

Guest editorial

The evolutionary psychology of healing: A human success story

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Humans are far from being the healthiest of animals. Whether in a modern city or primeval forest, their life-styles expose them to too many risks from infection and accident (a recent study of a group of Paraguayan hunter-gatherers revealed that men are too unwell to hunt 20% of the time [1]). Yet we argue in this essay that humans are by nature exceptionally good — perhaps even the best of all animals — at managing their own recovery when they do fall ill. And this superiority in what we call ‘natural health care’ rests on two special features of human psychology. First, humans are remarkably good at using environmental information to forecast the costs and benefits of deploying their biologically-based health defenses. Second, they are remarkably susceptible — benignly susceptible as it turns out — to culturally-based ‘medical disinformation’ in the guise of placebo treatments.

The *gubernator medicatrix*

We’ll start with what humans and their animal relatives have in common. Humans have of course inherited from their pre-human ancestors the standard mammalian tool-kit of health defenses: the *vis medicatrix naturae* that has been assembled by natural selection in the long course of evolution. These ancient healing powers include mechanisms for repairing damaged tissue, fighting infection, ridding the body of toxins, restricting movement to avoid further injury, as well as a variety of ‘sickness behaviors’.

The benefits of deploying such defenses are plain: the patient survives the illness. But the costs are plain too. Mounting an immune response is energetically expensive and uses up rare nutrients that will

later have to be replaced. Starving bacteria of iron produces debilitating anaemia. Vomiting and diarrhoea waste fluid and food stuffs. Running a high temperature to kill fungi or bacteria raises metabolism by up to 50%. Pain, nausea, fatigue, and other ‘protective states of mind’ not only get in the way of performing essential tasks but are highly disagreeable and, ironically, are often considered to be a form of illness in themselves. As the evolutionary psychiatrist Randolph Nesse has emphasised [2], nature has designed us to be safe not comfortable.

Given the real benefits, it will usually be adaptive to deploy a particular defense despite the costs. Better be in pain that reduces mobility than risk opening a wound. Better to put up with a fever that helps kill bacterial parasites than risk the infection flaring up out of control. But, equally, given the real costs, there will also be times when deploying the defense would actually be inadvisable. Better *not* to mount a full-blown immune response when there’s a risk of famine. Better *not* feel the pain from a sprained ankle when escaping from a predator.

In general, a particular healing measure can be expected to be adaptive only when the anticipated benefits are likely to exceed the anticipated costs. In short, self-healing involves — or ought to involve — a judgment call. It follows that, from early on in the evolution of the *vis medicatrix*, there must have been selective pressure to develop a secondary control system that can forecast the costs and benefits, and steer the *vis* accordingly.

We propose to call this secondary steering system the *gubernator medicatrix*, the ‘health governor’ (*gubernator* in Latin meaning ‘helmsman’). We have previously referred to this system as the natural ‘health management system’ [3,4], but have renamed it now to acknowledge the parallel with the ‘central governor’, identified ninety years ago by Nobel Prize-winning physiologist, A.V. Hill, that regulates energy expenditure in muscular exercise [5,6].

What this health governor has evolved to do is to perform a kind of economic analysis of what the costs and benefits of self-cure will be, taking account of how dangerous the

situation seems to be right now, what can be expected to happen next, what reserves there are in store, and so on. In effect, the health governor acts like a good hospital manager who, with finite resources, has to try to provide a service that maximizes patient satisfaction in the short-term while minimizing long-term risks. Crucially, he needs to be able to make an informed guess about *future* needs and opportunities, so that he can budget accordingly (Figure 1).

For example, the health governor might detect that days are getting longer, forecast that Spring is coming so that food supplies will become more readily available, and on this basis it can licence a full blown immune response. The governor might detect that family and friends are present, forecast that tender loving care will be provided, and so call off pain. It might observe that others are falling sick, forecast that there is contagion in the air, and lower the threshold for nausea. Or — a different kind of case — it might detect that it is in a pregnant mother, and so take additional precautions to protect the foetus.

Health governor mark I

The health governor is an ancient system. Top-down neuronal control of immunity has been found to exist even in nematode worms [7]. So we can assume the mammalian health governor has a ‘knowledge base’ about threats and opportunities that goes back hundreds of millions of years. Much of this knowledge will now consist of evolved ‘rules of thumb’, linking environmental contingencies to health outcomes, that have been hard-wired into the system by natural selection.

Suppose a hamster is injected with bacteria that make it sick — but in one case the hamster is on an artificial day/night cycle that corresponds to summer; in the other case it is on a cycle that corresponds to winter. Experiments show that, when the hamster is tricked into thinking it is summer, it throws everything it has got against the infection, develops a high fever and anorexia, and eliminates the bacteria. However, when it thinks it is winter, then it just mounts a holding operation [8]. But the hamster ‘thinks’ this or that? No, of course it doesn’t *think* it consciously — the light/dark

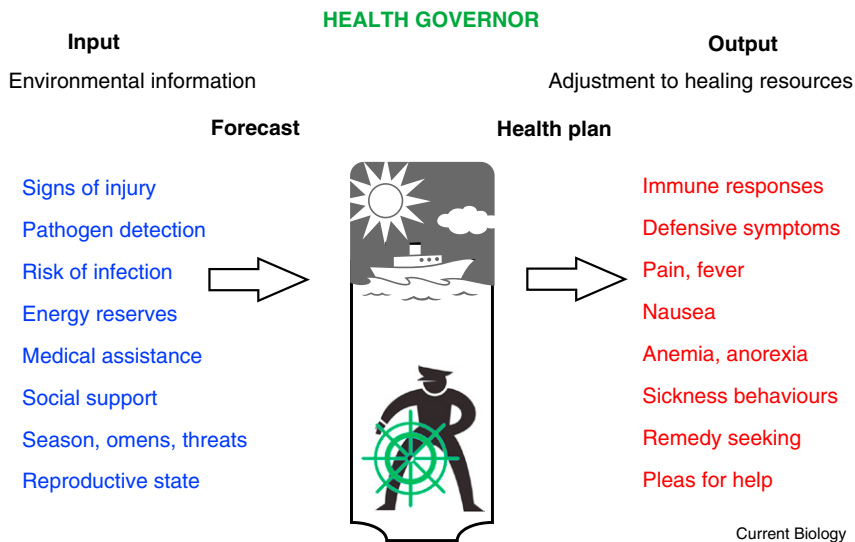


Figure 1. The health governor.

cycle acts as a *subconscious prime* to the hamster's health management system, which then triggers an automatic adjustment.

The same will be true for humans in many cases. When, for example, humans let a cold drag on much longer in winter than in summer, it is because their health governor, based on deep evolutionary history, reckons it is less safe to use our immune resources in winter than in summer. But this clearly takes place outside of conscious awareness [9]. When humans respond to the sight of someone else's sickness by mounting an immune response, again they don't consciously clock the environmental danger [10].

Health governor mark II

We can assume that, species by species, the knowledge base will have been continually updated by natural selection, so as to fit in with changing bodies and changing ecology. Nonetheless, in so far as the rules are based on statistical patterns, established over many generations, the health governor will be able to provide only rather coarse-grained prediction and control. It will have evolved to get things right *on average*. "Red sky at night, shepherd's delight/red sky in the morning, shepherd's warning". Perhaps. But even if such predictions work as a general rule, the health governor will not want to take chances. Presumably it will have been set up to err on the side

of caution — forgoing the benefits of self-cure if and when the possibility of unacceptable costs cannot be *ruled out*.

With the evolution of humans, however, a new chapter opened. Advances in human cognitive capacities and the possibility of sharing information between individuals must have brought about the potential for much more accurate forecasting. For a start, humans were acquiring an unprecedented capacity for 'mental time travel', enabling them literally to look into the future. At the same time, the development of language and culture was giving them access to a vastly greater body of relevant information about their prospects. What's more, it wasn't long before they began to make deliberate use of 'medical' procedures that could indeed be predicted to be helpful to restoring bodily well-being (that's why they were used).

Would this new forecasting power have been *available* to the ancestral health governor? The health governor, until this point, had operated outside of conscious thought, using wired-in rules. Now that humans were beginning to think ahead explicitly, would their predictions have been able to gain access to the system? Suppose a person were to have *learned* — either from personal experience or by being told by trusted experts — that, for example, "the red pill will help protect me from escalating infection". This

might now be true *every time*. And yet it's by no means obvious that such acquired knowledge, however reliable, would have been able to directly influence the immune system in the way instinctive knowledge could.

Still, the facts speak for themselves. We know there is ample evidence that learning and reasoning about the future do have major effects on how humans deploy their health defenses. The most obvious example is indeed the effects of acquired knowledge about medical treatments. People respond to the mere idea of a doctor or the sound of an ambulance as a safety signal. Fabrizio Benedetti in a series of elegant experiments has shown that 'open injection' of analgesics — in sight of the patient — can have twice the effect in relieving pain that hidden injection does [11]. One of the authors of this essay asked his GP how often patients, having spent twenty minutes in the waiting-room, come into her office and apologise because their symptoms have mysteriously gone away; she said it happens all the time.

One possibility (there may be others) is that the way that such learned forecasts come to be relevant to the health governor is simply by influencing the subject's *mood*, and in particular his or her level of *optimism*. People generally feel more hopeful the moment they reach the doctor's surgery. The same is true when the sun shines or the weekend approaches. Optimism can be generated by reasoned predictions or innate rules of thumb. Optimism has been identified as a dispositional factor in the behavior of a range of non-human animals, from rats to honeybees [12,13]. And in humans it has been specifically linked to health outcomes [14]. In fact optimism (or pessimism), at whatever level it is experienced, may be a mediating factor in most if not all the health governor's decisions.

Whatever the route, the point is that the human health governor does in fact now take advantage of superior forecasting. Though humans must still remain cautious when uncertain, they can be uncertain less of the time. Because there will likely be individual variation in the skills required, this may go some way towards explaining the strong correlation in humans

between general intelligence and health [15].

The problem of evolutionary inertia

The next step in the evolution of human healing came, as it were, out of left-field. From the earliest times, humans must have been making changes to their physical and social environment that we might expect to have had major implications for managing health defenses. Newly abundant and reliable food supplies, for example, would have meant that immune resources could more easily be replaced. New social structures, in particular close kinship ties, would have meant that convalescence could be less burdensome and defenses such as pain could be relaxed.

To take advantage of these long-term shifts in the balance of costs and benefits, the human health governor would have needed simply to readjust the weightings it gave to its forecasts, so as to move to a less conservative regime. Yet surprisingly this seems not to have happened. The evidence, as we read it (we'll come to this in a moment), suggests that even in the modern human environment, the health governor continues to play by the old precautionary rules.

Other things being equal, the evolutionary story might have ended there, with humans never achieving such an efficient level of health management as — in a rational world — they should have done. But, now the bigger surprise. Believe it or not (and we choose our words advisedly) what came to the rescue was a *dose of irrationality*. Humans discovered the potential of *fake medical treatments* — treatments that, while being quite useless in themselves, could produce the illusion that the forecast was better than it actually was, and so release self-cure that the health governor would otherwise have held back.

The ground for the discovery of fake treatments had no doubt been prepared by humans' experience with medical practices that were genuinely effective. Dietary medicines were probably already in use before humans split from the other apes (and are in use by chimpanzees today [16]). Other medicinally effective treatments — putting a splint on a broken leg,

sucking venom from a snake bite, honey to dress a wound, tender loving care of an invalid — were probably in use before humans left Africa (the evidence of skeletal remains of severely handicapped individuals who survived in spite of their injuries suggests they go back 100,000 or more years [17]). We may guess, then, that early humans were, with good reason, coming to *believe in medicine*. Indeed they had doubly good reason to do so. For the fact is the procedures must have been having the desired effects on health twice over. First, they will indeed have been directly curative. Second, for the reasons just discussed, they will have been indirectly curative as well, because when a patient had justified confidence that the procedures would work, this improved forecast would have induced the health governor to kick in with its own healing measures.

We contend that what followed from this, however irrational, was transformative. We assume there were already recognized 'healers' in the community — shamans, witch-doctors, wise-women, best friends. But now these healers discovered, against the odds, that *mumbo-jumbo* and *snake-oil* worked nearly as well as the practical cures they had to offer. And the hidden reason these fake treatments worked was precisely the second half of the reason the genuine ones did: just because patients expected them to work, they induced the health governor, with an improved forecast, to release self-cure.

But it was — and is — of course a trick. The fake treatments were duping people into making a better forecast, and so were giving them *unwarranted* confidence that it was safe to get well. Unwarranted, but as it happens, in the modern context, *not incorrect* — because, unknown to the health governor, the rules had changed. In short, fake treatments were now providing false safety signals in an environment *falsely assumed by the health governor to be risky*. So, these treatments not only worked to bring about self-cure, but crucially they worked without having the calamitous consequences that *premature* self-cure might have had in the past.

Placebo medicine had come into its own.

The placebo paradox

What evidence do we have for this last stage? We think the evidence lies in the very existence of the placebo effect in modern humans.

Medical science has long recognized the importance of placebo medicine to human health. In the last twenty years there has been a flurry of scientific interest in the physiological question of *how* it works [18]. Yet all too few scientists have thought to ask the functional question of *why* it works. Why did natural selection tolerate such a paradoxical effect?

The paradox is this. When people recover from illness under the influence of fake treatments, they must of course in reality be healing themselves. But if and when people have the capacity to heal themselves by their own efforts, why do they not simply get on with it? Why ever should they wait for third-party permission — from the shaman or the sugar pill — to heal themselves? How strange that people should be condemned to remain dysfunctionally sick just because — as must still often happen — they have not received permission.

It does indeed seem a puzzle for evolutionary biology. And we contend that the only explanation can be that the health governor remains stuck in the past, with rules for health expenditure that are overcautious for the modern environment.

Why should there have been this failure to catch up? Several possibilities come to mind. One would be that the improvements to the environment brought about by human culture have simply not been sufficiently prolonged or reliable on natural selection's time scale [19]. A more intriguing one would be that modern humans are descended from a sub-population of *Homo sapiens* whose conservative approach to health allowed them to survive catastrophes that left their more liberal cousins too exposed [20].

Whatever the explanation, we note that this is one area of human life where the so-called 'optimism bias' — which, according to Tali Sharot [21], is "one of the most consistent, prevalent, and robust biases documented in psychology" — fails to apply. In fact, rather the opposite. In our view the existence of the placebo effect suggests that, when it comes to

health management, the natural bias is actually towards pessimism. And this is precisely why it takes a dose of contrived optimism, riding on fake treatment, to restore confidence in the wisdom of self-cure.

A Keynesian twist

We likened the health governor to a hospital manager who has to manage the economics of health care. We'll end with a rather different economic analogy for placebo medicine as an antidote to an over-cautious pessimistic regime.

Imagine you are the Finance Minister of a country dependent on manufacture for creating wealth. And let's assume your main market is the domestic one. Then, for your country's economy to remain in good shape, your manufacturers must be able to sell their goods to your own citizens. So it is essential that your citizens, first do not save too much, and second spend what money they have on home-made goods. Now, suppose something bad happens beyond your borders which, though it doesn't yet directly affect things at home, makes everybody jittery about the future. Motivated by anxiety, your citizens start saving rather than spending, so as to make sure they have enough in reserve in case things get worse. The result is that your country's economy is headed for recession.

How then can you as Finance Minister get the economy back on track? The answer was proposed by the economist J.M. Keynes. What you have to do to is to artificially boost demand at home by *pretending* that things are going to be all right. And, just to the extent that the original refusal of your citizens to spend was unjustified by any objective threat, this solution will work.

So, Keynes discovered a placebo solution to the problem of wealth creation for a country whose citizens are inclined to conserve resources when they don't need to. But our real point is that human culture discovered a Keynesian solution to the problem of health creation for human bodies whose healing systems were designed to play too safe.

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Features

The ancestor's paunch

The obesity problem in the industrialized world is a recent phenomenon, potentially owing to a confluence of factors, most notably an abundance of fatty, sugary foods. But does our evolutionary past have any part to play? **Cyrus Martin** explores the role of diet in human evolution and current evolutionary theories explaining the obesity epidemic.

Our collective waistlines are expanding. The incidence of obesity in the US has risen to such levels that officials have resorted to drastic measures, as seen in mayor Michael Bloomberg's recent proposal of banning the sale of oversized sodas in New York City. This is in a country where government meddling in personal lives is fought tooth and nail, highlighting the extent of the crisis. If one looks at US adults, the overweight and obese comprise nearly 80% of the population. And a global survey shows that the obesity problem is rapidly worsening in nearly all industrialized nations, particularly in Europe but with Asia following closely behind. This trend should command society's attention as obesity is closely linked to a host of diseases, especially diabetes, cardiovascular disease and cancer. Obesity is in fact the second leading cause of cancer next to smoking. So how can we account for this obesity 'epidemic', as it is frequently referred to? Here, we are constantly reminded that the roots of obesity are two-fold: a sedentary lifestyle coupled with an abundance of fatty, sugary foods. But what if the question is approached from an evolutionary perspective? Is it possible that our history as a species can throw some additional light on the problem?

Diet and human evolution

Before tackling the specific question of obesity, it's instructive to consider what we know about the role of diet in shaping human evolution. One consistent theme in this area of evolutionary biology is the role of cultural innovations. There is good evidence, for example, that the use