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Kaleidoscope

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***In de Wildeman* is the lead author's favourite bar in Amsterdam. As well as having the best beers and most knowledgeable and friendly staff, its door-sign is of a gruff Neanderthal or early *Homo sapiens*.** Musing about this over some of Holland's finest brews made Tracy ponder early humans, in particular juxtaposing their stereotypic brutish caveman image against the evident complex emotional lives they must have had. Fortuitously, multiple papers in this month's column tap into this. *Homo sapiens* – us – are notably disproportionately more fearful than other primates from infancy onwards, something that at first glance (and indeed in a bulk of the psychological literature) might feel maladaptive, and indeed it is a trait that is associated with the development of anxiety and depression. Grossmann[1] offers a solution via the fearful ape hypothesis. Reviewed empirical ontogenic data show that greater expressed infant fearfulness, and its perception by mothers, elicits enhanced our species-unique levels of care-based responding and provisioning. Further, it produces greater cooperation within local social networks. 'We can easily forgive a child who is afraid of the dark; the real tragedy of life is when men are afraid of the light' taught Plato. Long seen as maladaptive, this darkest of emotions may have a central role in human bonding. Intriguingly, Grossmann's work offers up a putative answer to the conundrum of greater rates of affective disorders in WEIRD (Western, Educated, Industrialised, Rich and Democratic) societies, where fearfulness may be more maladaptive in societies marked by individualism and less on cooperative care.

Scrivner et al[2] broaden the discussion to cover a 'common grammar of social valuation'. They note how natural selection has refined social emotions to be – crudely – behaviour regulating programmes to solve adaptive problems. Starting off with a list of what felt like biblical deadly sins (or some perverse version of the Snow White and the Seven Dwarfs), they assay anger, pride, shame, sadness, guilt, envy and gratitude, explaining the adaptive mechanism of each. We lack the space to do them all justice here, but as a taster, pride has value in motivating the achievement and advertisement of socially valued acts; anger allows bargaining for better treatment; and guilt helps remedy situations wherein one puts insufficient weight on the welfare of a valuable other. What is common to them all – the proposed common grammar – is how an imputed valent trigger can be assayed by the mind across these emotions and shape behaviour. Fitting with a posited evolutionary, rather than cultural, basis, the authors note their universality across world cultures.

People – generally – turn out to be altruistic. It's an important finding from laboratory-based, behavioural economic public goods games that have produced a consensus that altruistic behaviour is 'baked into' humans. This stands in stark contrast to the ecological evidence offered by, for example, governments' economic policies and indeed experiences of many individuals' behaviour: try spending time on public transport, in a supermarket or trying to get served in a busy pub (the aforementioned *In de Wildeman* getting a notable pass here). But what if the altruism – inferred from participants' behaviour in these experiments – is an artefact of the laboratory environment and game mechanics rather tapping some evolved property of the human condition? Public goods games work by each participant donating some financial tokens into a public pot and, depending on the behaviour of the group, the total amount is divided among the players according to some rules. These games are often played iteratively, and the observed altruistic or selfish behaviour is inferred from changes in players' donations as they move from the initial to the final round of the game.

Burton-Chellew et al[3] examined this by placing players in four versions of a public goods game that enabled estimation of contrasts in behaviours between the game conditions that test one of two hypothesised patterns of behaviour. The first is that players act in a purely self-interested (selfish) way, but are 'confused learners' – meaning that the changes in donations on each round reflect players learning the game rules as they proceed, ignoring the behaviour of other players and actually behaving in a self-interested way. The second hypothesis is the 'conditional co-operators' pattern, where players genuinely adapt their behaviour to that of the other players, and changes in donations are genuinely conditioned on other players' observable altruism or selfishness. They found that, in fact, the four versions of the game support the confused learner (but not the conditional co-operator) hypothesis because one condition – where players are only shown their payoff but not the behaviours of other players on each round – generated the largest declines in donations (irrespective of what behaviour was shown to them). In addition, when the players were asked, they verbalised that they were confused about the games' rules as they played and, perhaps most persuasively, over half of players reported they were playing selfishly. In summary, a combination of learning the game rules and self-interest best explain the results traditionally offered as evidence of altruism in laboratory-based behavioural economic public goods games. It would seem that in group play, we are merely learning how best to shaft our comrades. None of this surprises the Kaleidoscope team, recognising as in the Walt Whitman poem and later cover by Bob Dylan 'I contain multitudes'; filled as we are with envy, anger pride and occasional confused altruism.

All this talk of the complexity of human emotions shows we'll never be replaced by artificial intelligence and robots, right? Right? Ok, so they beat chess grandmasters in the 1990s, and masters of the game of Go by 2016, but all still – relatively – simple in terms of human cognitive and emotional possibilities. Well, you might want to start rewatching the Terminator movies for survival tips, as a new paper in Science[4] 'introduces' Cicero (whom we choose to label the T-1000), an artificial intelligence agent that has achieved human-level performance in the game Diplomacy, a seven-player strategic game that requires a combination of cooperation and competition and utilises natural language negotiation and tactical coordination. Just re-read that last sentence: that's a lot of action for the artificial intelligence agent. Beyond a basic language model, it has to understand beliefs and intentions of others, and then try persuade change to align with its own goals. Contrast that with the purely adversarial, two-player zero-sum nature of chess. Cicero was able to integrate a language model with planning and reinforcement learning, inferring other players' beliefs from their actions and dialogue, and achieved its aims via dialogue with them. Notably, Cicero was entered anonymously into online games in a league of human players; in-game messaging suggested that none of the 82 humans suspected they had a machine playing with them. Overall, its score was more than twice that of the average human, and it fell in the top ten per cent of all players. Time for computers to take over diplomacy from our current crop of politicians (none of whom appear to us to be in the top ten per cent of anything)? Maybe… or maybe it's a good thing humans have been shown to feel and express fear from a young age. For those interested in the potential dangers of super-intelligent artificial intelligence, the 'genies, sovereigns,

oracles, and tools' conundrum, and having artificial intelligence values aligned with our own, we commend Sam Harris's recent podcast on the topic.

Thankfully, smart machines ultimately destroy themselves – we've seen enough movies to feel safe. But what about the idea that more intelligent people have greater mental health problems? Intelligence is well established as having an association with greater physical health and longevity, but the idea of the troubled genius is a hoary old trope. There have been data supporting this, though often skewed by sampling bias, inadequate (or no) controls and insufficient sample sizes. Williams et al[5] redress this with a UK Biobank study that included data from over a quarter of a million individuals: approximately 236 000 with a general intelligence (g-factor) within two standard deviations of the population mean and 16 000 with a high g-factor greater than two standard deviations. Self-report questionnaires and diagnostic data allowed delineation into 32 distinct phenotypes. High and average g-factor groups showed variance across about half of these phenotypes, though age and sex had no impact. And in terms of mental illness? Those with higher intelligence had statistically significantly less anxiety, post-traumatic stress disorder and social isolation; there were no differences for other mental illnesses. We know what you're thinking, and yes, they also had fewer adverse childhood experiences and/or abuse and fewer adult stressors. So, the challenge of associations versus causality inevitably raises its head. Nevertheless, as the largest study of its kind, it seems to put to bed the stereotype that intelligent people – presumably the modal *BJPsych* reader – will have greater psychological difficulties.

Finally, finishing our evolution special, and a scarcely imaginable outcome: the *de novo* appearance of multicellularity from a unicellular laboratory organism. It is perhaps difficult through everyday conceptualisations of gradual evolutionary change to consider some of the bedrock qualitative shifts in organisms that radically, overwhelmingly, changed life as we know it: the emergence of life in the first instance; the occurrence of eukaryotic cells with nuclei; the two great endosymbiotic events of capturing mitochondria in animal cells and chloroplasts in plant cells; and the emergence of multicellular organisms. Herron et al[6] appear to have recreated the last of these by subjecting populations of unicellular green algae to a selective pressure from the (also unicellular) filter-feeder *Paramecium tetraurelia*. Of note, the algae, *Chlamydomonas reinhardtii*, have no multicellular ancestors. Within 750 asexual generations (where mutations are inherently less common than occur with sexual reproduction), two of the five populations had evolved multicellular structures not seen in the controls. The specific multicellular changes were variable, including changes in cell numbers and size of propagules, and were demonstrated as providing additional benefit against predation due to greater size. The authors note that to cross a 'predation threshold', it may be easier for an organism to become multicellular than for a single cell to increase its size, owing to the various trade-offs that occur in scaling relationships in terms of surface area to volume ratios. It's difficult to overstate the philosophical impact of all this: for the aforementioned great qualitative leaps, it has been a major challenge to understand how easily or otherwise they might have occurred. For perspective, genetic data suggest that the development of eukaryotic cells and the capture of mitochondria might have occurred once in the history of earth, with all subsequent daughter cells and species derived from a single parent. For multicellularity, these new data affirm that this particular transition might have been a far easier and perhaps inevitable one. All enough to put the lead author in rather a philosophical and thoughtful mood and make him wistful about a zoetrope of very happy memories over some unicellular-yeast-enhanced beverages back *In de Wildeman. Saudade.*

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