception? Can one bring Ockham's Razor to bear and choose the best possible decision path?

In some cases, such as automobile accidents or house burglaries, we have sufficient examples for an accurate calculation of the average risk to be made. In others, like terrorist attacks or testing for the first few times a new, powerful wonder drug, or the many political decisions about infrastructure needs decades into the future, there have not been a sufficient number of occurrences to make accurate calculations. However, in both cases, we often make decisions on a possibly incorrect intuitive perception of the risks involved, as with sharks. Along this line, how dangerous is it, and how do you decide whether to indulge in: skiing; riding on the back of the bike of that gorgeous man; or having the heart operation only one of your physicians advise.

A correct evaluation of the risks involved would seem essential, and might have considerable implications for not just the individual but a population. Yet even if we understand the odds, how should one react? If you were told that data showed that 20% of people who attempt a particular action die within a few weeks you probably would not do it. Alternatively, if you were told, as the politicians of Greece were some two years ago, that there was a 20% chance of a significant, even possibly massive, eruption in the harbour of the beautiful island of Santorini during the coming summer, what is

the best reaction? First, what does a figure of 20% mean: to some it might suggest, erroneously, that in 100 lifetimes Santorini will erupt 20 times in one particular summer? Should you close down 20% of the tourist industry? What if nothing happens, and the economy of Santorini is ruined by the lack of tourists due to prior concern and notification? What if there is no notification – after all 20% is pretty small – and the eruption occurs and kills many, many tourists and inhabitants? In the end it was decided to do nothing, but keep a scientific eye on geological conditions beneath Santorini.   And nothing untoward happened – this time.

Edmund Hillary, the famous mountaineer, recalls that as he was clambering what we now know as the Hillary Step, near the top of Everest, he said to himself: Boy, this is very steep and dangerous. I could fall off and kill myself, taking Tenzing with me. But, he then thought: this is Everest; it is being climbed for the first time. It is worth the (large) risk. Did Mallory have similar thoughts?

The wife of an astronaut once complained to me that her husband was in a very risky business: seven fellow astronauts had died as a result of the Challenger explosion and many more, she asserted, had been killed during the construction, testing and training periods. But, Madam, I said: per passenger mile it must be the safest mode of transport, by far! She was not amused.

Card players take risks all the time. The better ones can calculate the associated probabilities, either mathematically or intuitively, better than their opponents, thereby making better decisions and winning more money, more often. Romans 2000 years ago enjoyed playing with dice and gambling on the outcome. But the dice, made from sheep knuckles, were far from unbiased, as we would now demand. Did some Romans have a 'feel' for the likely bias and win more often? I do not think we know. The mathematical theory of probability, now essential to all games, to the financial and insurance industries, to combatting criminals and terrorists, in addition to many other everyday situations, was not invented until the mid 1600s by the two great French mathematicians Blaise Pascal and Pierre de Fermat (of the famous eponymous theorem). They were approached by the Chevalier de Mere, an inveterate gambler, who felt that it seemed to him, from his long experience, that at least one six in the throw of four dice (or one die rolled four times)

occurred more often than two sixes in 24 throws. The mathematicians founded probability theory and showed that the gambler's instinct was right: one six in four throws is 3% more likely to occur than two sixes in 24 throws. That 3% difference were you to bet on it every five minutes or so could yield a handsome income – better than a Professor's salary I can assure you. The bottom line is: never bet with someone who can calculate the odds better than you. And, of course everyone in Australia knows that MONA, the wonderful new Art Gallery in Hobart, was partly financed by the proceeds of gambling.

In the same vein, because insurance companies have experts whose job is to ensure that the odds are in their favour and thereby make a profit, in general you will not make money by taking out insurance, of almost any form -- but you may feel better and safer.

Developing probability theory to understand gaming odds was quickly extended to consider a problem which is not yet solved today: how to evaluate the probability of the eventual outcome of an unfinished contest. As a punter, or a bookie, how should you react, and increase your bet or change the advertised odds, on the knowledge that the Socceroos are leading Manchester United 2-0.   There is not sufficient information to make any sensible evaluation. Is it 2-0 after 5 minutes or after 85 minutes? It would make a huge difference.

Knowing that the mighty Federer is leading the great Nadal 2-0 tells you very little about the probable outcome or the variance, which is the spread of possibilities. Is it 2-0 in games, when at least there has been a broken service game quite early but little more can be said. Even knowing it is 2-0 in sets, needs the extra information of whether it is a best of 3 or 5 set match.

What about medical risks to health? How dangerous is exercise, or smoking, or riding a horse. Recently, quantitative epidemiologists have collected enormous amounts of data on acute and chronic risks to longevity. They have introduced the concepts of a micromort and a microlife to help with rational decision making. A micromort is defined as the length of time pursuing a particular risky aspect of your life has a one in a million chance of your dying suddenly. One in a million, as the Chevallier de Mere no doubt knew, is roughly the chance of getting twenty heads in a row from the toss of

an unbiased coin. General data indicate that travelling ten kilometres on a motorbike, even carefully, generates a micromort – there is a one in a million chance of death due to an accident. 30 km walking, 400 km by car and 20,000 km by commercial jet all generate, on average, one micromort. By contrast, scuba diving generates, on average, about 10 micromorts per dive; skiing a micromort each day; skydiving 10 per jump and to return to an earlier theme, climbing Everest about 40,000 micromorts per attempt. Micromorts are what a mathematician calls nonlinear; in this case they are not simply additive. Thus, for example, driving a motor bike for twenty kilometres entails 2 micromorts; giving birth in Sydney about 50 micromorts. The cost of giving birth while driving a motor bike in Sydney is not 52 micromorts, but rather larger than that – probably closer to 52 followed by four zeros.

A Microlife, in contrast, either decreases or extends your life span by roughly half an hour each day, thus by about 2%. The concept was introduced by my Cambridge colleague, David Spiegelhalter, who noted that we enjoy roughly one million half hours in a life time. For example, smoking a pack of cigarettes each day, costs, on average, 10 microlifes, that is your life is curtailed by 20%, some 10 years. Sitting on your butt, watching television for two hours a day on average, results in the punishment of a microlife. On the positive side, exercising for twenty minutes each day is worth 2 microlifes – a 4% increase in length of life; eating five portions of fruit and vegetables a day is worth one microlife; taking statins is also worth one.

Unfortunately, however, all those extra years come at the end. What a pity that exercising 20 minutes a day does not mean that your care-free twenty--first year does not last for almost a thousand days!

Medically, with possibly large political outcomes, we face the risk of outbreak of disease and possibly death by the rapid spread of pathogens by trade and other movements. What should the politicians or medical advisers recommend? Terrorism, so far a rather rare event, could do enormous damage to a city, or even a country, and its inhabitants. What are the chances of this happening; how could we defend against it? Should we bother, if we live outside a big city? Many terrorism experts know numerous different methods by which to carry out terrifying and effective attacks. What none of them can answer effectively is why these have not been attempted by the

various groups. So far civilisation has been lucky. The noted scientist, astronomer and one-time President of the Royal Society, Lord Martin Rees, a good friend and colleague, summarises this all very succinctly as: by terror or error we are unlikely to reach 2100. I look forward to our proving him wrong.