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WHY HUMANS ARE COGNITIVE MISERS AND WHAT IT MEANS FOR THE GREAT RATIONALITY DEBATE

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Introduction

That humans are cognitive misers has been a major theme throughout the past 50 years of research in psychology and cognitive science (see Dawes, 1976; Kahneman, 2011; Simon, 1955; 1956; Shah & Oppenheimer, 2008; Taylor, 1981; Tversky & Kahneman, 1974). Humans are cognitive misers because their basic tendency is to default to processing mechanisms of low computational expense. Humorously, Hull (2001) has said that "the rule that human beings seem to follow is to engage the brain only when all else fails—and usually not even then" (p. 37). More seriously, Richerson and Boyd (2005) have put the same point in terms of its origins in evolution: "In effect, all animals are under stringent selection pressure to be as stupid as they can get away with" (p. 135). Miserly cognitive tendencies have evolved for reasons of computational efficiency. But that same computational efficiency simultaneously guarantees that humans will be less than perfectly rational—that they will display, instead, bounded rationality.

Miserly processing and human evolution

Of course, evolution guarantees human rationality in the dictionary sense of "the quality or state of being able to reason" because evolution built the human brain. But evolution does *not* guar-antee perfect rationality in a different sense—the sense used throughout cognitive science: as maximizing subjective expected utility. In contrast to maximization, natural selection works on a "better than" principle. The variation and selective retention logic of evolution "design" for the reproductive advantage of one organism over the next, not for the optimality of any one characteristic (including rationality). Natural selection is geared to immediate advantage rather than long-term strategy. Human rationality, in contrast, must incorporate the long-term interests of the individual and thus it can diverge from the short-term strategies of evolutionary adaptation.

Organisms have evolved to increase the reproductive fitness of genes, not to increase the rationality of humans, and increases in fitness do not always entail increases in rationality. For example, beliefs need not always track the world with maximum accuracy in order for fitness to increase (Mercier & Sperber, 2017; Stanovich, 2004). Evolution might fail to select out

epistemic mechanisms of high accuracy when they are costly in terms of organismic resources (for example, in terms of memory, energy, or attention). Unreliable, error–prone, risk–aversive strategies may well be favored by natural selection (Stich, 1990).

It is likewise in the domain of goals and desires. The purpose of evolution was not to maximize the happiness of human beings. As has become clear from research on affective forecasting (Gilbert, 2006; Kahneman, 2011), people are remarkably bad at making choices that make them happy. This should be no surprise. The reason we have pleasure circuits in our brains is to encourage us to do things (survive and reproduce, help kin) that propagate our genes. The pleasure centers were not designed to maximize the amount of time we are happy.

The instrumental rationality[1] of humans is not guaranteed by evolution for two further reasons. First, many genetic goals may no longer serve our ends because the environment has changed. The goals underlying these mechanisms have become detached from their evolutionary context (Li, van Vugt & Colarelli, 2018). Finally, the cultural evolution of rational standards is apt to occur at a pace markedly faster than that of human evolution (Richerson & Boyd, 2005; Stanovich, 2004)—thus providing ample opportunity for mental mechanisms of utility maximization to dissociate from local genetic fitness maximization.

That evolution does not guarantee perfect rationality in humans is the first fundamental concept that we need in order to resolve the Great Rationality Debate in cognitive science— the debate about how much rationality to ascribe to people (Cohen, 1981; Gigerenzer, 1996; Kahneman & Tversky, 1996; Kelman, 2011; Lee, 2006; Polonioli, 2015; Samuels & Stich, 2004; Stanovich, 1999, 2004; Stanovich & West, 2000; Stein, 1996; Tetlock & Mellers, 2002). The other two concepts that are needed are dual–process cognitive theory and an understanding of the logic of goals within the human organism. The first is well-known and has been exhaustively discussed, so I turn first to the latter (see Stanovich, 2004, for a fuller discussion).

The logic of goals in organisms of differing complexity

I will rely here on Dawkins' (1976, 1982) discussion of replicators and vehicles: replicators as entities (e.g., genes) that copy themselves and vehicles as the containers (e.g., organisms) in which replicators house themselves. It is vehicles that interact with the environment, and the differential success of the vehicles in interacting with the environment determines the success of the replicators that they house. Humans have proven to be good vehicles for genes, as have bees. But the goal structures of bees and humans are very different.

As a creature characterized primarily by a so-called Darwinian mind (see Dennett, 1996, 2017), a bee has a goal structure as indicated in Figure 11.1. The area labeled A indicates the majority of cases where the replicator and vehicle goals coincide. Not flying into a brick wall serves both the interests of the genes and of the bee itself as a coherent organism. Of course, the exact area represented by A is nothing more than a guess. The important point is that there exists a nonzero area B—a set of goals that serve only the interests of the replicators and that are antithetical to the interests of the vehicle itself.[2] A given bee will sacrifice itself as a vehicle if there is greater benefit to the same genes by helping other bees (e.g., causing its own death when it loses its stinger while protecting its genetically-related hive-Queen).

All of the goals in a bee are genetic goals pure and simple. Some of these goals overlap with the interests of the bee as a vehicle and some do not, but the bee does not know enough to care. Of course, the case of humans is radically different. The possibility of genetic interests and vehicle interests dissociating has profound implications for humans as self-contemplating vehicles.
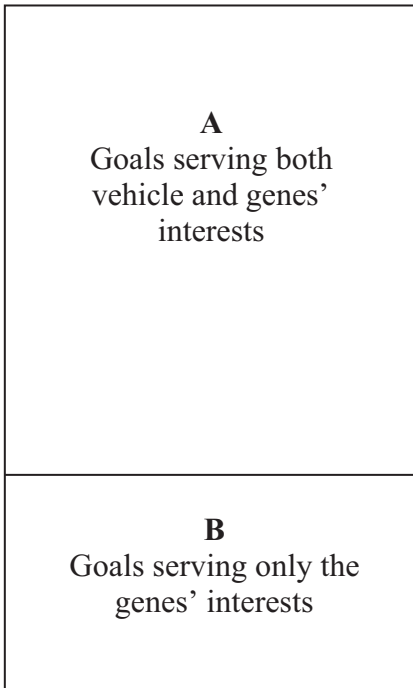
Goal structure:
Darwinian creature

Figure 11.1 Goal structure of a Darwinian creature. The areas indicate overlap and nonoverlap of vehicle and genetic "interests."

Humans were the first organisms capable of recognizing that there may be goals embedded in their brains that serve the interests of their genes rather than their own interests *and* the first organisms capable of choosing not to pursue those goals. An organism with a flexible intelligence and long-leash goals can, unlike the situation displayed in Figure 11.1, develop goals that are completely dissociated from genetic optimization. For the first time in evolutionary history, we have the possibility of a goal structure like that displayed in Figure 11.2 (again, the sizes of these areas are pure conjecture). Here, although we have area A as before (where gene and vehicle goals coincide) and area B as before (goals serving the genes' interests but not the vehicle's), we have a new area, C, which shows that, in humans, we have the possibility of goals that serve only the vehicle's interests and not those of the genes.

Why does area C come to exist in humans? When the limits of coding the moment-by-moment responses of their vehicles were reached, the genes began adding long-leash strategies to the brain (Dennett, 1996, 2017; Stanovich, 2004). At some point in evolutionary development, these long-leash strategies increased in flexibility to the point that—to anthropomorphize—the genes said the equivalent of: "Things will be changing too fast out there, brain, for us to tell you exactly what to do—you just go ahead and do what you think is best given the general goals (survival, sexual reproduction) that we (the genes) have inserted." But once the goal has become this general, a potential gap has been created whereby behaviors that might serve the

Goal structure:
humans

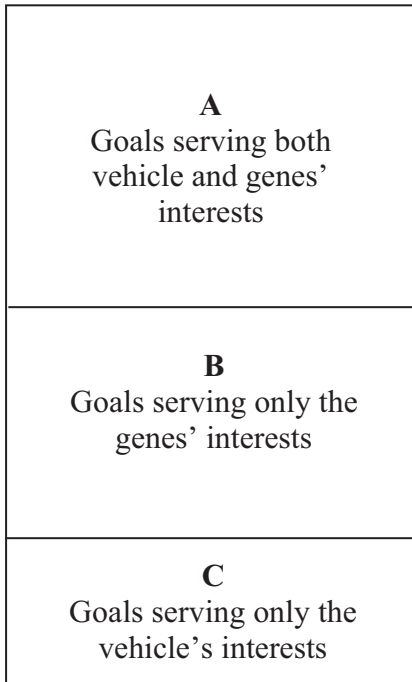| |
| --- |
| **A** |
| Goals serving both |
| vehicle and genes' |
| interests |
| **B** |
| Goals serving only the |
| genes' interests |
| **C** |
| Goals serving only the |
| vehicle's interests |

Figure 11.2   The logic of the goal structure in a human

vehicle's goal might not serve that of the genes. We need not go beyond the obvious example of sex with contraception—an act which serves the vehicle's goal of pleasure without serving the genes' goal of reproduction. The logic of the situation here is that the goals of the vehicle—being *general* instantiations of things that probabilistically tend to reproduce genes—can diverge from the specific reproductive goal itself.

Genetic and vehicle goals in a dual-process organism

The last global concept that is needed to contextualize the Great Rationality Debate is that of dual-process theory. To simplify the discussion, we need only the most basic assumptions of such a theory (Stanovich & Toplak, 2012) along with the subsequent clarifications and caveats that have been much discussed in the literature (Evans, 2008, 2014, 2018; Evans & Stanovich, 2013; Stanovich, 2011). In many such theories, the defining feature of System 1 processing is its autonomy. Execution of these processes is mandatory when their triggering stimuli are encountered, and they are not dependent on input from high-level control systems. The category of autonomous, System 1 processes would include: processes of emotional regulation; the encapsulated modules for solving specific adaptive problems that have been posited by evolutionary psychologists; processes of implicit learning; and the automatic firing of overlearned associations.

In contrast to System 1 processing, System 2 processing is nonautonomous and computationally expensive. Many System 1 processes can operate in parallel, but System 2 processing is largely serial. One of the most critical functions of System 2 processing is to override nonoptimal System 1 processing (for extensive discussion of the details of these broad generalizations, see De Neys, 2018; Evans & Stanovich, 2013; Pennycook et al., 2015; Stanovich, 2004, 2011, 2018; Thompson, 2009). There are individual differences in the System 2 tendency to override, and thus there are individual differences in how miserly people are (Stanovich, West, & Toplak, 2016).

System 1 is partially composed of older evolutionary structures (Amati & Shallice, 2007; Mithen, 1996, 2002; Reber, 1993) that more directly code the goals of the genes (reproductive success), whereas the goal structure of System 2—a more recently evolved brain capability (Evans, 2010; Mithen, 1996, 2002; Stanovich, 2004, 2011)—is more flexible and on an ongoing basis attempts to coordinate the goals of the broader social environment with the more domain-specific short-leash goals of System 1. System 2 is primarily a control system focused on the interests of the whole person. It is the primary maximizer of an individual's *personal* goal satisfaction.

Because System 2 is more attuned to the person's needs as a coherent organism than is System 1 (which is more directly tuned to the ancient reproductive goals of the subpersonal replicators), in the minority of cases where the outputs of the two systems conflict, people will often be better off if they can accomplish an override of the System 1-triggered output. Such a system conflict could be signaling a vehicle/replicator goal mismatch and, statistically, such a mismatch is more likely to be resolved in favor of the vehicle (which all of us should want) if the System 1 output is overridden.

Figure 11.3 displays a graphic representation of the logic of the situation (of course, the exact size of the areas of overlap are mere guesses; it is only the relative proportions that are necessary to sustain the argument here). It illustrates that override is a statistically good bet in cases of conflict because System 1 contains a disproportionate share of the goals serving only the genes' interests and not the vehicle's (area A) and System 2 contains a disproportionate share of the goals serving only the vehicle's interests and not the genes' (area F). An assumption reflected in Figure 11.3 is that vehicle and gene goals coincide in the vast majority of real-life situations (the areas labeled B and E). For example, accurately navigating around objects in the natural world fostered evolutionary adaptation—and it likewise serves our personal goals as we carry out our lives in the modern world. But the most important feature of Figure 11.3 is that it illustrates the asymmetries in the interests served by the goal distributions of the two systems.

Many of the goals instantiated in System 1 were acquired nonreflectively—they have not undergone an evaluation in terms of whether they served the *person's* interests (area A in Figure 11.3). They have in fact been evaluated, but by a different set of criteria entirely: whether they enhanced the longevity and fecundity of the replicators in the evolutionary past. From the standpoint of the individual person (the vehicle), these can become dangerous goals because they reflect genetic goals only.[3] They are the goals that sacrifice the vehicle to the interests of replicators—the ones that lead the bee to sacrifice itself for its genetically-related hive-Queen. These are the goals that should be strong candidates for override.

The right side of Figure 11.3 indicates the goal structure of System 2. Through its exercise of a reflective intelligence, this system derives flexible long-leash goals that often serve the overall ends of the organism but thwart the goals of the genes (area F in Figure 11.3—for example, sex with contraception; resource use after the reproductive years have ended, etc.). Of course, a reflectively acquired goal can, if habitually invoked, become part of System 1 as well (Bago & De Neys, 2017; Stanovich, 2018). This fact explains why there is a small[4] section (area

Goal structure

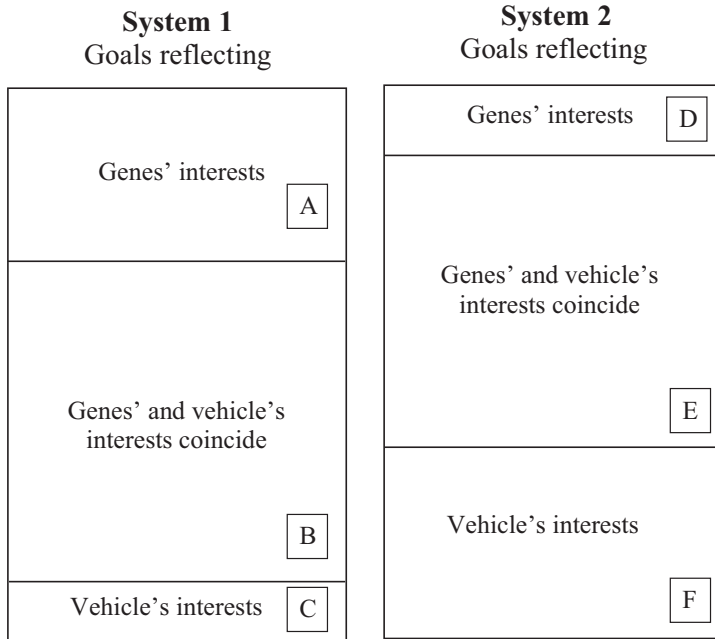| System 1	System 2
Goals reflecting	Goals reflecting

Figure 11.3   Genetic and vehicle goal overlap in System 1 and System 2

C) in System 1 representing goals that serve the vehicle's interests only. Reflectively acquired goal-states might be taken on for their unique advantages to the vehicle (advantages that might accrue because they trump contrary gene-installed goals—"don't flirt with your boss's wife") and then may become instantiated in System 1 through practice. We might say that in situations such as this, System 1 in humans reflects the consequences of residing in a brain along with a reflective System 2. This is why the goal-structure of System 1 in humans does not simply recapitulate the structure of a Darwinian creature depicted in Figure 11.1.

Nevertheless, with the small but important exception of area C, System 1 can be understood, roughly, as the part of the brain on a short genetic leash. In contrast, most of the goals that the System 2 is trying to coordinate are derived goals. When humans live in complex societies, basic goals and primary drives (bodily pleasure, safety, sustenance) are satisfied indirectly by maximizing secondary symbolic goals such as prestige, status, employment, and remuneration. In order to achieve many of these secondary goals, the more directly-coded System 1 responses must be suppressed—at least temporarily. Long-leashed derived goals create the conditions for a separation between the goals of evolutionary adaptation and the interests of the vehicle.

Because of its properties of autonomy, System 1 will often provide an output relevant to a problem in which System 2 is engaged. Such a system conflict could be signaling a vehicle/replicator goal mismatch and, statistically, such a mismatch is more likely to be resolved in favor of the vehicle (which all of us should want) if the System 1 output is overridden (area E + F exceeds area B + C). This is why, in cases of response conflict, override is a statistically good bet.

Reconciling the opposing positions in the Great Rationality Debate

Researchers working in the heuristics and biases tradition tend to see a large gap between normative models of rational responding and descriptive models of what people actually do. These researchers have been termed Meliorists (Stanovich, 1999, 2004, 2010) because they assume that human reasoning is not as good as it could be, and that thinking could be improved (Stanovich et al., 2016).

However, over the last several decades, an alternative interpretation of the findings from the heuristics and biases research program has been championed. Contributing to this alternative interpretation have been philosophers, evolutionary psychologists, adaptationist modelers, and ecological theorists (Cohen, 1981; Gigerenzer, 2007; Oaksford & Chater, 2007, 2012; Todd & Gigerenzer, 2000). They have reinterpreted the modal response in most of the classic heuristics and biases experiments as indicating an optimal information processing adaptation on the part of the subjects. This group of theorists—who argue that an assumption of maximal human rationality is the proper default position to take—have been termed the Panglossians.

The Panglossian theorists often argue either that the normative model being applied is not the appropriate one because the subject's interpretation of the task is different from what the researcher assumes it is, or that the modal response in the task makes perfect sense from an evolutionary perspective. The contrasting positions of the Panglossians and Meliorists define the differing poles in what has been termed the Great Rationality Debate in cognitive science—the debate about whether humans can be systematically irrational.

A reconciliation of the views of the Panglossians and Meliorists is possible, however. I argued above that the statistical distributions of the types of goals being pursued by System 1 and System 2 processing are different. Because System 2 processing is more attuned to the person's needs as a coherent organism, in the minority of cases where the outputs of the two systems conflict, people will often be better off if they can accomplish a System 1 override (the full argument[5] is contained in Stanovich, 2004). Instances where there is a conflict between the responses primed by System 1 and System 2 processing are interpreted as reflecting conflicts between two different types of optimization—fitness maximization at the subpersonal genetic level and utility maximization at the personal level.

A failure to differentiate these interests is at the heart of the disputes between researchers working in the heuristics and biases tradition and their critics in the evolutionary psychology camp. First, it certainly must be said that the evolutionary psychologists are on to something with respect to the tasks they have analyzed, because in most cases the adaptive response is the *modal* response in the task—the one most subjects give. Nevertheless, this must be reconciled with a triangulating data pattern relevant to this discussion—an analysis of patterns of covariation and individual differences across these tasks. Specifically, we have found that cognitive ability often (but not always) dissociates from the response deemed adaptive from an evolutionary analysis (Stanovich & West, 1998, 1999, 2000).

These two data patterns can be reconciled, however. The evolutionary psychologists are probably correct that most System 1 processing is evolutionarily adaptive. Nevertheless, their evolutionary interpretations do not impeach the position of the heuristics and biases researchers that the alternative response given by the minority of subjects is rational at the level of the individual. Subjects of higher analytic intelligence are simply more prone to override System 1 processing in order to produce responses that are epistemically and instrumentally rational. This rapprochement between the two camps was introduced by Stanovich (1999) and subsequent research has only reinforced it (see Kahneman and Frederick, 2002; Kelman, 2011; Samuels & Stich, 2004; Stanovich, 2004, 2011).

It is possible to continue to resist this rapprochement, of course, but only at the expense of taking rather extreme positions. A Meliorist could resist the rapprochement by continuing to deny the efficacy of much of our cognition from the standpoint of evolution—a position that denies much of evolutionary cognitive science. A Panglossian might decide to reject the rapprochement by siding with the goals of the genes over the goals of the vehicle when the two conflict. But most people find this choice unpalatable, and few of those who claim they do not have considered exactly what they are endorsing when they do. For example, Cooper (1989), in an essay describing how some nonoptimal behavioral tendencies could be genetically optimal, admits that such behaviors are indeed detrimental to the reasoner's own welfare. Nonetheless, he goes on to counter that the behaviors are still justified because: "What if the individual identifies its own welfare with that of its genotype?" (p. 477).

But who are these people with such loyalty to the random shuffle of genes that is their genotype? I really doubt that there are such people. To be precise, I am doubting whether there are people who say they value their genome *and have an accurate view of what they are valuing* when they say this. For example, in such a case, the person would have to be absolutely clear that valuing your own genome is not some proxy for valuing your children; be clear that having children does not replicate one's genome; and be clear about the fact that the genome is a *subpersonal* entity. Most people, I think, would eschew this Panglossian path if it were properly understood and adopt the view of philosopher Alan Gibbard, who offers the more reasoned view that

> a person's evolutionary *telos* explains his having the propensities in virtue of which he develops the goals he does, but his goals are distinct from this surrogate purpose. My evolutionary *telos*, the reproduction of my genes, has no straightforward bearing on what it makes sense for me to want or act to attain ... A like conclusion would hold if I knew that I was created by a deity for some purpose of his: his goal need not be mine.
>
> *1990, pp. 28–29*

Gibbard's view is shared by distinguished biologist George Williams (1988), who feels that

> There is no conceivable justification for any personal concern with the interests (long-term average proliferation) of the genes we received in the lottery of meiosis and fertilization. As Huxley was the first to recognize, there is every reason to rebel against any tendency to serve such interest.
>
> *p. 403*

Hence the title of an earlier book of mine, *The Robot's Rebellion* (Stanovich, 2004). The opportunity exists for a remarkable cultural project that involves advancing human rationality by honoring human interests over genetic interests when the two do not coincide. Its emancipatory potential is lost if we fail to see the critical divergence of interests that creates the distinction between genetic fitness and maximizing human satisfaction.

Notes

1 I define instrumental rationality standardly here as: Behaving in the world so that you get exactly what you most want, given the resources (physical and mental) available to you. More formally, economists and cognitive scientists define maximizing instrumental rationality as choosing among options based on which option has the largest expected utility.

2 Strictly speaking, there are two conceptually different subspaces within area B. There are goals that are currently serving genetic fitness that are antithetical to the vehicle's interests, and there are goals within this area that serve neither genetic nor vehicle interests. The reason there are the latter is because genetic goals arose in the ancient environment in which our brains evolved (the environment of evolutionary adaptation, EEA). Environments can change faster than evolutionary adaptations, so that some genetic goals may not always be perfectly adapted to the current environment. Whether these goals currently facilitate genetic fitness—or only facilitated reproductive fitness in the past—is irrelevant for the present argument. In either case, goals which diverge from vehicle goals reside in the brain because of the genes. For example, whether the consumption of excess fat serves current reproductive fitness or not, it is a vehicle-thwarting tendency (for most of us!), and it is there because it served reproductive fitness at some earlier point in time.

3 The caveat in note 1 is relevant here as well. When something is labeled a genetic goal, it does not necessarily mean that the goal is *currently* serving the interests of reproductive fitness—only that it did so sometime in the past in the EEA.

4 Of course, the absolute sizes of the areas in Figure 11.3 are a matter of conjecture. The argument here depends only on the assumption that area A is larger than area D.

5 The full treatment in Stanovich (2004) also discusses the case of goals serving the interests of memes (and not genes *or* vehicles).

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