Smarter and gentler

Rationality has been found to be growing and violence is on the decline, says s ananthanarayanan

THAT facts contradict the notions of falling intellectual ability and the rise in violence in modern times is the message of *The Better Angels of Our Nature — The Decline of Violence in History and its Causes*, the new book by Steven Pinker, of the Department of Psychology, University of Harvard. "The 20^{th} century was the bloodiest in history… This frequently asserted claim is popular among the romantic, the religious, the nostalgic and the cynical. They use it to impugn a range of ideas that flourished in that century, including science, reason, secularism, Darwinism and the ideal of progress. But this historical factoid is rarely backed up by numbers, and it is almost certainly an illusion," says Pinker in an article based on his book in *Nature.*

He says this popular picture of the last century is both because we know more about these recent events and also because today we are more sensitive, which is to say, more refined. Military conquests in past centuries, which have been described as glorious victories of heaven-sent monarchs, would more likely, in current thinking, be described as genocide committed by insane despots and many kings described with the suffix, "the great" would qualify for trial as war criminals.

Pinker looks at the figures — the estimates of lives lost in violent campaigns, like collapsing empires, conquests, invasions, the slave trade, destruction of native peoples, in earlier centuries, if adjusted for population, turn out to be comparable with each of the two World Wars.

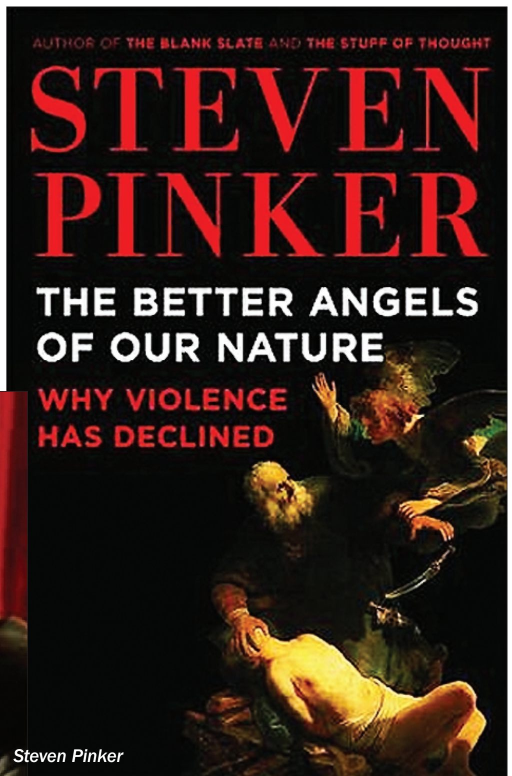
The conditions before the rise of civilisation, in the form of cities and states, were no better — archaeological studies indicate that about 15 per cent of ancient people had violent deaths, a figure that is five times higher than that in the 20^{th} century, after considering the wars, the genocide and man-made famines!

The second half of the 20^{th} century has been unprecedented in its avoidance of wars between developed states — all the power and communication ability at our disposal has helped diplomacy as much as aggression. And the death count from war in the last 10 years has been well below that in any of the five preceding decades.

And beyond falling levels of military violence, there has been a reduction of civil violence, as characterised by the incidence of homicide.

Using statistics available for Europe, it has been found that there has been a 30-fold reduction since the Middle Ages — from 40 per 100,000 people in the 14th Century to 1.3 per 100,000 at the end of the 20^{th} century. With this dramatic reduction in domestic and civil violence there has been the disappearance of barbaric practices — human sacrifice, persecution of witches and heretics, slavery, blood sports, officially sanctioned torture, sadisitic executions, executions for so-called crimes of morality or honour, even the death penalty in the larger part of the world. There has been social reform — thinkers and writers have brought about universal sufferance (women have the vote), recognition of women's rights, children's rights, animal rights — which has brought down the level of lynching, pogroms, rape, the beating of wives and children, hunting and the callous use of laboratory animals.

How has this marked reduction in violence come about? Pinker notes that violence is not fad behaviour and aggression is part of genetics, with the urge for rage and dominance that shows in the play-fights of little boys and much of the popularity of sport. But violence has not been an unvarying part of history and there is no evidence that it is a biological need like hunger, sleep or sex. Nor can there have been any genetic change, as such changes take scores of generations, not a handful of decades. Pinker says that the decline in violence, in the regions where there is documentation, has been with the engaging of the components of the human mind that inhibit violence. He lists empathy, even moral sense, and the growth of rationality.



Steven Pinker

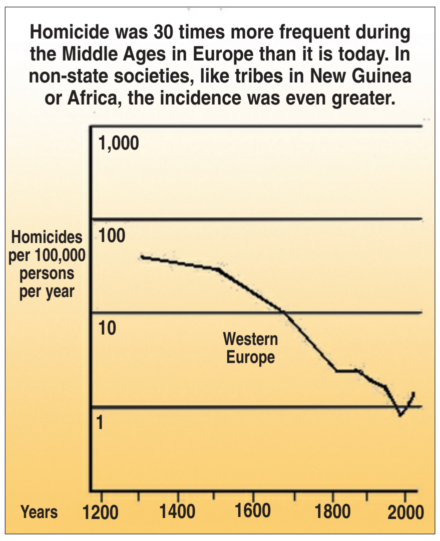
But empathy, whether it comes from literacy, travel, communications, cannot of its own bring about such a marked and universal change of attitudes to violence, for empathy is readily diverted or even turned around. Morality, again, provides a framework where infractions can be legitimately punished — permission for violence, apparently without motive. Pinker says the most important psychological factor leading to a decline in violence is the growth of reason — "cognitive faculties, honed by the exchange of ideas through language, that allow us to understand the world and negotiate social arrangements".

He notes again that the popular notion is that scholarship and rationality are themselves disappearing — the nature of the TV soap and the vacuity of commercial advertisements are routinely cited as evidence of a lowering of the cerebral plane. Political doublespeak, cornering and manipulation of markets are materials for journalists, and even for scientists, to project the rise of brainless world citizens. But is this true? Pinker says it is not, for all the foolishness in the air — modern societies have been getting smarter.

A simple measure is pure IQ. In the IQ metric, the "average" person scores 100; to score above 120 is "very intelligent" and 135 is "genius". But the questions in the IQ test need to be "calibrated" so that the "average" person scores 100 on the test. In 1980, it was observed that IQ tests needed to be periodically "recalibrated" as the "average" kept rising. New Zealand philosopher James Flynn noted that an average teenager (one who scores 100), if he/she took a test administered in 1910, would score 130. And the average person of 1910 would do no better than 70 on a present day test.

This conclusion has been rigorously tested to cover all components of intelligence — vocabulary, arithmetic, general knowledge, abstract reasoning — noting analogies and similarities, and the reason for the increase in the use of the brain explained in terms of more hours/years of schooling, the use of symbols and their manipulation, scientific and analytical reasoning in everyday life.

Well, so we are getting smarter but does that mean less violent? Pinker says smarter means understanding more acutely that one needs to avoid injury and a community of smarter people who can comprehend each other's reasoning. With community living rising over millennia, in the development of the race from ape-like groups to small bands to villages, and states with the appearance of literacy, travel and communications, collective rationality began to hold sway over short-sighted violence, and the treating of others as we would that they treat us.



But it has taken many centuries for the understanding to come that avoiding violence is a general good — to know that it was wrong to keep slaves, to beat wives and children or to go to war for vanity.

With the rise in intelligence has come the change that thinkers have wrought on values and beliefs. The great driver of rationality has been the spread of science and analytical thinking that examines assumptions. Pinker quotes French writer Voltaire. "Those who can make you believe absurdities can make you commit atrocities." Science helps "debunk hogwash". Now we do not believe that the gods demand human sacrifice, that certain communities are evil or brutish, that kings have a divine right to rule and commit the country to war — democracy itself is an aspect of scientific thinking. Not that rationality will cure all ills, but it has improved our health and longevity and we live more peacefully and safely than ever before.

The writer can be contacted at simplescience@gmail.com

Practical quantum computers seem closer

And it's all thanks to two recent advances by physicists, writes saswato r das

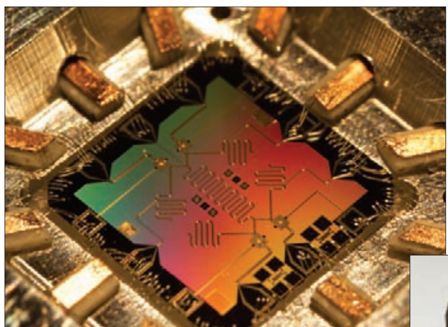
THE long-promised arrival of practical quantum computers – which exploit the laws of quantum mechanics to solve complex problems exponentially faster than conventional computers — seems a step closer, thanks to two recent advances by physicists. In the first advance, reported in a recent issue of *Nature* by Serge Haroche of the Ecole Normale Supérieure and the College de France in Paris, and colleagues, the research team created a real-time feedback mechanism for a quantum computer. Control mechanisms such as feedback loops are central to the operation of large conventional computers.

In the second advance, reported almost simultaneously in *Science* by a group led by Matteo Mariantoni and John Martinis of the University of California at Santa Barbara, the scientists created a quantum Central Processing Unit with memory — the first quantum computing chip, if you will, based on the much-used von Neumann processor-memory architecture.

Experts unanimously praised the work. Dick Slusher, director of the Quantum Institute at the Georgia Institute of Technology, Atlanta, said it was wonderful that it was now possible to "feedback control a quantum state" and called the quantum CPU "tremendous progress".

Quantum computing is an emerging field that has witnessed a lot of advances in recent years. However, a practical quantum computer — one that would rival the processing abilities of a conventional computer — has proved difficult to construct. Part of the problem lies in the fragility of quantum states, which break down (or decohere, in the parlance of quantum mechanics) rather quickly. So far, only rudimentary quantum computers with a handful of qubits (as quantum bits are called) have been built.

As they seek to create larger quantum systems, scientists are trying to incorporate some of the same system engineering concepts that have been developed for classical computers, but it is tricky for quantum systems. "These machines are very fragile," says Haroche. "The coupling to their environment causes decoherence, which destroys the quantum features required to achieve their tasks. Correcting the effects of decoherence is, thus, a very important aspect of quantum information. One possibility

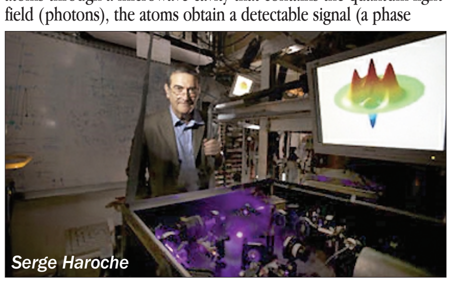


Qubit architecture.

is to control the quantum machine by quantum feedback."

Yet there is a challenge — in the quantum world, the mere act of looking at photons or atoms perturbs their motion and changes their positions and velocities. This is the challenge for quantum feedback: one should be able to observe the system by performing "weak measurements", perturbing it only minimally and the computer must take the perturbation into account before applying the correction.

Haroche and his colleagues used a quantum sensor — a small collection of atoms — to overcome the challenge. By passing the atoms through a microwave cavity that contains the quantum light field (photons), the atoms obtain a detectable signal (a phase



Serge Haroche

shift). While this provides information about the state of the photons, it only performs a weak measurement on the system and does not lead to a total collapse of the light's quantum nature. Measuring changes in the final state of atoms that sequentially pass through the light field provides a signal that can be used to control the light.

"The work is a very impressive demonstration experiment showing that the many techniques developed in the systems engineering community can be translated to the quantum regime — if one is clever enough," said Michael Biercuk, a quantum physicist at the University of Sydney, Australia.

How to incorporate the common von Neumann processor-memory architecture also motivated the second team of researchers. To build the quantum CPU and Random Access Memory, Mariantoni and Martinis and their colleagues used two superconducting Josephson junctions (two pieces of superconducting metals separated by a thin insulating layer) as qubits. They connected the qubits using a bus made of a superconducting microwave resonator. Each qubit's RAM was made using microwave resonators as well. Microwave pulses drove the circuit. They tested their CPU by allowing it to solve a few quantum operations, including a quantum Fourier transform algorithm.

Matteo Mariantoni.

"Our results provide optimism for the near-term implementation of a larger scale quantum processor based on superconducing circuits," the researchers wrote in *Science*.

While the CPU is "really only a two-qubit device (plus a number of extra circuit elements)", said Biercuk, "the fact that algorithmic capability is quickly catching up with demonstrations using trapped ions performed over the last decade is extremely exciting".

While no one expects a quantum computer to rival a conventional computer in the very near future, experts were pleased. Raymond Laflamme, executive director of the Institute of Quantum Computing at the University of Waterloo, Canada, called both experiments "very strong results", saying they "demonstrate an increasing amount of control of quantum processors".

The writer is based in New York and can be contacted at saswatodas@gmail.com

Of mice & medicine

Animal experiments in the UK are on the rise. Though controversial, these tests are transforming human lives, paul vallely **discovers**

A SAD-EYED, mournful-mouthed beagle stares out from a poster on a bus shelter by the front door of the Ear Institute of University College London. Below the melancholy dog blares the legend, "Boycott Vivisection". It is clearly intended to be a reprimand to the scientists passing through the door into one of the world's leading research centres on hearing and deafness. Not that there are any experiments on dogs going on in the institute, but then facts are not always the first currency when it comes to the emotive subject of experiments on animals.

The number of research procedures on animals carried out in the UK rose by three per cent last year. The figure has risen steadily over the past decade to just over 3.7 million in 2010. "Procedures" is the term used by the Home Office, which is looking at ways to meet a commitment in the government's coalition agreement to reduce the use of animals in scientific research. And it is a significant word, for behind it lies a major shift in animal experimentation.

The headline figure disguises considerable changes. Experiments on many of the kind of animals which most inspire protest among animal rights activists were down: dogs by two per cent, rabbits by 10 per cent and cats by 32 per cent. Even the eponymous guinea pigs were down 29 per cent. There was also a fall of 11 per cent in the number of animals used in toxicity trials, as, thanks to rule changes, one test can now be used to satisfy several requirements.

Where there was an increase was in mice and fish — the latter up a whopping 23 per cent. What that reveals is a switch to animals whose genes can be easily modified. An extraordinary 44 per cent of those "procedures" turn out not to be what most members of the public imagine as an "animal experiment" but merely the act of breeding transgenic creatures, mostly done by allowing mice to do what male and female mice do naturally, anyway. But the nature of the experiments has undergone a notable change.

Professor David McAlpine

Inside the Ear Institute, research is being done by Professor David McAlpine and his colleagues into the problem of tinnitus — that odd buzzing sound in the ears which afflicts most of us when we leave a noisy rock concert. "People with tinnitus hear a constant noise in their ears, a buzzing, beeping or whining. It can get very distressing," says a senior researcher, Dr Roland Schaette. "Around 10 per cent of the population are chronic sufferers. And for one to two per cent, their quality of life is badly affected. They lose silence. Some can't relax or sleep. Social isolation and depression can follow. It can drive some people to suicide."

Dr Schaette uses mice in his research to fill the gap between theoretical models and his experiments on human subjects. "We do behavioural training with the mice," he explains. "Obviously you can't ask them what they are experiencing so you have to train them to behave. We play a loud noise, and they jump. Next we play a low noise before the loud one and they learn not to jump when the big noise comes. Then you induce tinnitus in them and play a low constant noise at the same pitch as the first low noise. Mice with tinnitus don't hear (this) so they jump when the big noise comes; mice without, don't."

What happens then is that Dr Schaette and his research assistant use electro-physiological recording techniques to see how nerve activities are affected. "We place a tiny wire into the brain of a mouse that has been sedated with anaesthetic, and given a pain killer," he says. "Then we can record the reaction of a tiny area of the brain, even down to a single neuron, to see how nerve activities are affected, how it alters and what mechanisms alter it." At the end of the experiment the scientists increase the sedative to a fatal dose so that the mouse dies.

So couldn't they achieve the same ends without using an animal? "There are lots of ways of finding things out," interjects Professor McAlpine. "For some tasks you can use a dish of cells. For others you can use brain imaging like magneto-encephalography, which maps activity by the brain's natural electrical currents by recording the magnetic fields they generate. But that is a very limited technique. It is great for telling how the human brain lights up when the body is doing particular activities. But it won't tell you how neural pathways change in tinnitus. You can't tell without an animal model to investigate the neurons. There are more synapses — connections between neurons in the brain — than there are stars in the universe. We can look at which connections grow when a mouse learns a task."

But it is not research like this which accounts for the rise in animal experiments. Across the river at King's College London, in the school of biomedical sciences, research is being done on manipulating mice genes in search for a cure for Parkinson's Disease, the progressive disorder that causes problems with movement, including tremor and muscle rigidity. This debilitating disease is caused by the death of nerve cells in the brain. It gets worse as more nerve cells die. Doctors don't know why. But through experiments on animals they have discovered drugs that dramatically alleviate the terrible shaking which characterises the disease. The problem is these only work for five years. So further experiments are underway as Roger Morris, Professor of Molecular Neurobiology and head of the School of Biomedical Sciences at King's College explains.

"The primary cause of Parkinson's is the death of neurons that deliver an essential chemical called dopamine to the forebrain," he says. "The primary treatment is to provide a substitute chemical, L-DOPA. But in the healthy brain, dopamine is released only in very specific regions. L-DOPA, however, penetrates the whole brain, in a way that the body is not used to. Abnormal changes start to happen, resulting in continuous uncontrolled limb and body movements." Scientists at King's — which has 22,000 experimental animals, 21,000 of them mice — have, over the past couple of decades, used marmosets to discover the dose of L-DOPA which brings the fewest unwanted side effects. Work with such non-human primates is not quite so controversial as experiments with African monkeys. But this is the kind of work which most incenses animal rights activists.

Professor Morris is unapologetic. "There is a lot you can do without animals. Most scientists who use animals do so as part of a whole portfolio of techniques, which will include work with isolated molecules and genes, building up to whole cells growing on plastic dishes in tissue culture to study the more complex integration of cells to work together as a single tissue," he says. Some 90 per cent of his staff's work is done with individual molecules and cells in culture.

"At all these stages, extensive use is made of computational modelling, and analyses of databases, to bring together all the information available on how the particular aspect we work on functions in a living body," he continues. "And there are now non-invasive brain imaging techniques that tell us a lot. But real diseases are diseases of the whole body, and can only be studied in the whole body."

The Independent, London