A critique of pure reason

A new psychology says that the mind is not a computer that works by the rules of logic, but a set of tools evolved to help people live pre-industrial lives

YOU are a barman and you will lose your licence if you serve a drink to an underage drinker. At your bar are four people; you know what two are drinking (one has beer, one has coke) and you know the ages of the other two (one adult, one teenager). Ask the minimum number of questions that will ascertain if you are breaking the law. If your answer is that you need only ask the beer drinker's age and teenager's tipple, then you join the 75% of those asked the question who get it right. Muted congratulations.

Now consider someone faced with cards which have letters on one side and numbers on the other. He wants to check the rule "a card with a D on one side must have a 3 on the other", and he is presented with card D, card F, card 3 and card 7. Which cards must he turn over? More congratulations for the right answer this time, because only 25% of people say D and 7.

The intriguing thing about these two problems is that, to a logician, they are the same. The structure of the card problem, and the answer, are identical to the drinking problem. Why then is one problem easy and the other relatively hard? A small group of psychologists think they know the answer to this meta-question; if they are right, a new theory of the mind will be in order, one which has no such thing as general intelligence within it, and is not dominated by symbolic reasoning skills. The mind is not, they say, a reasoning machine—it is a machine designed for scraping out an existence in a clan of hunter gatherers.

The tests in the first paragraph are called Wason tests, after the psychologist who first tortured people with them. They are the essence of a simple reasoning task—the application of the rule "if p, then q". If the mind were a straightforward reasoning machine, all Wason tests would be equally soluble. In fact their solution depends on the story around them. Psychologists first guessed that it is all about familiarity with the content of the story—a familiar story would be easier for the mind to reduce to soluble ps and qs. The barman's problem is obvious, the other one is obscure. But experiments have ruled that out. Familiar contexts ("if a person eats hot chilli peppers, then he will drink cold beer") prove difficult, while strange ones ("if a man eats cassava root, then he must have a tattoo on his face") sometimes prove easy.

Leda Cosmides and John Tooby of the University of California at Santa Barbara are among the band that thinks it has an explanation. They argue that the underlying logical structure is of little relevance, and that the familiarity of the context does not matter much either. What matters a lot is the nature of the context. If a rule of the form "he who takes the benefit must pay the cost" is at stake, then solving the problem means spotting cheats. People do this well. The mind is not following abstract reason; it is enforcing a social contract.

To demonstrate this, Dr Cosmides gave students at Stanford University a series of Wason tests. Some were set in a fictitious culture in which rules such as the one that restricts cassava root to tattoo-wearers are laid down by a chief called Big Kiku. Others were simply nonsensical conjunctions of events: "If you eat duiker meat, then you have found an ostrich eggshell". The students proved far better at enforcing Big Kiku's laws than at pursuing arbitrary pieces of if-then logic.

Gerd Gigerenzer, of Salzburg University, and his colleagues have gone one step further. In an ingenious Wason test, they asked two groups of students to turn over cards to test the statement: "If an employee gets a pension, then that employee must have worked for the firm for at least ten years." The statements on the cards were "Gets a pension", "Did not get a pension", "Worked for eight years", "Worked for 12 years". The difference between the two groups was that one was told they were employers, the other that they were employees.

If they were solving the problem in some purely logical way, both groups should get the right answer; the rule is broken only when somebody has worked for less than ten years but gets a pension, so the cards to turn are "Gets a pension" and "Worked for eight years". But if they are looking for cheats, employees will worry about those who worked for 12 years and do not get a pension, even though this is strictly irrelevant to the problem. So it proves. Almost all the employers, whose interests coincide with the right answer, turned the correct cards. The employees, however, apparently more concerned with justice than logic, plumped for "Did not get a pension" and "Worked for 12 years" by a ratio of six to one.

Dr Cosmides and Dr Tooby take all this to mean that the Wason test awakens a specific mental mechanism that keeps the accounts in social contracts and is on the lookout for cheats. Following on from that, they suggest that the brain is a bundle of such job-specific mechanisms, shaped by evolution, rather than applying the same general-purpose "reason" to all the problems it encounters.

The inspiration for this notion is the

idea that society is based on social exchange of the form "You scratch my back, I'll scratch yours." In animal societies, all apparently altruistic behaviour that is not based on kinship seems to work like this. Baboons help each other in fights and keep a close account of who owes whom favours. A vampire bat that does not regurgitate part of its blood meal with a neighbour who came home hungry forfeits the return favour at a later date.

Some anthropologists are coming to see human societies in much the same light. Kim Hill of the University of Michigan, who studies the Aché in Paraguay, has found that a hunter who returns from the forest laden with meat will give some to his partner and children, some surreptitiously to a woman he wants to have sex with—the trade is explicit—and some to other hunters who might return the favour later. A fatherless Aché family often nearly starves, because nobody has an incentive to share meat with a family that cannot reciprocate. Such a system of debts is well suited to hunters. A hunter may return empty-handed for days on end and then suddenly kill a tapir—far more than he can eat. Better to share it, and thus be owed a debt, than waste it.

Gambling on certainty

Other aspects of rationality are starting to fall by the wayside, too. Dr Gigerenzer, a probability theorist by training, has tried, using similar ideas, and similar experiments to his work on social contracts, to explain the mistakes people make when thinking about probabilities.

Probability theorists have always been split over the question of what probability is. "Bayesians"—named after the originator of their point of view—say it is a measure of subjective certainty about single events: "I'm 90% sure of my horse winning this race". "Frequentists" say it is the long-run frequency of events: "Nine out of my last ten tips were winners". People are quite good at assessing the latter while, to the delight of bookmakers, they are generally hopeless at the former.

One example of this is the psychological paradox known as the "overconfidence effect". Overconfidence tends to be specific rather than general. When asked a general-knowledge question such as "which city is bigger, Bonn or Heidelberg?" people are more likely to think they know the correct answer than actually to know it. But after answering a string of questions, they are good at estimating the number they got right. Psychologists have used such "fallacies" to argue that people are bad at statistics. Dr Gigerenzer thinks, rather, that people are natural frequentists. He has found that merely rephrasing a problem in frequentist rather than Bayesian terms generally increases the number of people who can solve it (see box).

Think again

ARGUMENTS about Bayesian v frequentist statistics may sound esoteric, but they touch the real world. Dr Cosmides and Dr Tooby applied Dr Gigerenzer's ideas to a disturbing piece of research done in the late 1970s.

Ward Casscells and his colleagues at Harvard Medical School had stopped 60 doctors in the corridors of a prestigious hospital and asked them the question: "If a test to detect a disease, whose prevalence is 1/1,000, has a false-positive rate of 5%, what is the chance that a person found to have a positive result actually has the disease, assuming you know nothing about the person's symptoms?"

Only 11, or 18%, of the doctors knew the answer. Most said 95%, and the average answer was 56%. (The correct answer is one in 51, just under 2%.)

Dr Cosmides and Dr Tooby asked the question of a group of Stanford students and got the same poor success rate. Even when they clarified the meaning of the term "false-positive", which laymen might not be familiar with (though doctors should be), people still got it wrong. Then they rephrased it. Instead of a Bayesian-style question about about the chance of a single infection, they asked a more frequentist one: "How many of 1,000 people who tested positive actually had the disease?" They expected the students (who were neither medically nor statistically trained) to do slightly better. They were stunned by the result: three times as many as before got the right answer.

Nor is this just an abstract experiment. One young American recently committed suicide on learning he had tested positive for HIV. The test had a 4% rate of false positives and he believed his chance of carrying the virus was 96%. It was 10%. Beware of Bayesians bearing diagnoses; the mind is a frequentist device.

Again, a look at primitive life suggests a reason why. The probability of a single event is a meaningless fact in a hunter's world: what can he do about the fact that his chances of killing a tapir today are 3%? But the frequency of past events and past conjunctions is vitally important and always has been: he killed a tapir on three of the last 100 visits to that valley, and five out of 100 visits to this one. A German psychologist, Egon Brunswik, argued as early as the 1960s that human brains are constantly, and unconsciously, assessing such frequencies as guides to future events.

Given this view of man—a natural trader, ever concerned with social debts and an uncertain future—it is little wonder that human minds are interested in detecting cheats, not pursuing pure logic, and in sampling frequencies rather than making risky one-off guesses. Reasoning, in this view, depends on a number of such mental subroutines. Logic is a refinement and codification of their results—a creative and powerful generalisation, but the crowning glory of human intellectual achievement rather than its deep foundation. ■

Repairing vision

Light work

IN THE future—as revealed through science fiction—nobody wears glasses. Perhaps they all wear contact lenses; perhaps they all have perfect eyes. Today one person in three is unlucky enough to suffer poor vision, mostly mildly long or short sight. As a result, glasses and contact lenses are the most common physical aids worn. But they can be troublesome: glasses are noticeable and breakable, contact lenses pop out at inconvenient moments and may cause infections. After 700 years of grinding lenses to augment the eye, some doctors are now grinding away at the eye itself. Lasers are their tools.

Lasers have been used to zap diseased retinas—the filmy curtains at the back of eyes which begin the process of changing light into mental images—since the 1960s. But only recently have they been used to change the shape of the cornea, the clear outer layer of the eye.

Though it is not normally called a lens,

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