had their wisdom teeth removed. The results suggest that kappa-opioid agonists not only fail to alleviate pain in men, they can actually make it worse.

Dr Gear and Dr Levine believe that as well as an analgesia (i.e., pain-suppression) circuit, the brain contains what they call an anti-analgesia circuit— one which, when activated, pumps pain up. They have shown that which circuit is activated depends not only on the type of receptor a drug acts on, but also the dose given. Among their dental patients, low doses of nalbuphine had a short-lasting analgesic effect in the women, but profoundly enhanced pain in the men. However, when they added a low dose of naloxone—a drug that blocks all types of opioid receptor to the nalbuphine, the sex difference disappeared and pain relief was significantly enhanced in everyone. After refining the relative proportions of these two drugs in the mixture, they have succeeded in finding (and patenting) a combination that is effective in both sexes.

Nor is it only the mechanism of pain perception that differs between the sexes. Dr Keogh and his colleagues argue that there are significant differences in the ways men and women cope with pain, as well.

This conclusion is based on studies involving hospital patients, as well as on volunteers who were exposed to a painful stimulus, such as an ice-water arm-bath. Using this, the researchers were able to measure the point at which people first noticed pain, as well as their tolerance—the point at which they could no longer stand it. Men were able to minimize their experience of pain by concentrating on the sensory aspects—their actual physical sensations. But this strategy did not help women, who focused more on the emotional aspects. Since the emotions associated with pain, such as fear and anxiety, tend to be negative, the researchers suggest that the female approach may actually exacerbate pain rather than alleviating it.

Dr Keogh, a psychologist, sees this difference as an effect of social conditioning—and uses it to point out the dangers of underestimating social influences in favour of the male view of the genes. But it is not obvious why such male and female "coding strategies" should not be underpinned by genetics, in the same way that perceptions are.

The evolutionary reason why men resist pain better than women is, however, a mystery. After all, pain is there to stop you doing bad things to yourself. Perhaps it is because males and females are exposed to different sorts of pain. Males, for instance, get into fights much more often than females do, and thus get wounded more often. On the other hand, they do not have to undergo the visceral pain of childbirth. And perhaps a willingness to tolerate less pain than men do helps to explain why women live longer than their menfolk.

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**Modelling conflict**

**Rules of engagement**

Scientists find surprising regularities in war and terrorism

ON JULY 19th, Iraq Body Count, a group of academics who are attempting to monitor the casualties of the conflict in that country, published a report suggesting that almost 25,000 civilians have been killed in it so far. In other words, 34 a day. But that is an average. On some days the total is lower, and on some higher—occasionally much higher.

It is this variation around the mean that interests Neil Johnson of the University of Oxford and Michael Spagat of Royal Holloway College, London. They think it is possible to trace and model the development of wars from the patterns of casualties they throw up. In particular, by analysing Iraq Body Count's data and comparing them with equivalent numbers from the conflict in Colombia, they have concluded that, from very different beginnings, these conflicts are evolving into something rather similar to one another.

The groundwork for this sort of study was laid by Lewis Fry Richardson, a British physicist, with a paper on the mathematics of war that was published in 1948. Using data from conflicts that took place between 1812 and 1945, Fry Richardson made a graph displaying the number of wars that had death tolls in various ranges. The outcome was startling: rather than varying wildly or chaotically, the probability of individual wars having particular numbers of casualties followed a mathematical relationship known as a power law.

Power-law relationships crop up in many fields of science and are often a characteristic of complex and highly interacting systems (which war certainly is). Earthquake frequencies and stockmarket fluctuations are both described by power laws, for example. Power laws also have properties that make them different from statistical distributions such as the normal curve (or bell curve, as it is familiarly known). Unlike a bell curve, a power-law distribution has only one tail and no peak. Small tremors occur frequently, but over a few decades enormously large earthquakes will also occur with a reasonable frequency. As will deadly wars and attacks.

In May, Aaron Clauset and Maxwell Young, of the University of New Mexico, modified Fry Richardson's method to look at terrorist attacks. Instead of total casualties in a conflict, they plotted the deaths from individual incidents. Again, they got a power law. Actually, they got two.

Power-law relationships are characterised by a number called an index. For each tenfold increase in the death toll, the probability of such an event occurring decreases by a factor of ten raised to the power of this index, which is how the distributions get their name. Terrorist attacks within 67 countries could be distinguished from those inside non-G7 countries by their different indices. G7 countries were more likely to suffer large attacks. Indeed, in an article published earlier this year by Britain’s Institute of Physics, Mr Clauset and Mr Young said that “if we assume that the scaling relationship and the frequency of events do not change in the future, we can expect to see another attack at least as severe as September 11th within the next seven years.”

Dr Johnson and Dr Spagat took the method a couple of steps further. They extended Mr Clauset’s and Mr Maxwell’s idea of looking at the sizes of individual incidents within a campaign to other sorts of conflict, and also looked at how those conflicts have changed over time. As they report in a paper published recently in arXiv, an online archive, they found, yet again, that the data follow power laws. And for both of the wars they studied, the indices of the power laws have been approaching the value Mr Clauset and Mr Maxwell found for non-G7 terrorism, though from different directions. In other words, for the war in Iraq, the data indicate a transition from an index characteristic of more lethal, conventional war between armies to one closer to terrorism. No real surprise.
there, perhaps, though it is interesting to see perceptions on the ground reflected in the maths. For the Colombian conflict, though, the data show the opposite, a transition from a war characterised by smaller, less cohesive forces to a more unified rebel front—something that ought to worry Colombia’s government.

Dr Johnson and Dr Spagat put forward as an explanation a mathematical model they have developed. It consists of a group of self-contained “attack units”, each of a particular strength. Such units can join together or fragment into smaller pieces. Over time, an equilibrium of joining and breaking is reached, but where that equilibrium lies depends on the strength of any central organisation. The model explains the power-law behaviour seen in both conventional wars and terrorist attacks. Different rates of fragmentation lead to different indices—conventional war is fought with robust armies that are unlikely to fragment, while terrorists are more likely to have shifting alliances.

Dr Spagat points out that, if their model is correct, it makes casualty data useful in a situation where intelligence about the enemy is hard to come by—as seems to be the case in Iraq at the moment. For instance, it should be possible to distinguish an insurgency with a rigid command structure from a group of smaller, randomly linked units. Learning about the distribution of earthquakes may not prevent the Big One, but for war and terrorism, power-law statistics may teach governments something about how to defeat the enemy, and make war less deadly.

Avian influenza
Malign influences

More deaths from bird flu in Asia

The first human deaths from avian influenza in Indonesia were announced on July 20th by the country’s health minister, Siti Fadillah Supari. She said that three members of a family living on the outskirts of Jakarta had been killed in the past ten days. Human cases of bird flu in Indonesia have been reported since June, but there are no known fatalities.

Normally, people who catch the virus, which has been rampaging through the domestic fowl of South-East Asia since 2002, do so directly from birds. In this case, although the World Health Organisation had yet to confirm Dr Supari’s announcement when “The Economist” went to press, its officials are worried there is no obvious avian source for the infection. That, plus the fact that the victims lived together, raises the possibility that one of them gave it to the others. Dr Fadillah was keen to play down the idea of such human-to-human transmission, but more than 300 people who had contact with the three victims are being tested for the virus just in case, and plans are under way to test animals within a 20km radius and slaughter those that are infected.

Virologists have long been concerned about bird flu, worrying that the virus which causes it might mutate in a way that allowed it to be transmitted easily from person to person. This, they fear, might result in a catastrophic epidemic among humans, similar to the one that occurred after the first world war that killed 20m-40m people.

It is by no means certain that such a mutation has happened in the Jakarta cases, even if they do turn out to have been transmitted between family members. According to Ian Jones, a professor of virology at the University of Reading, in England, it is possible that there could have been transmission between humans simply because one of the family members was carrying unusually large amounts of the mutated virus.

In addition, Dr Fadillah says that the genetic sequence of the virus in question has been obtained, and that it was indeed a conventional one. However, some virologists urge sceptical caution. Peter Openshaw, head of respiratory infections at the National Heart and Lung Institute in London, said that he would want to see any statement about the genetic sequence of the virus—and its difference from other isolates—coming from a scientist rather than a politician.

On top of this, a paper in this week’s Proceedings of the National Academy of Science reported a different sort of mutation. It suggested that the virus circulating in the avian population has been evolving into a form less lethal to birds. That raises concerns that birds which have survived the disease may act as a reservoir—and that if migratory wildfowl caught it, they could carry it out of South-East Asia.

The British government, meanwhile, announced it would stockpile 2m doses of a vaccine against the strain of bird flu currently in circulation. It is hoped these would confer resistance to any human virus that might emerge and could be used to protect medical workers in an outbreak.