

EVOLUTION

Selection for positive illusions

Everybody knows that overconfidence can be foolhardy. But a study reveals that having an overly positive self-image might confer an evolutionary advantage if the rewards outweigh the risks. [SEE LETTER P.317](#)

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Ask anyone with a driver's licence to rate their own abilities behind the wheel, and most people will report that they are above average¹. The same is true for self-assessments of performance in cognitive tasks², of attractiveness³ (by men, not by women) and of the healthiness of our behaviour⁴: people typically place themselves higher on the ladder than they really are. In a survey of 1 million high-school students⁵, a solid 70% rated themselves as above-average leaders (versus 2% who thought of themselves as below average), and a spectacular 94% of college professors possess teaching abilities that are above average — according to themselves⁶.

Obviously they cannot all be right, but that does not make them dysfunctional or mentally unhealthy. In fact, one way to get self-assessments to obey some minimal aggregate consistency is to restrict surveys to sufficiently depressed people⁷ (although this finding has been questioned^{8,9}). Mentally healthy people blissfully suffer from what are called positive illusions: they overestimate their abilities, as well as their control over events, and they underestimate their vulnerability to risk¹⁰. Of course, one can overrate oneself too much, as do sufferers from narcissistic personality disorder or megalomania, but healthy people's estimates of their own abilities seem to start just a little above where they really are. Reporting on page 317 of this issue, Johnson and Fowler¹¹ describe a model that might explain why this is so.

An obvious question is how overconfidence survives the process of natural selection. The prevalence of rose-tinted self-assessments suggests that it might even be adaptive to be overconfident — in contrast to schizophrenia, for instance, which is maladaptive but nonetheless exists in moderate proportions in humans. But how can it be adaptive to misjudge how you compare with others? You would think that an incorrect assessment of one's own capabilities can induce only misguided decisions.

One suggested explanation is that there is a benefit in having others think that you're great. And as there is no better way of being a strong persuader than firmly believing in yourself, this would lead to an upward bias in how



GETTY IMAGES

Figure 1 | Float like a butterfly, sting like a bee. Muhammad Ali saw himself as “the king of the world”. His supreme confidence helped him to win many fights. Johnson and Fowler¹¹ report that overconfidence can confer an evolutionary advantage.

people perceive themselves compared with others¹². That may lead to a mistake here and there, but the benefits of the esteem of others could outweigh that (Fig. 1).

Johnson and Fowler¹¹ suggest a remarkable alternative explanation. According to their model, a biased self-belief can actually lead people to make the right decision, whereas an unbiased self-image would lead to a suboptimal decision. That sounds counter-intuitive, but the key lies in the authors' departure from what could be called the ‘naive economist's' idea of how humans arrive at decisions (‘naive’ because many economists are not that naive at all).

The authors' model envisages a valuable resource that two individuals can decide to claim or not. If both claim it, then they will fight over it — which is costly for both. The stronger individual will win the fight and gain access to the resource. If only one of them claims the resource, it goes to that person. If neither claims it, no one gets it.

Now if both contenders could simply assess the fighting strength of the other with perfect accuracy, the optimal strategy would be a

no-brainer: fight if you are stronger, concede if you are weaker. But it gets interesting if the contestants have imperfect information about each other's strength. In this situation, contestants might back off because they think their opponent is stronger than he or she really is. A weaker contestant could then win a reward if she claims it while the opponent backs off.

This situation can be dealt with within the realm of what economists call perfect rationality, which assumes that both parties understand all aspects of their situation, and that they correctly anticipate the odds that the other player will claim the resource. But Johnson and Fowler suggest that there is a short cut to the right decision. The short cut combines a simple heuristic — fight if you think you're stronger — with a bias. If the resource is valuable relative to the cost of fighting, then the risk of an extra battle here and there is outweighed by the gains made when otherwise unclaimed resources are won, which makes overestimating one's own fighting abilities worthwhile. If the cost of fighting is large relative to the value of the resource, then it is better to underestimate one's own strength. The behaviours

described by the authors' model are actually more complex than described above, because the model also predicts that populations can, for instance, evolve to a stable mixture of both over- and under-confident people.

Another evolutionary explanation is the following: overconfidence could reduce average pay-off, but top performers will still come from the group of overconfident individuals. For example, overconfidence about roulette-playing 'abilities' will lead to overall losses from this game, but the best performers will have played often. Strong selection — as in 'winner takes all' — should favour overconfidence.

Johnson and Fowler's study¹¹ prompts a variety of interesting questions. The 'winning strategy' (for low fighting costs) can be wired into the brain in two ways. The first involves a simple heuristic plus overconfidence: only fight when you think you are stronger, but overestimate your strength. The second way involves perfect rationality without overconfidence: given some uncertainty, the winning strategy can be to fight opponents even if they seem slightly stronger than you. Future empirical and theoretical studies might help to decide

which of these two describes us best.

It would also be interesting to establish a link between the authors' findings and overconfidence in trading behaviour¹³, the willingness to buy overly complex financial products (which are thought to have led to the current crisis in the banking system), political decisions that lead to war¹⁴, and the evolution of fighting behaviour in animals¹⁵. Given that 94% of college professors rate themselves as above average, there should be enough overconfidence around to tackle all the natural follow-up questions. ■

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CELL DIVISION

Six degrees of separation

During cell division, the DNA-associated CENP-A protein recruits the kinetochore protein complex to assemble on chromosomes. A region of just six amino-acid residues earmarks CENP-A for this purpose. SEE LETTER P.354

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In chromosomes, a series of protein particles act like spools, packaging DNA into a structure called chromatin. The spools are known as nucleosomes, and most are composed of eight subunits — two subunits of each of the four major histone proteins, H2A, H2B, H3 and H4. However, the centromeric sites, which are required for chromosome segregation during cell division, are different. Instead of two subunits of H3, centromeric nucleosomes contain the centromere-specific histone H3 variant called CENP-A. Two papers^{1,2}, including one by Guse *et al.* on page 354 of this issue, provide structural and mechanistic insights into the workings of CENP-A-containing nucleosomes.

At cell division, chromosome segregation is orchestrated by the kinetochore — a complex machinery composed of more than 100 proteins through which chromosomes attach to the microtubules that form the spindle apparatus, which allows chromosome segregation. In most

eukaryotes (organisms such as animals, plants and fungi), kinetochores are assembled at centromeres. Centromeres frequently contain extensive arrays of repetitive DNA sequences, such as the 100–10,000-kilobase repeats in the 'α-satellite' DNA family found in human centromeres. Kinetochores assemble on only a subset of these repeats, indicating that factors other than primary DNA sequence influence the site of assembly^{3,4}.

It is well known that heritable changes in genome function can occur through alterations that are independent of the DNA sequence — a process referred to as epigenetic propagation. Epigenetic phenomena are frequently mediated by post-translational modification of histones through the addition of chemical entities such as acetyl and methyl groups, which form epigenetic 'marks'. Such marks promote the assembly of specific chromatin states that are crucial for many cellular and developmental processes. CENP-A itself has an extreme epigenetic character, and, by replacing histone H3, it provides a pivotal

mark for the formation of centromeres at a particular location on chromosomes^{3,4}.

Previous work⁵ in fruitfly cells showed that overexpression of CENP-A leads to the assembly of kinetochores at new sites, suggesting that CENP-A nucleosomes act alone to form a platform for kinetochore formation. Nonetheless, similar experiments on cultured human cells⁶ did not induce abnormal localization of kinetochores. To investigate how CENP-A directly effects the interaction between the centromere and kinetochores, Guse *et al.*¹ generated *in vitro* arrays of CENP-A nucleosomes assembled on DNA.

The authors find that, when placed in frog egg extracts, CENP-A nucleosomes can recruit kinetochore proteins. However, it remains unclear whether these structures contain the full repertoire of components associated with native centromeres, or whether they can mediate processes such as chromosome movement along microtubules. Nevertheless, Guse and colleagues' synthetic kinetochores clearly show aspects of normal kinetochore function: they display enhanced microtubule binding, and they seem to sense interactions with microtubules, eliciting a response that is indicative of an operational spindle-assembly checkpoint — the surveillance mechanism that ensures accurate chromosome segregation during cell division. Thus, in this *in vitro* system at least, CENP-A nucleosomes are sufficient to dictate 'functional' kinetochore assembly, whereas H3 nucleosomes assembled on the same DNA sequence are not. In other words, incorporating CENP-A in place of H3 makes the crucial difference that allows kinetochore formation *in vitro*.