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To trust is human

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Putting your faith in others should be the surest way to get walked all over, yet most of us are full of goodwill. We just can't help ourselves, says Ken Grimes

"IT'S good to trust; it's better not to," goes an Italian proverb. Player 1 may not know these particular words of wisdom, but chances are she's thinking much the same as she tries to decide whether to send Player 2 some of her $10 stake. If she does, the money will be tripled, and her anonymous partner can choose to return none, some, or all of the cash. But why should Player 2 send anything back? And why should Player 1 give anything in the first place? Despite the iron logic of this argument, she types in her command to send some money. A few moments later she smiles, seeing from her screen that Player 2 has returned a tidy sum that leaves them both showing a net profit.

This outcome doesn't just flout proverbial wisdom, it thumbs its nose at economic theory. Based on exactly the same cold logic that Player 1 dismissed, the so-called Nash equilibrium predicts that in economic transactions between strangers, where one has to make decisions based on a forecast of another's response, the optimal level of trust is zero. Yet despite the economic orthodoxy, the behaviour of Players 1 and 2 is not exceptional. In fact, over the course of hundreds of such trials, it turns out that about half of Player 1s send some money, and three-quarters of Player 2s who receive it send some back.

So, what do the players know that the transaction theorists don't? "The reason that this high degree of trust in the laboratory is proving a mystery to economists is that they haven't taken into account the neurological component of trust," says Paul Zak of Claremont Graduate University in California, who leads the team doing these experiments. He points out that our brains have been tailored by evolution to cope with group living. So along with our so-

called Machiavellian intelligence - which allows us to outwit rivals for mates, food and status - our social brain is also adapted to be cooperative. Individuals can benefit by working together. But that requires trust, which is why, according to Zak, we have a biological urge to trust one another.

Zak is a leading protagonist in the relatively new field of neuroeconomics, which aims to understand human social interactions through every level from synapse to society. It is a hugely ambitious undertaking. By laying bare the mysteries of such nebulous human attributes as trust, neuroeconomists hope to transform our self-understanding. They believe their findings even have the potential to help make societies more productive and successful. "As we learn more about the remarkable internal order of the mind, we will also understand far more deeply the social mind and therefore the external order of personal exchange, and the extended order of exchange through markets," says neuroeconomist Vernon Smith of George Mason University in Virginia, whose Nobel Prize last year signalled the arrival of experimental economics on the world stage. "We are just at the beginning of a great intellectual adventure."

Experiments by Zak, Smith and others confirm what life teaches us: people frequently choose to be cooperative, trusting and generous during economic negotiations. Now the search is on to find the biological mechanisms that underpin such behaviour. Zak's latest research, for example, attempts to correlate variations in trust-based behaviours with changes in levels of eight hormones. Only one has emerged as a strong candidate for a human "trust chemical": oxytocin, a reproductive hormone primarily responsible for uterine contractions and lactation in female mammals. Studies in animals also link oxytocin with pro-social behaviours such as bonding with offspring, and with sexual pair-bonding in some mammals (see "From love to monogamy to trust"). Zak and others are taking these findings one step further to show how oxytocin might underpin behaviours such as trust in humans.

Oxytocin production is triggered by pleasant experiences that include eating, warm baths, gentle vibration and sex. The hormone acts through the parasympathetic nervous system, one half of the mammalian autonomic nervous system that regulates unconscious processes such as breathing and heart rate. The other half, the sympathetic nervous system, uses stress hormones such as adrenaline to activate the so-called "fight or flight" response. The parasympathetic system, in contrast, generates the "rest and digest" response, signalling to the body that things are safe and that stress hormones can subside. But Zak and his colleagues suspect that, in addition to this physiological

activity, oxytocin may also bring about a psychological response in humans that they have dubbed "lust and trust".

Oxytocin is properly described as a "neuromodulator", because it has a wide-ranging role in the nervous system. It affects the autonomic nervous system as a hormone both in brain cells and in blood, and also acts as a neurotransmitter affecting the central nervous system. Maps of oxytocin pathways through the human brain confirm it as a likely candidate for a feel-good trust generator. Receptors for the hormone are massed in the hypothalamus, which regulates the autonomic nervous system, and the limbic system - especially the amygdalae - which is the primary centre of the emotions. Neurological pathways connect these regions of the brain to areas associated with memory, and there are also projections from the limbic system to the prefrontal cortex, where decision-making occurs. Social interactions, including trust-based ones, involve all these parts of the brain as they employ a combination of emotions, memory and decision-making, Zak points out.

So how does this help to explain the unexpected outcomes of Zak's trust game? Two other experimental results are important here: when Player 2s receive larger money transfers from 1s, they return higher amounts. They also show larger increases in blood oxytocin levels, whereas Player 1s show no increase, whichever way they play the game. Zak points out that the amount of money sent by Player 1 is a measure of trust, and that returned by 2 a measure of trustworthiness. Although Player 1's "trust" might conceivably be the outcome of a poor conscious decision combining greed with blind optimism, no such rationale can explain the end-of-transaction trustworthiness displayed by three-quarters of Player 2s. "The experiment suggests that oxytocin is strongly related to trustworthiness," says Zak. And the fact that Player 1s do not have elevated oxytocin levels indicates that it is released as a response to the social signal of trust. "Trusting is a highly social activity," says Zak.

Even more intriguingly, it seems that this urge to respond positively when someone shows trust in us is largely outside our control. "In light of the underlying neural anatomy, our experimental results suggest that oxytocin influences human trust decisions in ways largely beyond the realm of conscious perception, since the structures where it is activated are situated outside the large frontal cortex," says Zak. "Trust in our species therefore appears to be driven by an emotional 'sense' of what to do, rather than a conscious determination." Surprisingly, this civilising will-to-trust arises in relatively primitive areas of the brain where the majority of oxytocin receptors are located.

Zak's interpretation of his findings poses a challenge to economic tenets like the Nash equilibrium that assume we consciously and rationally seek to maximise personal profits. These models see human motivation as a kind of "lucid greed", transparent to the introspection of oneself and others. Observed cooperation is then explained as an emergent property of culture and society, imposed from above on the natural selfishness that is the human default motivation. Zak's work suggests, in contrast, that social cooperation can arise as a primitive impulse in ancient brain areas - an impulse that successfully contests the lucid greed generated by more recently evolved brain regions.

That may be so, but it surely can't be the whole story, argue Smith and his colleague Kevin McCabe, who pioneered the trust game used by Zak. Raised oxytocin may unconsciously increase trustworthiness, but it seems to be a response to having trust placed in us by another human being. Smith and McCabe argue that decisions about whether or not to trust someone in the first place are made more consciously because we need to take into consideration our beliefs about another person's intentions. This implies a combination of sophisticated cognitive processes: "theory of mind" to recognise that another's viewpoint and motivation may differ from our own; "joint attention" to focus on the object of the other individual's interest; and "delay of gratification" to renounce immediate rewards in favour of later but larger ones. These processes are associated with activity in two particular regions of the prefrontal cortex known as Brodmann's Areas 8 and 10, so Smith and McCabe decided to look at these in their trust experiments (*Proceedings of the National Academy of Sciences*, vol 98, p 11832).

They used functional magnetic resonance imaging to record brain activity in Player 1s who knew they were up against either a human partner or a computer programmed to act with a known and low probability of trustworthiness. As the researchers predicted, those subjects who opted to trust showed patterns of increased brain activity in Brodmann's Areas 8 and 10 when playing with human partners, and none when playing with computers. Non-trusters showed little activity in either situation. Smith and McCabe conclude that the decision to trust depends on projecting one's own cooperative intentions onto another person.

A new study by economist Ernst Fehr from the University of Zurich in Switzerland seems to confirm this (*Nature*, vol 422, p 137). Using a similar trust game, Fehr found that Player 2s are more likely to show trustworthiness when they are trusted by Player 1s rather than threatened.

"Threats introduce hostility and distrust into a relationship," Fehr says, "and that initial distrust may be self-fulfilling because it seems to generate untrustworthy behaviour." He adds, "I think that trust has an emotional component and a cognitive, conscious component. It is important to understand both."

Zak accepts that the higher, executive brain plays a role, but suggests that oxytocin may make us more trusting than our logic tells us to be, by allowing the primitive brain to impose a "sneaky veto" on purely self-interested behaviour. He concludes that diverse and complementary trust mechanisms have emerged at different stages of human brain evolution. McCabe thinks he could be right. "The theory-of-mind, delay-of-gratification loop may simply be the most advanced trust mechanism, making it possible for humans to reciprocate over a much larger cross-range of goods and behaviours," he says. The important point, the neuroeconomists agree, is that we trust when it is advantageous to do so, because trusting can only have evolved as an adaptation to group living if it gives an individual the edge in terms of survival and reproduction. And it clearly is adaptive, says Zak. "In our experiments, those individuals who chose to trust came out better."

Crucially for international economic development, what is true for individuals turns out also to be true for nations. As Zak's collaborator Steve Knack of the World Bank points out: "Trust is one of the most powerful factors affecting a country's economic health. Where trust is low, individuals and organisations are more wary about engaging in financial transactions, which tends to depress the national economy."

And trust levels differ greatly between nations. The World Values Survey, based at the University of Michigan, Ann Arbor, has asked people in countries around the world, "Do you think strangers can generally be trusted?" The positive response rate varies from about 65 per cent in Norway to about 5 per cent in Brazil. Disturbingly, countries where trust is lower than a critical level of about 30 per cent - as is the case in much of South America and Africa - risk falling into a permanent suspicion-locked poverty trap. "Policy-makers in these latter countries might be urgently interested in mechanisms that enable them to raise national trust levels," observes Knack.

National trust

Zak thinks his neuroeconomics findings can help. "We need to examine what national factors influence oxytocin," he says. This is exactly what he has done in a new study that looks at 85 environmental, economic and social

factors predicted from animal studies to affect oxytocin levels in humans. His results not only confirm the link between trust and many of these factors, but also suggest that together they explained 97 per cent of the variation in trust levels across the 41 countries studied. Some of the factors have a direct biochemical effect on oxytocin receptors - eating legumes, for example, which is positively correlated with trust, and air pollution, which has a negative correlation. Others reflect oxytocin's natural role as a reproductive hormone. These include marriage rate (positive correlation) and bottle-feeding (negative). Still others - notably, socio-political stability and equality - probably reflect the hormone's more general "rest and digest" role and its antithetical relationship to stress situations.

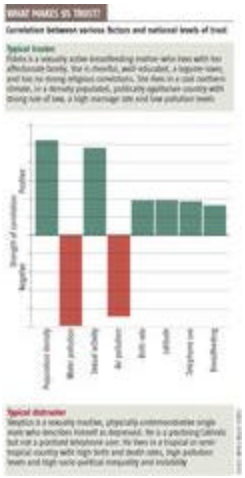
One surprise is the negative correlation between trust and religious belief. But Knack has an explanation. "Lack of trust in other people increases the need for religious faith," he says. "If you can't rely on others, you have to rely on a higher power." He also points out that the positive correlation between trust and higher latitude is not as straightforward as it might first appear. "The most fascinating piece of evidence I've seen on trust is that the highest-trust areas of the US are those with the most descendants of Scandinavian immigrants," he says. In other words, the tendency to trust seems to persist over several generations even when transplanted to a very different environment.

In the light of Zak's study, what measures would Knack take to raise trust if he were the benign tyrant of a poverty-trapped country? "Independent media; transparency in policy-making; rule of law, including equal access to courts; and equal accountability before the law for the benign tyrant, his family and cronies," he says.

To this list Zak adds: provision of universal education; clean water and environment; public health measures; strengthening of social ties (for example, subsidising social activities and having parades); poverty reduction; better telephone coverage; promoting breastfeeding and family planning (more investment in, and bonding with, a smaller number of kids); volunteering; and encouraging greater consumption of healthy food, especially soya, legumes and green vegetables. Fehr believes that absence of corruption is a crucial factor.

So it seems that the best way to improve a country's economic performance is to create Utopia. The power to implement this blueprint for a better world clearly rests with institutional policy-makers - and nobody's pretending that it would be easy. But Zak has already pointed out that there is something private citizens can do to help their nation

thrive economically. "The easiest way for individuals to raise their own trust-and-transaction-boosting oxytocin is, well, sex," he says. Not too onerous a civic duty, then.



From love to monogamy to trust

Mother love really is the mother of all loves, according to Cort Pedersen, professor of psychiatry at the University of North Carolina in Chapel Hill. "Love is a by-product of the evolution of mammals. And the original form of this by-product was maternal love, because it increased the chances of offspring survival." For this to work, mammalian mothers needed a new system in the brain to activate maternal care and suppress the feelings of fear and aggression elicited by unfamiliar newborns. "That's where oxytocin came in," says Pedersen.

Pedersen suspects the love hormone has its origins in reptile sex. "In lower vertebrates, the evolution of copulation required both a motivational system to get physically close, and the capacity to suppress fear, aggression and stress during intimate contact with strangers," he says. A hormonal system based on precursors of oxytocin evolved in response to these pressures to "attach" to a mate. And it's this primitive attachment mechanism that was co-opted for mother love.

Oxytocin has come a long way since then. From mother love it went on to play a further role in social evolution, helping create the sexual bond between parents that is associated with joint childcare and monogamy. Later it was roped in to help in forming attachments between close relatives, allowing them to work together for the benefit of their shared genes. "In mammals and especially primates, emotional attachment systems are particularly important in promoting altruism among kin," says Pedersen.

And so to the kindness of strangers. Reciprocal altruism began to emerge because alliances with non-family could sometimes increase an individual's reproductive success as well as that of its close relatives. But because the cooperating parties do not share genes this can only work if there is no cheating. "The emotional attachment system based on oxytocin may have evolved to become very sensitive to generosity and positive reciprocity," says Pedersen.

Indeed, James Rilling and colleagues at Princeton University have used brain imaging to show that when people cooperate, the reward centres of their brains light up (*Neuron*, vol 35, p 395). In other words, it feels good to trust and be trusted.

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