Evolved Human Cognition as Risk Mitigation: Toward a Theoretical Innovation in Risk Communication

- and -

Lessons for Risk Communication Learned through the Kahneman-Gigerenzer Debate

by

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Abstracts

Essay One

The foundational premise of this paper is that influencing an organism's action depends upon intervention into its psychological processes. Risk communication is not merely about the transfer of information regarding the risk. While information transfer is valuable, if that information fails to avert or at least minimize deleterious outcomes from the threat, this is a sterile exercise. Risk communication is designed not only to inform, but also to motivate relevant individuals to take the appropriate actions to avoid or overcome the greatest risks posed by a circumstance. Achieving such risk reduction outcomes requires not only effective communication technique, but an understanding of evolved human cognition.

The paper examines three cases of human evolved adaptations with an eye to how evolution has structured risk mitigation into the evolved cognitive apparatus. These are 1) the unique human version of predator detection mechanisms; 2) the evolution of language; and 3) the role of health symptoms as alarm warnings. In all three of these cases, risk mitigation turns out to be a central feature of natural selection. If risk communication practitioners do indeed need to leverage human psychology for effective interventions that reduce risky behaviour, learning more about evolved human psychology and cognition would seem to provide valuable means for accomplishing those ends.

In the end, the paper acknowledges, that while natural selection tends toward risk mitigation, sexual selection can move in the opposite direction, actually increasing the likelihood of risk seeking. For an effective psychology of risk communication, much benefit comes from a deep understanding of what these schools of evolutionary scholarship offer.

Essay Two

This paper looks more deeply at the role of both mismatch and sexual selection, in the process of exploring one of the most famous debates in psychology, between Daniel Kahneman's heuristics and biases school and Gerd Gigerenzer's fast and frugal school. Kahneman's school emphasizes the heuristic and bias characteristics of those mental modules illustrated by the study of evolutionary psychology and evolved human cognition, while the Gigerenzer school emphasizes the fast and frugal economy of problem solving made possible by those modules, which if anything can be hindered by increased awareness or information. Kahneman characterizes the dynamics to which he points as irrational, while Gigerenzer insists upon a deeper rationality – an ecological rationality. This is a rationality molded by evolutionary pressures. The lesson for a risk communications practice that wanted to learn from the Kahneman-Gigerenzer debate is not to parse out who is right and who is wrong, but rather to recognize the lesson that comes from seeing how little they actually disagree. A risk communication practice that assumed Kahneman's scepticism was the expected norm would be incapable of taking advantage of all those situations in which natural selection has properly primed humans for effective risk mitigation behaviour and the specific kinds of risk tolerance generated by sexual selection. On the other hand, a risk communication practice that assumed Gigerenzer's optimism was the expected norm would not be well prepared to recognize and respond to those situations in which mismatch generated abnormal outcomes from otherwise perfectly sensibly, evolutionarily generated, risk responses. There are several ways in which evolved psychology can play into risk related behaviours in the modern world. In some cases, risk communication practice has to get out of the way; in some cases, that practice needs to know how to leverage those evolved dispositions; and, in some cases, it requires a sophisticated understanding of how and why such evolved risk mitigation dispositions may misfire and go astray.

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Evolved Human Cognition as Risk Mitigation: Toward a Theoretical Innovation in Risk Communication

Introduction

Risk is at the very core of life. Etymologically, it derives from a 16th century Italian term (*riscare*) for "run into danger." In modern usage, we concede that the danger may coming running after you. In our contemporary world of vast agriculture food chains and remarkable industrial engineering, where most of us, most of the time, have our daily needs for nourishment and shelter met as a routine part of life, it is easy to forget that such shelter from the risks of nature is not the norm for biological organisms. Most organisms alive today, and certainly over the history of the last 560,000 or so millions of years, during which large multicellular organisms have expanded across the earth, have enjoyed no such insolation from the endemic risks of nature. The risk of starvation, predation and intraspecific rivalry animate the existence of animals and plants alike. For hundreds of thousands of years, prior to the agricultural revolution of about ten thousand years ago, and even more recent industrial revolution, such risk characterized the lives of our ancestors, too.

Indeed, Darwinian evolution, now near universally acknowledged as the organizing principle of biology, is correctly understood as a massive risk response mechanism. Ironically, though, as will be seen, the response has not always been toward risk mitigation. This paper builds on the realization that evolution is overwhelmingly concerned with risk response and sets out to lay a foundation for exploring how insights drawn from this understanding can be valuable to the practice of risk communication in the modern world.

Earlier research by the author has endeavoured to point in the direction of how insights into reliable human cognitive responses might be leveraged to better inform improved practice of risk communication. Though such insights, from evolutionary biology, evolutionary psychology, socio-biology, behavioural ecology, behavioural genetics, etc., could benefit all areas of risk communication practice and theory, the primary concern there was for risk communication in relation to disaster events.

The key findings from that earlier research are reviewed, here, setting the context for the relevance of the current research agenda. Afterward, building upon that context, the present paper aspires to flesh out a more thorough theoretical underpinning, drawing upon the evolutionary scholarship on human cognition. The objective is to lay out markers, within an underexplored theoretical space, which can help risk communication theorists and practitioners to gain better insight into the motives and dispositions of those whom they aspire to influence through their risk communication methods.

Risk communication, in general, and particularly as it relates to disaster events, is not merely about the transfer of information regarding the risk. While information transfer is valuable, if that information fails to avert or at least minimize deleterious outcomes from the disaster, this is a sterile exercise. Risk communication is designed not only to inform, but also to motivate relevant individuals to take the appropriate actions to avoid or overcome the greatest risks posed by a disaster event. Achieving such risk reduction outcomes requires not only effective communication technique, but an understanding of evolved human cognition. Communication messages that are insufficiently formed for motivating the appropriate risk reduction actions will fail as effective risk communication strategies. Ensuring such effectiveness then is dependent upon a sound and accurate understanding of evolved human cognition.

The markers to be laid out in this underexplored theoretical space, for the benefit of risk communication theorists and practitioners, will be organized around three conceptual areas in which evolutionary theory helps illuminate the core functions of evolved human cognition as a set of risk mitigation mechanisms molded by natural selection pressures. The three conceptual areas to be addressed are our predator detection systems; the evolution of language; and the insights provided by evolutionary medicine. These latter insights focus upon the convergence of evolved risk mitigation systems with high false positive bias interacting with an environment mismatched for their adapted fitness benefits.

By the end of the paper it will be clear that risk mitigation in general, and indeed even risk communication specifically, is hardwired into evolved human cognitive processes through the forces of natural selection. However, in light of false positive biases, mismatched environments can produce counterproductive effects from such risk mitigation systems. Constructing effective risk communication strategies and practices neglects at its peril these lessons about our evolved, innate, complex relation to risk within the modern world. What this paper did not have space to address was the countervailing forces of sexual selection which can actually contribute to increased risk tolerance as a function of Trivers' famous observations on the sexually dimorphic consequences of parental investment strategies. The paper ends with final thoughts about paths forward for this research agenda.

A Caveat on Cognition

Before carrying on it will be beneficial to clarify a term, or set of related phrases, used throughout this paper. This is the idea of an evolved human cognition or cognitive capacity, system, mechanism, etc. The vernacular use of cognition is something along the lines of “knowing or understanding.” During the “cognitive revolution” of the 1960s the use of the term was adjusted to refer to neural functions of informational processing. In a broad sense, it might be characterized as problem-solving, provided a broadly enough defined use of the term problem was employed. This is a computational approach to the functions and purposes of cognition.

One point to be emphasized here is that cognition is not reduced to the rational side of a supposed rational-emotional divide within the operations of the human mind – or any other mind for that matter. Cognition is the process by which environmentally relevant information is taken in and an appropriate behavioural response is generated. From this perspective, cognition has always been the purpose and function of nervous systems, long before the evolutionary emergence of brains. The original, crudest nervous systems regulated the mobility of those early organisms in relation to elements in the environment that presented advantages or disadvantages: e.g., moving away form or toward warmth or cold, depending upon the needs of the organism.

As nervous systems have evolved to become more complex a broader range of relevant information has been accessible from the environment, providing a richer and more finely grained set of behavioural responses. The fundamental function and purpose of nervous systems, though, has not changed with the evolution of the centralized nervous systems that we call brains. In this context, emotions are very much a part of this cognitive process. Fear alerts the organism to dangers that need to be avoided for its survival; love ensures care for the young necessary to perpetuate future generations; jealousy triggers mate guarding instincts that prevent the squandering of resources on offspring unrelated to the jealous individuals. When evolution is understood, through the lens of what Dawkins calls the selfish gene (2006), the role of emotion as an important part of evolved cognition becomes clear.

Cognition then is an evolved capacity for processing information to solve life problems in the interest of enhancing the organism's effectiveness at getting its genes into future generations. If the reader can hold this explanation in mind moving forward, it will provide a robust understanding of what is meant by the many references to human cognition or evolved cognitive system, etc. (Barrett, 2015; Cosmides & Tooby, 1992; Gallistel & King, 2010; Marcus, 2004; Perner, 2010). As will be seen, though, evolutionarily refined mechanisms like our cognitive capacities, displaced into an environment discrepant with the environment, which originally molded such mechanisms, can lead to surprising and even counter-fitness outcomes.

Evolutionary Psychology and Risk Communication

An earlier paper written to explore the plausibility of an integration of evolutionary psychology with risk communication scholarship (Karrass, 2017) began with a brief overview of the history of applying evolutionary principles to human experience, noting some of the controversies which have resulted (Segerstrale, 2000). Though there are debates to be had about what was the initial moment in the emergence of evolutionary psychology, the modern version, sometimes called the Santa Barbara School, is generally acknowledged to have taken shape in the late 80s and early 90s. This scholarship took the hardline naturalistic approach, rejecting Cartesian dualism. If the human brain is composed of biological material and no supernatural influence is granted as an explanatory possibility, then the human brain must have been molded by evolutionary forces, like everything else biological in the world. If one rejects the supernatural and Cartesian dualism, then this means that the human mind, which can only be the function of neural processes, must be molded by evolution for fitness enhancing purposes (Barkow, Cosmides, & Tooby, 1992; Pinker, 1997).

The core insight of evolutionary psychology, which took its inspiration from the cognitive revolution and advances of artificial intelligence research in computer science, was that the human mind had to be evolved as a set of highly specialized mechanisms or algorithms, sometimes called modules, which dedicated parts of our neural operations to solving highly specific problems which posed themselves to our ancient ancestors (Kurzban, 2010; Minsky, 1988; Pinker, 1997, 2002; Tooby & Cosmides, 2005). Following the standard logic of evolutionary processes: problems were posed, those individuals better able to solve those problems were more reliably able to stay alive and find a mate for purposes of transferring their genes into future generations. To the degree their ability to better solve such problems were genetically based, those genes spread through the gene pool, creating a generalized trait within the relevant species. As true as this was for beaks of finches or the tails of peacocks, so must it be true for all animals' nervous systems, including human brains.

It is important to remember, though, that being evolutionarily generated, these mechanisms or algorithms are evolved to solve the problems of our ancestors in the evolutionary past. Much that was true about the lives of those ancestors and our own remain consistent, so our adaptations for mating, rivalry within dominance hierarchies, parenting and coalition building remain largely unchanged and the relevant mechanisms continue to work well as they have for millions of years. Others, though, such as our preference for sweet, salty and fatty foods, are now environmental mismatches. In the evolutionary settings of our ancestors these appetites provided the incentives to take the risks necessary to obtain these nutritionally valuable, but difficult and sometimes dangerous to obtain foods. Today, when such foods are readily available to most of us thanks to modern international markets and supply chains, such appetites arguably have become counter-adaptive.

Such mismatch though is a useful source of empirical evidence for demonstrating the operation of evolved psychology at work. Not only does the evolutionary explanation explain the appetites, but the appetites demonstrate the existence and operation of the mechanisms. Another example of these processes which was discussed in the earlier paper was childhood fears. Though among the major causes of contemporary childhood death and injury in the industrialized world today are bathtubs, automobiles and stoves, virtually no children have phobias over such routine encounters. Yet, virtually all children, at some point in their life, experience fear of skeletons, darkness and snakes.[1] Again, for millions of years, our ancestors gained fitness advantages when children were hyper-sensitive to these manifestations of serious threat to their healths and well-being. Very rarely do children in the modern, industrialized world suffer from such threats; the mechanisms evolved to protect our ancestors though remain, operative, parts of our brains and nervous system.

The simple formula then is that these psychological mechanisms generate behaviour; that behaviour has some impact on reproductive success, also called fitness; depending upon whether fitness is increased or decreased the relevant trait expands or shrinks through the gene pool. Presumably, the extremely rapid change of conditions humans have experienced, first over the last 10,000, then even more dramatically over the last couple hundred, years will eventually change our evolved psychology – assuming the current conditions of prosperity are sustainable. However, there has not yet been anything close to enough time to rewire our current cognitive mechanisms, dating back at least hundreds of thousands, in many cases millions, or even tens or hundreds of millions, of years.

Consequently, if we want to understand human motivations, with an eye to effective disaster response in our risk communication practices, it is important to

[1] Indeed, fear of snakes is a pervasive human experience, probably pointing back to an evolutionary arms race that goes a long way in explaining human cognition – especially our acute visual apparatus (Isbell, 2011).

understand human psychology as it is and has evolved: the ultimate motivation for all human psychology is by necessity successful replication of an organism's genes into future generations. This was the gist of Richard Dawkins' famous coining of the phrase "the selfish gene" (Dawkins, 2006). In addition to the obvious venue of sexual reproduction, though, there are numerous proximate avenues for achieving this end: advancing the interests of kin through nepotism; making coalitions with those who can help gain access to resources required for attracting mates and investing in offspring; reciprocal exchange partnerships, that can also increase the store or variety of such resources (Buss, 1991). The selfish gene need not necessarily generate selfish behaviour exclusively at the level of the individual organism. All such behaviour, including cooperation, empathy and altruism, though, are traced back through the fitness advantage they bestow.

Recognizing these functions of the selfish gene further informs a more evolutionarily sophisticated assessment of human sociality. The highly social behaviour that our selfish genes can generate provide massive fitness enhancing advantages: safety in numbers, comparative advantage in specialization, economies of scale, etc. At the same time, though, the extraordinarily high propensity for sociality among humans also creates opportunities for free riding on that sociality. A little lying and cheating, on the margins, can generate tremendous advantages over the long term. And the evidence is that we all lie and cheat to some degree, regulated by certain internal measures of our own self-assessment, though environmental inputs, such as observing blatant cheating of an identifiable out-group member, can dramatically increase our propensity to engage in the same behaviour (Ariely, 2013). It appears that we may have evolved the capacity for self-deception precisely as a means to improve our capacity for successful deception of others in such social contexts (Kurzban, 2010; Smith, 2007; Trivers, 2014). Indeed, there is a strong case to be made that all political and moral positioning is a function of trying to manipulate others in our environment to behave in ways that benefit our own evolutionary fitness (R. Alexander, 1987; R. D. Alexander, 1982; Weeden & Kurzban, 2014).

Evolutionary psychology also provides important insights into assumptions about human rationality. Too often such ability is assumed to be an unqualified, free floating capacity. This of course makes no sense in terms of evolutionary theory. If a mental capacity, so highly functional, exists it must have fitness enhancing purposes, which means, as a specialized mechanism, like our sweet tooth and snake fear, it must have limits to its natural extension (Cosmides & Tooby, 1994). Unsurprisingly, then, all kinds of failures in human rationality, from confirmation bias (Evans & Wason, 1976) to motivated reasoning (Kahan, 2013) to moral dumbfounding (Haidt, 2012), have been found frequently operating to undermine pure rationality. Indeed, an entire discipline called behavioral economics has emerged that makes a career of endlessly demonstrating our failures of rationality (Kahneman, 2013; Tversky & Kahneman, 1974).

What may be missed in such dispelling of the myth of human triumphant rationalism is that our rationality is in fact highly developed for the purposes for which it seems to have been evolved. One example of this is how heuristically effective we can be under the ecologically relevant conditions (Gigerenzer, 2002; Todd & Gigerenzer, 2012). An example of this was the discovery of the first module in human evolved psychology by Leda Cosmides. Her research built upon the earlier work of Peter Wason, who had shocked the comfortable post-WWII consensus on rational choice theory in psychology and economics by demonstrating that the vast majority of subjects failed when trying to solve a basic *p and q* propositional logic problem, requiring them to test a hypothesis by selecting the correct choices from four cards. And, more precisely, his clinical experiments revealed the subjects failed because of their inclination to indulge in confirmation bias (Wason, 1968).

In the later 1980s, Cosmides revisited this problem. She challenged her subjects to solve the very same *p and q* propositional logic problem, however, instead of using abstract variables (e.g. letters on one side, numbers on the other), she organized the choices as a means of solving a social cheater violation (e.g., age restricted drinks on one side, drinker's age on the other). It turned out that whereas using the abstract variables some 80% of subjects got the wrong answer, the very same *p and q* propositional problem, when rendered as the solution of a social problem, resulted in some 80% of subjects getting the correct answer (Cosmides, 1989; Cosmides & Tooby, 1992). This experiment has been replicated numerous times. It appears that human rationality has evolved not to solve logical problems, certainly, as we'll see, not statistical ones, but rather to solve social problems. Mercier and Sperber, in a modern classic paper, have demonstrated that human rationality is not evolved to solve logical problems, but to persuade listeners. Its fitness benefits come from the influence and status arising from being socially persuasive. Seen through this lens, ostensible bugs in human rationality – such as confirmation bias or motivated reasoning – are actually beneficial features. They reduce the noise ratio in thinkers' thought processes, keeping them focused on pressing their own point rather than risking compromising the strength of their case with the acknowledgement of potentially valid objections raised by others. (Mercier & Sperber, 2011).

If humans cannot expect to act fully rationally outside of the social context where their evolved dispositions have resulted in adaptations for dealing with social circumstances, this would seem to be an important consideration for risk communicators concerned with creating the appropriate responses to emergency conditions. Again, evolutionary psychology provides us an insight into possible psychological tools that can be leveraged for effective risk communication for optimal disaster response. While a number of examples were considered in the earlier paper of how these dynamics could play out, this discussion of that earlier research will conclude with a review of an argument from Gerd Gigerenzer. Gigerenzer has been an especially prominent advocate for setting human cognitive processes in their evolutionary-ecological contexts. He has been especially outspoken about the dangers posed by our inability to assess risk in the modern world as a consequence of the mismatch between contemporary risk and our evolved risk mitigation mental adaptations (Gigerenzer, 2002, 2014; Goldstein & Gigerenzer, 2002; Todd & Gigerenzer, 2012).

In the case at hand, Gigerenzer addresses behavioral reactions to terrorist attacks (Gigerenzer, 2006). He focuses on the aftermath impact and related harms resulting from disaster events and subsequent failure of risk communicators to provide adequate disaster response. The aftermath of the September 11, 2001 attacks on the United States were a good example of how our evolved risk mitigation cognitive mechanisms may not provide effective protection in the face of statistical probabilities for which we do not have effective evolved assessment capacities.

In this paper, Gigerenzer discusses what he calls "dread risk." The situation he is exploring here is one in which the deleterious impact of a disaster is compounded by ancillary consequences. As he puts it, the full consequences of such a disaster are not fully represented by an exclusive focus upon the direct damage resulting from the events under consideration. Rather, an additional set of indirect damages are revealed once we evaluate risk through the lens of evolved human dispositions. In the case of the 9/11 attacks, the direct damage, measured in casualties, was the well-known death toll of 3000. The death toll from the attacks though did not end on September 11. He argues that there were in fact an additional some 1500 casualties from the 9/11 attacks, not usually acknowledged, because they resulted from the psychological aftermath.

A dread risk is one experienced in terms of immediate magnitude. This is why people will respond to something like a terrorist attack in a different psychological way than they do to a chronic source of fatalities, such as the 44,000 to 98,000 people who die every year in U.S. hospitals because of documented and preventable medical errors. Gigerenzer identifies the evolutionary psychology underpinning the apparently inconsistent emotional response we have to dread and non-dread risk:

> human minds are prepared to learn the association between dread risk and avoidance behavior in one trial. The suggested reason is that for our evolutionary ancestors, living in small bands of hunter-gatherers, the loss of many members at one point of time could have brought the group beyond a critical threshold that threatened their survival. (Gigerenzer, 2014, p. 348)

Our fitness was better served by heightened sensitivities to these kinds of group threatening risks. Risk was and remains impossible to entirely avoid, though, and more banal risks can have surprising consequences. For instance, in the eighteen months following the 9/11 attacks, Americans responded to the triggering of their evolved sensitivity to dread risk by reducing their use of commercial flights. This reduction of flying resulted in an increase of motor traffic, which as it turns out is a more dangerous mode of transportation. For a period of 12 months, October 2001 to September 2002, the number of fatal accidents exceeded the five-year baseline every month, as well as the baseline adjusted by the average monthly increase of nine fatal crashes pre-September 2001. The surplus death toll was highest in January and March of 2002. After one year, fatal crashes returned to the baseline before the attack, at the same point in time when the road traffic levels returned to normal.

Gigerenzer estimates, comparing data from a series of sources, that the death toll during this period of increased motor traffic, in the year following the 9/11 attacks, was 1,595. This number, take note, is about six times higher than the total number of passengers (265) who died in the four fatal flights on that day in September, 2001. He also applied his model to the Madrid train attacks of March 2004. While, for a variety of cultural reasons, Spaniards did not take to their automobiles to the extent Americans had, the evolved dread risk psychology was evident, as train travel significantly declined in the months after the attack.

Gigerenzer concludes with some considerations for disaster response risk communication. Considering the choice to call such mass homicides as 9/11 and the Madrid train bombings “terrorist” attacks (since the very use of the term terror has hardwired into it the presumption of psychological effects), it is ironic just how insufficient is the account taken of psychological post-event consequences in counter-terrorism planning. Residual casualties from such attacks could be considerably reduced with a greater awareness of the psychological impacts. Effectively taking account of such post-event consequences, in a way that anticipates, and acts to reduce, the likely evolved reactions to dread risk, requires an awareness of our evolved cognitive tendencies to respond differently to diverse kinds of risk. Disasters, like terrorists attacks, pose particular and unique challenges and opportunities in this regard.

The earlier, preliminary research into the potential benefits of integrating an evolutionary model of human psychology already pointed in the direction of valuable lessons available to risk communication scholars and practitioners. This was particularly so as such lessons related to disaster risk communication. In the rest of this paper, the analysis will dig deeper into the existential role of risk in the formation of broader human cognition. Some of the lessons above will be relied upon in the arguments below. Ultimately, this research opens up the prospect for an exploration of how an evolutionarily informed disaster risk communication practice could have better mitigated human harm in prior risk communication failures.

Evolved Human Cognition as Risk Mitigation

A key premise of both evolutionary psychology and behavioral ecology is that in purely material terms any organism has a virtually limitless number of choices about how to behave in the moment. However, the harsh reality is that the vast majority of those choices result in death. Using the logic of the selfish gene, our genes have designed us so that our actual choices, as multi-cellular organisms, are practically limited to those that improve our fitness: reducing the likelihood of death, for instance. Concentration on foraging at the expense of predator monitoring; neglect of offspring; or indifference to potential mating opportunities are all perfectly possible behaviours, but they lead to either death in the short term or genetic extinction in the longer term. These are risks to our survival and reproductive success. Seen from this perspective, then, natural selection is entirely – arguably even exclusively – a giant risk mitigation system. The rest of the paper examines three cases of human evolved adaptations with an eye to how evolution has structured risk mitigation into our evolved cognitive apparatus. These are 1) the unique human version of predator detection mechanisms; 2) the evolution of language; and 3) the role of health symptoms as alarm warnings. The paper concludes with discussion of potential benefits of recognizing the deep risk mitigation character of our evolved human cognitive apparatus and a brief nod to a topic which space limitations prevented being discussed at length: how sexual selection can work in the opposite direction, increasing certain propensities to risk seeking.

Predator Detection Cognition

Predation is not merely endemic to the natural world, but in a sense its very lifeblood. Nothing lives unless something else dies to be its dinner. Ensuring that you're not the one who does the dying is what a great deal of natural selection is all about. In this regard, humans and our early ancestors are no different than all those other species. However, in one sense, humans are different and this difference is worth considering for a fuller understanding of how our evolutionary cognition works. A fuller appreciation of the deep mechanics of human predator detection not only explains how human evolved cognition works, but can help those, like risk communication scholars and practitioner, to better appreciate the capacity for a more fine grained leveraging of evolved human risk avoidance.

A couple years back, H. Clark Barrett wrote possibly the most important book to date explaining the tie-in between the modularly conceived model of evolutionary psychology and the neuro-cognitive processes that ultimately must underpin them (Barrett, 2015). Prior to writing this sweeping and thorough treatment, though, Barrett had started working out the general lines of the argument in a now famous article on human predator detection. The unique challenge to human predator detection is the remarkable range of environments across the planet that it has had to be able to effectively operate. It has been a common mistake in the study of animals for researchers to project subtleties into behaviour that simply are not justified on the basis of the evidence. From this perspective it would be easy to assume that all animals' predator detection operated with a flexibility characteristic of human responses. Provided a species is limited to a fairly constrained ecology – as are most species – their predator detection could be little more than an evolutionarily conditioned response to the presence of a particular predator (Penn & Povinelli, 2007, 2013; Povinelli, 2004; Shettleworth, 2010): or some set of them, as in the case of vervet monkeys. Humans however have spread to live all across the face of the earth and could only have done so effectively if they possessed a predator detection system that could recognize predator risk, with a high level of success, right from the start – presumably even upon first meeting of such novel predators. Otherwise the initial meetings would result in death, leaving no opportunity for adaptation.

So, while human predator detection has to have been molded by evolution prior to our species' exit from Africa, probably some 70,000 or so years ago (Oppenheimer, 2004), it must possess the flexibility necessary to recognize geographically novel predators. Relying upon various kinds of primate, ethnographic and neonatal research, Barrett identifies several components that likely cognitively combine to create this distinctive human predator detection system. Key elements of human predator detection are gaze direction detection (if something is gazing at you, that could be trouble); posture assessments (postures suggesting attentiveness, looming and stalking are particularly concerning); theory of mechanism and theory of mind. Theory of mechanism refers to the well-established human ability, noted already in babies, to distinguish self-propelled motion from billiard ball type effect motion. Theory of mind is the equally well-established ability to accurately recognize and assess the intentions of others. And another essential component of the human predator detection and response cognitive apparatus is fear. Fear involves intuiting danger. This emotional response sets evasive actions into motion. It also resolves preference conflicts, redirecting attention away from otherwise vitally important activities such as feeding and mating (Barrett, 2005).

This combination of cognitive abilities, most of which were likely evolved for other purposes, once combined into a functional suite of adaptations, operate to provide an open-ended system of predator detection, which can operate in any environment, allowing humans to recognize and respond to the presence of entirely novel predators. Lions, jaguars, grizzly or polar bears are just a few of the different kinds of predators that humans have had to cope with as they spread across the earth the last 70,000 years. Thanks to an evolved predator detection system, molded to mitigate predation risk, based not upon the conditioned reflexive response to particular ecological threats, but rather to a set of postures and behaviours typical of predators (e.g., gazing, stalking, looming, self-propulsion) our ancestors have been able to effectively cope with novel predator threats all across the earth. As noted above, understanding how a risk mitigation system like human predator detection works may provide risk communication scholars and practitioners valuable insight into how to take a more finely grained approach to assessing how such evolved risk avoidance traits might be more effectively leveraged for improved risk communication strategy.

Language Adaptation

Whatever direct use insights into the coordination of a suite of (likely) independently evolved traits/adaptations, to produce a predator risk mitigation system for humans, may provide risk communication scholars and practitioners, understanding how such evolved human cognition operates within our evolutionary psychology provides a helpful template for thinking through evolved risk mitigation adaptations which may not seem so obvious in their function. A compelling case in this regard is the adaptation of language. Over the history of language study there has been debate about the nature and origin of human languages. A key development in the field, which seemed inevitably to tip the balance, was Chomsky's successful case for humans possessing an innate language capacity (Chomsky, 1957).

Once such an innate language capacity had been acknowledged, it became clear that language was not something that was invented by some humans and travelled with them to other human groups, like agriculture or the alphabet. Language seems to be a human trait and always has been. The fact that different humans speak different languages is only a reflection of their having lived in different ecological conditions for very long periods of time. The basic operation of grammar and syntax though appear across human languages, with startlingly few variances (Pinker, 1994). The separation of language content from grammar was illustrated by Chomsky in his pioneering book *Syntactic Structure* (1957) by the offering of the fully grammatical sentence: colorless green ideas sleep furiously.[2] Although utter nonsense semantically, even a three year old English-speaking child recognizes this as grammatically and syntactically correct sentence.

So, since semantic content is irrelevant to the capacity to produce and recognize syntactical languages, and therefore the diversity of languages is no argument against language as an evolutionary adaptation, while the universality of language among humans is an argument in its favour, in the second half of the 20th century, gradually, the tide began to turn against the anti-adaptation position. By the early 90s, an essay co-authored by Paul Bloom and Steven Pinker proved to be the decisive blow in favour of studying language as an evolutionary adaptation, which like any other such adaptation only exists as a function of improved fitness (Pinker & Bloom, 1992).

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[2] At the time Chomsky coined the sentence “green ideas” was as equally nonsensical as the rest of the sentence. Since the environmentalist movement has changed that association, a more accurate illustration of Chomsky’s point might come from substituting “purple” for “green”: colorless purple ideas sleep furiously.

There was then though an additional matter concerning in what regard the evolution of language constituted a fitness enhancing adaptation. The initially obvious claim is that language emerged as a function of humans' unique high level of sociality. Robin Dunbar for instance argues that language arose as a replacement of our primate disposition for coalition maintenance through grooming once human social groups became too large to be held together through mutual grooming (Dunbar, 1998). It seems then reasonable and even obvious that an extremely gregarious primate would be open to evolving language for social purposes. This recognition though only kicks down the road the more nuanced question of which social purposes were benefited. Certainly there are good candidates in the parent-child bond (P. J. Wilson, 1983), mating (Miller, 2001), and coalition building (Flinn, Geary, & Ward, 2005). But as Pinker and Bloom observed in their landmark essay, risk mitigation surely was a significant dimension of the fitness enhancing benefits of an evolved language:

> It makes a difference whether a far-off region is reached by taking the trail that is in front of the large tree or the trail that the large tree is in front of. It makes a difference whether that region has animals that you can eat or animals that can eat you. It makes a difference whether it has fruit that is ripe or fruit that was ripe or fruit that will be ripe. It makes a difference whether you can get there if you walk for three days or whether can get there and walk for three days. (Pinker & Bloom, 1992)

Knowing whether a region has animals you can eat or animals that can eat you would seem of pretty obvious importance, but their other examples shouldn't be given short shrift due to the obviousness of that one. In the life of our hunter-gatherer ancestors, among whom language first emerged, opportunity costs could be massive and becoming cut off from the band meant death for most. The only energy they had to rely upon to meet their biological needs was their own, produced by their own calorie intake; energy expended in an enterprise of folly posed the real danger of not having the energy necessary to correct the error and, say, provide the food that a false indication failed to deliver. A long journey for the promise of ripe fruit posed very real risk if the information was wrong and the fruit was past being ripe or not yet near enough ripe to eat. The energy expended in the journey was lost, leading to a need to find a new lead for nutrition, now with a depleted tank of energy to fuel that search. In this way, opportunity costs arising from incorrect information could pose serious survival risks.

Likewise, any time an individual or small group went out into the wilderness, the danger of not returning posed a survival risk. Presumably our hunter-gatherer ancestors were accomplished enough at living in the wilderness that they wouldn't perish anywhere near as quickly as most modern, urbanized humans would under such conditions. However, the role of banishment observed in extant hunter-gatherer societies makes clear that those living such lives appreciate that even accomplished hunter-gatherers, cut off too long from the band, would face almost certain death (Boehm, 1999). So, being led down the wrong path, figuratively or literally, could well lead such individuals to become lost and put in danger of not finding their way back to their band, with the prospect of death consequently looming.

So, while it may not be possible to argue that language evolved exclusively among humans as a risk mitigation system – though it hardly follows that an ability to argue such a case means it isn't true, time and more research presumably will tell – it seems certain that risk mitigation in fact has played a role, perhaps a huge one, in the evolution of human language. Human language at least in significant part is itself evolved as a form of risk communication.

Lessons from Evolutionary Medicine

For the final case to be examined, toward an appreciation of the extent to which risk mitigation is evolved right into the fabric of human cognitive processes, we'll examine one that not only illustrates the centrality of such risk mitigation as the evolutionary forces selecting for the relevant traits, but one that – viewed through the lens of the contemporary world – illustrates the importance of what has been discussed above as mismatch conditions. Mismatch, recall, is the idea that evolved adaptations, which improved fitness at the time of their evolutionary selection, under the radically novel circumstances of the modern world may be at least misunderstood, leading to inappropriate responses, or even in some cases actually now counter-fitness enhancing. The case of the species-typical human sweet tooth was an example discussed above.

For this case, appropriately for the larger purposes of the paper at hand, we'll be drawing upon the field which has benefited the most in terms of practical application of human evolutionary frameworks to the resolution of practical human problems and distress. This is the field which has come to be known as evolutionary medicine. As evolved organisms, the human body should be expected to interact with pathogens, parasites and toxins in a manner molded by natural selection to enhance their fitness. Likewise, of course, pathogens and parasites, also biological organisms, have their own evolutionary processes, often caught up in an arms race with the evolved human immune system. Recognizing these facts has generated the growth of a field of evolutionary medicine which tries to leverage insights from evolutionary biology to better understand both threats to human health and the often debilitating responses by the body to health threats. The focus here is upon the latter set of considerations.

The discussion begins with distinctly somatic dynamics. With that example providing a template for clear thinking on the topic, we turn to the more evolutionary psychology approach, emphasizing the risk mitigation dimensions of some mental health symptoms. A pioneer in both of these evolutionary medicine approaches has been the psychiatrist Randolph Nesse. His contributions are followed by way of illustrations of the broader theoretical claims.

There is something of a cliché surrounding popular culture ideas of medicine that the goal is to treat the cause, not the symptom. When viewed through the lens of evolutionary medicine though it becomes evident that, on the contrary, very often the purpose of medical care is indeed to treat the symptom. Certainly when it comes to the types of pathogens and parasites to which our bodies have ancestral relations, our immune system is well adapted to fight them. Modern medicine has often provided solutions to threats for which we have no adapted response, such as cancer treatment, and it has provided treatments that augment our natural defenses, such as antibiotics. However, often, a great deal of what being sick involves is the suffering of the body's natural responses to threats. Sweat and chills regulate body temperature within a range that ideally will fight off infections without damaging physiological processes, severe hacking coughs are dislodging phlegm from the bronchi which could impede respiration, and pain prevents us from further stressing already damaged tissue.

The lesson for evolutionary medicine from the selfish gene framework is that our genes will “design” us in such a way as to ensure that we remain viable vehicles for moving them forward into future generations. That’s all that matters to our genes; whatever suffering we experience in the process is irrelevant to our genes – as long as such suffering doesn’t impede prospects for future reproduction. As a consequence we have evolved risk mitigation systems that have a scorched earth flavour to them. Nesse has described this tendency as the smoke detector principle (Nesse, 2005). Understanding this principle helps us understand why it is efficacious to medically constrain our symptoms, reducing the suffering they produce. After all, if the symptoms have evolved to defend us from pathogens and parasites, wouldn’t treating the symptoms actually be putting us at greater risk by reducing our natural defenses?

Understanding why that isn’t so is benefited by an appreciation of the smoke detector principle. This principle hinges on the relative costs of either false negatives or false positives. Many people have experienced the annoying outcome of smoke detectors being triggered while in the process of cooking dinner. And in fact such false positives – yes, there’s smoke, but there’s no fire risk – can be a lot more costly than that: they can empty out whole apartment or office buildings, disrupting the life and work of dozens or even hundreds of people. Such costs are not to be sloughed off lightly, yet these are small in comparison to the potential costs of false negatives, in which a smoke detector fails to alert us to the existence of an actual fire risk. The cost there of course can be death.

In light of such trade-offs, even engineers, who can choose to calibrate human built smoke detectors for an ideal optimization, perfectly balancing cost and benefit, nonetheless error on the side of over-sensitivity to false positives. It is better that people have their lives or work disrupted than that they risk death. Unsurprisingly, given the nature of our selfish genes, they have proven to be much less measured than those human engineers in the design of our natural risk mitigation responses. The pain for example is usually far more than needed to dissuade us from putting damaged tissue further at risk; the fever is more than necessary to kill off the infection. Our selfish genes have designed these risk mitigation systems with a high degree of overkill – insuring we'll survive to reproduce regardless of the suffering we endure to do so. This is why it is possible for medical treatment to considerably reduce the suffering experienced through such symptoms without hindering their risk mitigating effects.

As a trained psychiatrist, Nesse has applied these same principles to the operation of evolved human cognitive processes. Anxiety is a common psychological disorder encountered by mental health professionals. As Nesse explains, this is the same type of smoke detector process. What we call a panic attack is a highly fitness enhancing risk mitigation response in its evolved context. Imagine you are a hunter-gatherer charged with fetching the band's drinking supply from the local water hole, but just as you bend toward the water you hear bushes rustling behind a boulder. It could be a harmless monkey; it could be a deadly lion. There's a cost to fleeing the watering hole without the drinking supplies; there's a far greater cost to being killed. The evolved risk mitigation system of our cognitive apparatus errors on the side of the false positive with anxiety and panic responses that send us fleeing (Nesse, 2011).

While this story follows the same general template, there is an important difference to consider here. That's the influence of mismatch: an adaptation which now finds itself operating in a world for which it was not evolved – like the sweet tooth discussed earlier. Anxiety is not only an evolved response to other species predators, but to the predators of our own species. As Richard Alexander famously observed, a key dimension of our distinctive human evolution is that we came so much to dominate our ecological niche that it became members of our own species that constituted our primary hostile force of nature (R. Alexander, 1989; Flinn et al., 2005). As remarkably social an animal as we are, we still seem most socially comfortable in a social world of around 150 people (Dunbar, 2010). Now, though, most of us live in cities with at least hundreds of thousands, often millions, of total strangers. Each one of these inscrutable strangers is a potential lion behind the boulder. Nesse acknowledges that in such a context, it is not entirely clear that the anxiety response of his patients may not in fact be the more appropriate one (Nesse, 2011, p. 706). And, interestingly, though dealing with a different psychological state, there is evidence that depressed people have a more realistic assessment of the world (Alloy, Albright, Abramson, & Dykman, 1990). This observation provides an apropos segue into the next example.

We can see how the combination of an evolved risk mitigation system, significantly biased in favour of false positives, combined with the effects of a mismatched environment, produce debilitating psychological states. Along similar lines, Nesse has argued that depression is an adaptation for regulating resource investment that improves fitness by short circuiting continued investment in low probability goal pursuit, avoiding the risk of resource depletion (Nesse, 2009). All organisms have a limited caloric budget from which to fuel their essential biological activities: excessive expenditure upon goals with dwindling prospects for success threatens the organism’s biological sustainability. This seems to be likely a legacy of a pre-hominid evolved cognitive mechanism for making sound foraging decisions (Charnov, 1976). In the modern world, with its immensely complex social, economic and political systems, the average person engages vastly more such goals, goals that stretch over vastly longer time spans, and goals whose relevance to survival and mating fitness are far more abstract and obscure than the goal pursuing experience of our hunter-gatherer ancestors (Nesse, 2009). Again, an evolved sensitivity to false positives, operating in this mismatched environment, could explain the apparent rapid growth of depression in modern society.

Discussion and Future Research

Building upon past research, this paper has advanced from an original hypothesis that an understanding of evolutionary psychology could benefit risk communication practices to the still more radical claim that risk mitigation has been the guiding light of the evolution of human cognitive processes. The potential implication would be a radically expanded conceptual space for conceiving of the opportunities for leveraging that evolved human cognition in the interest of improved risk communication. Indeed, it seems increasingly clear that most evolution, certainly most natural selection, is a function of risk mitigation. As the paper demonstrates, these facts appear to be distinctly relevant to humans. Both the distinctive human need for a predator detector system which operates effectively in any earthly ecosystem, recognizing any novel predator, and the pretty much uniquely human evolution of language – which turns out to be largely a risk communication system – are emblematic of the degree to which human cognition has been molded by risk mitigation imperatives.

The space limitations of this paper has required the exclusion of some other important topics. Another, obviously important, dimension of uniquely evolved human cognition is our distinct capacity for intelligence. Given how closely correlated intelligence is in the modern world to beneficial health outcomes and lifetime income (Deary, Whiteman, Starr, Whalley, & Fox, 2004; Gottfredson, 1997; Gottfredson & Deary, 2004; Strachan, Deary, Ewing, & Frier, 1997), it seems a plausible hypothesis that very high intelligence, by which is meant *g*-factor, evolved specifically to deal with novel risks arising from our species' exit from Africa some 70,000 years ago (Kanazawa, 2004). The exploration of intelligence remains a fruitful area in which to carry on this research.

Intelligence, as a method of solving novel, complex problems, is too a product of natural selection. However, natural selection is not the only selection process that constitutes Darwinian evolution. And, it turns out that the other main organic selection process, sexual selection, may act to increase risky behaviour. Lower investing parents regard higher investing parents as precious resources and are tuned by evolutionary processes to engage in considerable, even life threatening, risks to gain mating opportunities with them (Trivers, 2002). Indeed, through the effects of the handicap principle, sexual selection can increase risk to the point of an extinction threat. Across a great range of species, these risk dynamics have long been observed in evolutionary biology, evolutionary psychology and behavioral ecology (Andersson, 1982; Eggers, Griesser, Nystrand, & Ekman, 2006; Godin & Briggs, 1996; Kotiaho, Alatalo, Mappes, Parri, & Rivero, 1998; McLain, Moulton, & Redfearn, 1995; Morrow & Pitcher, 2003; van Schaik & Kappeler, 1997; Walters & Juanes, 2011; Wang, 2002; Zahavi, 1975).

Research in evolutionary psychology has demonstrated the costly effects of these processes on the life outcomes of human male youth (Daly, 2016; M. Wilson & Daly, 1988).

So, ironically, as powerfully as natural selection selects for risk mitigation, sexual selection may select in exactly the opposite direction. Space limitations have also prevented the possibility of exploring these complex dynamics. On the face of it, these mixed messages from our evolutionary past may turn out to provide significant insight into some of the famous failures of risk management and risk communication. The next logical step in this research project may be to study one or more of these risk communication failures with an eye to assessing how lessons about the evolved nature of human cognition as risk mitigation (or risk promotion) reveal what went wrong and how the failure might have been avoided.

Conclusion & Acknowledgement

Beginning with the premise that risk mitigation has been structured into our very nature by evolution, this paper set out to discover if key dimensions of evolved human cognitive processes could indeed be traced back to risk mitigation benefits reinforced through natural selection. Prior research had already established that insights from evolutionary psychology offered tools for improved risk communication. This deeper theoretical exploration sought to get an initial grasp upon the extent and kinds of mechanisms that natural selection had molded into evolved human cognitive processes that were intrinsically risk mitigation operations.

Three key areas were explored: 1) the evolution of a, possibly uniquely human, prey detection mechanism that allowed humans to spread across the earth, responding effectively to novel predators in any ecosystem. This example not only demonstrated the role of risk mitigation in such evolution, but provided insight into how such a mechanism was constituted in human cognition. A fuller appreciation of the deep mechanics of human predator detection not only explains how human evolved cognition works, but can help those, like risk communication scholars and practitioner, to better appreciate the capacity for a more fine grained leveraging of evolved human risk avoidance. As human predator detection is composed from a suite of traits, it is possible that amplifying any one of them may serve to heighten the risk mitigation operation of the adaptation.

2) The evolution of language as part of human cognition was explored. Building upon Chomsky's early observation that humans possessed an innate capacity for syntax and grammar, it has become increasingly clear that language capacity evolved in humans, like any other functional, fitness enhancing trait, through the gradual forces of natural selection. It appears that a major, if not the major, fitness pressure driving the evolution of language was the risk communication benefits it provided: allowing for the coordination of efforts with the minimization of squandered energy or resources – which under the conditions of our hunter-gatherer ancestors posed serious risk of death.

3) The examination of evolutionary medicine perhaps had a uniquely valuable set of lessons to teach risk communication scholars and practitioners. It turns out that in a great many cases, especially those related to ancient forms of illness, our evolved natural defenses are highly efficient at reducing risk. Yet, because of our selfish gene's concern to ensure our usefulness as vehicles for moving themselves into future generations, they

have evolved a scorched earth approach to killing off such threats. As selfish genes, they are indifferent to the suffering of the organism. As humans, the latter does concern us and once we appreciate the overkill strategy of our evolved immune systems, it becomes practical to actually treat the symptoms that create the misery, without obstructing the effectiveness of our natural defenses. It also turned out that the same kinds of processes are operating at the level of mental health. Conditions like anxiety and depression are valuable, evolved, risk mitigation functions. Being evolved for overkill, though, they can sometimes do as much harm emotionally to the individual human as the good they are doing in responding to ancient risks. This situation is aggravated by the mismatch between our current complex, urban, technological ways of life and the original environments in which such defenses evolved. These insights might prove to be the most valuable for risk communication scholars and practitioners as the field takes a deeper appreciation of the role of evolved human psychology in risk assessment, mitigation and response.

Space limitations prevented a complete exploration of the topic. Particularly, the role of sexual selection in actually promoting high-risk tolerance could not be explored. Moving forward with this research project, the two obvious areas of further exploration are either to round out this theoretical exploration, with attention to the effects of sexual selection upon risk response in human cognition, or to look at a well-documented case of risk (or disaster) communication failure with an eye to examining whether the kinds of insights into evolved human cognition’s relationship to risk might have better informed those risk mitigation efforts, producing better results.

The author acknowledges that the focus and scope of this essay lie virtually exclusively on evolutionary biology and evolved human cognition and the fundamental lessons for risk communicators and practitioners thereof. The author chose not to include a discussion of the role of culture and media, which she recognizes do play an essential role in mediating how the public engages with risk, but which are not examined for the purposes of this present research essay.

References

Alexander, R. (1987). *The Biology of Moral Systems*. Hawthorne, N.Y: Aldine Transaction.

Alexander, R. (1989). The Evolution of the Human Psyche. In P. Mellars & C. Stringer (Eds.), *The Human Revolution*. Edinburgh University Press.

Alexander, R. D. (1982). *Darwinism and Human Affairs*. Seattle: University of Washington Press.

Alloy, L. B., Albright, J. S., Abramson, L. Y., & Dykman, B. M. (1990). Depressive Realism and Nondepressive Optimistic Illusions: The Role of the Self. In R. E. Ingram (Ed.), *Contemporary Psychological Approaches to Depression* (pp. 71–86). New York: Plenum Press. https://doi.org/10.1007/978-1-4613-0649-8_6

Andersson, M. (1982). Sexual selection, natural selection and quality advertisement. *Biological Journal of the Linnean Society*, *17*(4), 375–393. https://doi.org/10.1111/j.1095-8312.1982.tb02028.x

Ariely, D. (2013). *The Honest Truth About Dishonesty: How We Lie to Everyone--Especially Ourselves* (Reprint edition). New York: Harper Perennial.

Barkow, J. H., Cosmides, L., & Tooby, J. (Eds.). (1992). *The Adapted Mind: Evolutionary Psychology and the Generation of Culture* (Reprint edition). New York: Oxford University Press.

Barrett, H. C. (2005). Adaptation to predator and prey. In D. Buss (Ed.), *The Handbook of Evolutionary Psychology* (1 edition, pp. 200–223). Hoboken, N.J: Wiley.

Barrett, H. C. (2015). *The Shape of Thought: How Mental Adaptations Evolve* (1 edition). New York: Oxford University Press.

Boehm, C. (1999). *Hierarchy in the Forest: The Evolution of Egalitarian Behavior*. Cambridge, Mass.: Harvard University Press.

Buss, D. (1991). Evolutionary Personality Psychology. *Annual Review of Psychology*, *42*(1), 459–491. https://doi.org/10.1146/annurev.ps.42.020191.002331

Charnov, E. L. (1976). Optimal foraging, the marginal value theorem. *Theoretical Population Biology*, *9*(2), 129–136. https://doi.org/10.1016/0040-5809(76)90040-X

Chomsky, N. (1957). *Syntactic Structures*. Martino Fine Books.

Cosmides, L. (1989). The logic of social exchange: Has natural selection shaped how humans reason? Studies with the Wason selection task. *Cognition*, *31*(3), 187–276. https://doi.org/10.1016/0010-0277(89)90023-1

Cosmides, L., & Tooby, J. (1992). Cognitive adaptations for social exchange. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The Adapted Mind: Evolutionary Psychology and the Generation of Culture* (Reprint edition). New York: Oxford University Press.

Cosmides, L., & Tooby, J. (1994). Better than Rational: Evolutionary Psychology and the Invisible Hand. *American Economic Review*, *84*(2), 327–332.

Daly, M. (2016). *Killing the Competition: Economic Inequality and Homicide* (1 edition). New Brunswick: Routledge.

Dawkins, R. (2006). *The Selfish Gene: 30th Anniversary edition* (3 edition). OUP Oxford.

Deary, I. J., Whiteman, M. C., Starr, J. M., Whalley, L. J., & Fox, H. C. (2004). The impact of childhood intelligence on later life: following up the Scottish mental surveys of 1932 and 1947. *Journal of Personality and Social Psychology*, *86*(1), 130–147. https://doi.org/10.1037/0022-3514.86.1.130

Dunbar, R. (1998). *Grooming, Gossip, and the Evolution of Language*. Cambridge, Mass: Harvard University Press.

Dunbar, R. (2010). *How Many Friends Does One Person Need?: Dunbar's Number and Other Evolutionary Quirks*. London: Faber & Faber.

Eggers, S., Griesser, M., Nystrand, M., & Ekman, J. (2006). Predation risk induces changes in nest-site selection and clutch size in the Siberian jay. *Proceedings of the Royal Society B: Biological Sciences*, *273*(1587), 701–706. https://doi.org/10.1098/rspb.2005.3373

Evans, J. S. B. T., & Wason, P. C. (1976). Rationalization in a Reasoning Task. *British Journal of Psychology*, *67*(4), 479–486. https://doi.org/10.1111/j.2044-8295.1976.tb01536.x

Flinn, M. V., Geary, D. C., & Ward, C. V. (2005). Ecological dominance, social competition, and coalitionary arms races. *Evolution and Human Behavior*, *26*(1), 10–46. https://doi.org/10.1016/j.evolhumbehav.2004.08.005

Gallistel, C. R., & King, A. P. (2010). *Memory and the Computational Brain: Why Cognitive Science will Transform Neuroscience* (1 edition). Chichester UK: Wiley-Blackwell.

Gigerenzer, G. (2002). *Adaptive Thinking: Rationality in the Real World*. New York; Oxford: Oxford University Press.

Gigerenzer, G. (2006). Out of the frying pan into the fire: behavioral reactions to terrorist attacks. *Risk Analysis: An Official Publication of the Society for Risk Analysis*, *26*(2), 347–351. https://doi.org/10.1111/j.1539-6924.2006.00753.x

Gigerenzer, G. (2014). *Risk Savvy: How to Make Good Decisions*. New York: Viking.

Godin, J.-G. J., & Briggs, S. E. (1996). Female mate choice under predation risk in the guppy. *Animal Behaviour*, *51*(1), 117–130. https://doi.org/10.1006/anbe.1996.0010

Goldstein, D. G., & Gigerenzer, G. (2002). Models of ecological rationality: The recognition heuristic. *Psychological Review*, *109*(1), 75–90. https://doi.org/10.1037/0033-295X.109.1.75

Gottfredson, L. S. (1997). Why g matters: The complexity of everyday life. *Intelligence*, *24*(1), 79–132. https://doi.org/10.1016/S0160-2896(97)90014-3

Gottfredson, L. S., & Deary, I. J. (2004). Intelligence Predicts Health and Longevity, but Why? *Current Directions in Psychological Science*, *13*(1), 1–4. https://doi.org/10.1111/j.0963-7214.2004.01301001.x

Haidt, J. (2012). *The Righteous Mind: Why Good People Are Divided by Politics and Religion* (1 edition). Vintage.

Isbell, L. A. (2011). *The Fruit, the Tree, and the Serpent: Why We See So Well*. Cambridge, MA: Harvard University Press.

Kahan, D. M. (2013). *Ideology, Motivated Reasoning, and Cognitive Reflection: An Experimental Study* (SSRN Scholarly Paper No. ID 2182588). Rochester, NY: Social Science Research Network. Retrieved from http://papers.ssrn.com/abstract=2182588

Kahneman, D. (2013). *Thinking, Fast and Slow* (1st edition). New York: Farrar, Straus and Giroux.

Kanazawa, S. (2004). General Intelligence as a Domain-Specific Adaptation. *Psychological Review*, *111*(2), 512–523.

Karrass, D. (2017). Disaster Response Risk Communication and Evolutionary Psychology: Toward an integrated understanding of risk induced behaviour. *Unpublished Manuscript*.

Kotiaho, J., Alatalo, R. V., Mappes, J., Parri, S., & Rivero, A. (1998). Male mating success and risk of predation in a wolf spider: a balance between sexual and natural selection? *Journal of Animal Ecology*, *67*(2), 287–291. https://doi.org/10.1046/j.1365-2656.1998.00192.x

Kurzban, R. (2010). *Why Everyone (Else) Is a Hypocrite: Evolution and the Modular Mind*. Princeton, N.J.: Princeton University Press.

Marcus, G. (2004). *The Birth of the Mind: How a Tiny Number of Genes Creates The Complexities of Human Thought: Gary Marcus: 9780465044061: Amazon.com: Books*. New York: Basic Books. Retrieved from http://www.amazon.com/Birth-Mind-Creates-Complexities-Thought/dp/0465044069/ref=sr_1_1?ie=UTF8&qid=1458406553&sr=8-1&keywords=birth+of+the+mind

McLain, D. K., Moulton, M. P., & Redfearn, T. P. (1995). Sexual Selection and the Risk of Extinction of Introduced Birds on Oceanic Islands. *Oikos*, *74*(1), 27–34. https://doi.org/10.2307/3545671

Mercier, H., & Sperber, D. (2011). Why Do Humans Reason? Arguments for an Argumentative Theory. *Behavioral and Brain Sciences*, *34*(2), 57–74.

Miller, G. (2001). *The Mating Mind: How Sexual Choice Shaped the Evolution of Human Nature* (Reprint edition). New York: Anchor.

Minsky, M. (1988). *The Society of Mind*. New York: Simon & Schuster.

Morrow, E. H., & Pitcher, T. E. (2003). Sexual selection and the risk of extinction in birds. *Proceedings of the Royal Society of London B: Biological Sciences*, *270*(1526), 1793–1799. https://doi.org/10.1098/rspb.2003.2441

Nesse, R. M. (2005). Natural selection and the regulation of defenses: A signal detection analysis of the smoke detector principle. *Evolution and Human Behavior*, *26*(1), 88–105. https://doi.org/10.1016/j.evolhumbehav.2004.08.002

Nesse, R. M. (2009). Explaining depression: neuroscience is not enough, evolution is essential. In D. Nutt, L. Wolpert, C. M. Pariante, & R. M. Nesse (Eds.), *Understanding depression: A translational approach* (1 edition). London; New York: Oxford University Press.

Nesse, R. M. (2011). Why has natural selection left us so vulnerable to anxiety and mood disorders? *Canadian Journal of Psychiatry. Revue Canadienne De Psychiatrie*, *56*(12), 705–706. https://doi.org/10.1177/070674371105601201

Oppenheimer, S. (2004). *Out of Eden: The Peopling of the World*. London: Robinson Publishing.

Penn, D. C., & Povinelli, D. J. (2007). On the lack of evidence that non-human animals possess anything remotely resembling a 'theory of mind.' *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *362*(1480), 731–744. https://doi.org/10.1098/rstb.2006.2023

Penn, D. C., & Povinelli, D. J. (2013). The comparative delusion: The"behavoristic/mentalistic" dichotomy in comparative theory of mind research. In J. Metcalfe & H. S. Terrace (Eds.), *Agency and Joint Attention*. Oxford: Oxford University Press.

Perner, J. (2010). Who took the cog out of cognitive science? In P. A. Frensch & R. Schwarzer (Eds.), *Perception, attention, and action* (Vol. 1). East Sussex, UK: Psychology Press.

Pinker, S. (1994). *The Language Instinct: How the Mind Creates Language*. New York: Harper Perennial Modern Classics.

Pinker, S. (1997). *How the Mind Works*. New York: W. W. Norton & Company.

Pinker, S. (2002). *The Blank Slate: The Modern Denial of Human Nature*. New York: Penguin Books.

Pinker, S., & Bloom, P. (1992). Natural Language and Natural Selection. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The Adapted Mind: Evolutionary Psychology and the Generation of Culture* (Reprint edition). New York: Oxford University Press.

Povinelli, D. J. (2004). Behind the ape's appearance: escaping anthropocentrism in the study of other minds. *Daedalus*, *133*(1), 29–41. https://doi.org/10.1162/001152604772746675

Segerstrale, U. (2000). *Defenders of the Truth: The Battle for Science in the Sociobiology Debate and Beyond* (First Edition edition). Oxford ; New York: Oxford University Press.

Shettleworth, S. J. (2010). *Cognition, Evolution, and Behavior* (2 edition). Oxford ; New York: Oxford University Press.

Smith, D. L. (2007). *Why We Lie: The Evolutionary Roots of Deception and the Unconscious Mind*. St. Martin's Griffin.

Strachan, M. W. J., Deary, I. J., Ewing, F. M. E., & Frier, B. M. (1997). Is Type II Diabetes Associated With an Increased Risk of Cognitive Dysfunction?: A critical review of published studies. *Diabetes Care, 20*(3), 438–445. https://doi.org/10.2337/diacare.20.3.438

Todd, P. M., & Gigerenzer, G. (Eds.). (2012). *Ecological Rationality: Intelligence in the World* (1 edition). Oxford ; New York: Oxford University Press.

Tooby, J., & Cosmides, L. (2005). Conceptual Foundations of Evolutionary Psychology. In D. Buss (Ed.), *The Handbook of Evolutionary Psychology*. John Wiley & Sons.

Trivers, R. (2002). *Natural Selection and Social Theory: Selected Papers of Robert Trivers*. New York: Oxford University Press.

Trivers, R. (2014). *The Folly of Fools: The Logic of Deceit and Self-Deception in Human Life* (First Trade Paper Edition edition). Basic Books.

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science*, *185*(4157), 1124–1131. https://doi.org/10.1126/science.185.4157.1124 van Schaik, C. P., & Kappeler, P. M. (1997). Infanticide risk and the evolution of male-female association in primates. *Proceedings of the Royal Society B: Biological Sciences*, *264*(1388), 1687–1694.

Walters, C. J., & Juanes, F. (2011, April). Recruitment Limitation as a Consequence of Natural Selection for Use of Restricted Feeding Habitats and Predation Risk Taking by Juvenile Fishes. http://dx.doi.org/10.1139/f93-229

Wang, X. T. (2002). Risk as reproductive variance. *Evolution and Human Behavior*, *23*(1), 35–57. https://doi.org/10.1016/S1090-5138(01)00091-5

Wason, P. C. (1968). Reasoning about a rule. *Quarterly Journal of Experimental Psychology*, *20*(3), 273–281. https://doi.org/10.1080/14640746808400161

Weeden, J., & Kurzban, R. (2014). *The Hidden Agenda of the Political Mind: How Self-Interest Shapes Our Opinions and Why We Won't Admit It*. Princeton: Princeton University Press.

Wilson, M., & Daly, M. (1988). *Homicide*. New York: Aldine Transaction.

Wilson, P. J. (1983). *Man, The Promising Primate: The Conditions of Human Evolution, Second edition* (2 edition). New Haven: Yale University Press.

Zahavi, A. (1975). Mate selection—A selection for a handicap. *Journal of Theoretical Biology*, *53*(1), 205–214. https://doi.org/10.1016/0022-5193(75)90111-3

Lessons for Risk Communication Learned through the Kahneman-Gigerenzer Debate

Introduction

Whether it's the dramatic events of a Hurricane Katrina (Cole & Fellows, 2008; Comfort & Haase, 2006) or the slow burn of pushback on youth smoking reduction policy (Califano, 2012; U.S. Surgeon General, n.d.), risk communication failures are well documented and put lives and well-being in danger. Trying to remedy such failures, though, through emphasizing the "communication" part of the concern – e.g., improved messaging, reducing channel noise, or audience management – misses the core concern.

However effective the communication becomes, it is the "risk" that is the telling factor. And risk is a subjective fact of life. To understand risk requires understanding the humans who experience and perceive it. This is why risk communication scholarship has correctly taken an interest in psychology. Treating psychology, though, as separate from biology is to succumb to Cartesian dualism. If we resist the temptation of the supernatural, we are left only with a naturalistic foundation for psychology: the brain which produces all psychology is biota, which, like all biota, is molded by evolutionary pressures for specific purposes.

The present author's work has been aimed at paving the way for a fuller engagement by risk communication scholarship with the lessons of evolutionary biology and psychology. If risk communication needs psychology to optimize its effectiveness, that effectiveness by necessity is conditional upon the rigor and reliability of the psychology being used. A case in point that illustrates this claim is the famous debate between the Heuristics and Biases school of social psychology and behavioral economics, closely associated with the work of Daniel Kahneman, and the Fast and Frugal school, studying the same phenomena, closely associated with the work of Gerd Gigerenzer.

The Kahneman School is famous for decrying the surprising failures of human rationality and noting the many ways we are biased toward making poor, self-injuring decisions. On the other hand, the Gigerenzer School is noted for claiming that in fact our intuitive or instinctual reactions are remarkably successful and in fact very often result in better outcomes than are possible under conditions of heightened awareness or increased information. Obviously, both claims cannot be true. Or, at least, this is how the debate is often portrayed.

The present paper demonstrates that in fact the differences between these two schools, for all the associated bluster, is largely one of emphasis rather than substantive incompatibility. The resolution of their differences, it turns out, though, hinges upon reducing their arguments to the conceptual common denominator that gives rise to the psychological effects that intrigue each. And this conceptual common denominator is the nature and function of evolved human cognition. Once viewed through the naturalistic lens of an evolved psychology, what, at the more superficial level of proximate causes and events, appears as contradictory claims and premises, turns out to be just different angles on the same true north point.

This resolution of one of psychology's most celebrated debates illustrates the explanatory power of evolutionary psychology at a theoretical level. More to the pressing issue at hand, though, it illustrates the importance of risk communication scholars and practitioners – who hope to improve risk communication efficacy through learning from psychology – not being distracted by proximate level effects, but rather drilling down into the foundational psychology in human evolutionary biology for ultimate causes. If risk communication scholars and practitioners need psychology to understand risk better, so that their communication efforts are effective, then they need the foundational psychology that explains fundamental causes. Only the biological processes that give rise to all psychology offer this foundation. The analysis of the Kahneman-Gigerenzer debate herein provides a case in point.

The paper begins with discussions of the broader intellectual and the evolutionary contexts of the Kahneman-Gigerenzer debate, laying the groundwork and providing examples that will be then more economically available for shorthand reference in the later analysis of the debate. That analysis then follows, sketching out the core ideas around the key claims of each school, before being re-examined through the lens of evolutionary biology. The paper concludes with lessons to be drawn from the debate, and its resolution, through the lens of the evolved biology of cognition, for risk communication scholars and practitioners. These lessons touch upon both errors that can be avoided by not being distracted by proximate level effects and opportunities that may become available moving forward with a focus on ultimate (which is to say) biological level causes.

The Intellectual Context

If we think of risk communication as a communicative intervention in the space between human observation and behaviour – toward encouraging behaviour that reduces risk when confronted with the observation of risky conditions – then risk communication addresses an interface with human cognition. It is human cognition that turns observations of the world into specific behaviour. That interface with human cognition then requires of risk communication, if it's to be effective, a functional psychology. At the very least, it requires a theory and understanding of human cognition. Earlier work by the present author has sought to demonstrate the importance and value of grounding such a psychology and theory in material facts of evolutionary science (Karrass, 2017a, 2017b). Only evolutionary science provides the ultimate explanation for human cognition. It may not always be necessary to understand those ultimate explanations to make a correct assessment; proximate understanding can work. It can though also fail dramatically. The better understanding that risk communication scholars and practitioners have, the less likely they are to be led astray by a misunderstanding of apparent proximate causes. Also, the more insight they have into the workings of human risk attitudes, the more effective and realistic can be any intervention into that space between human observation and behaviour.

Previous work by the present author has endeavoured to establish the complicated nature of evolved human dispositions toward risk (Karrass, 2017b). It was shown that risk mitigation is a major component of evolution at the level of natural selection, though, at the too often underappreciated level of sexual selection, there is plenty of incentive to engage in high levels of risk pursuit. This is especially true for species' low investment parents. While it will prove useful to keep these insights in mind, the current paper takes this research in another direction. It builds instead upon even earlier work by the present author, which explored how evolved disposition contributed to high-risk behaviour, with an eye to how risk communication scholars and practitioners might learn from and respond to such insights (Karrass, 2017a). That work looked at a couple of examples of risky behaviour with evolutionary roots. One of those, which falls naturally into the sexual selection silo, was the example of how young male gang members, who engage in high-risk gang violence, increase their sexual access to peer females. The other example from that paper is more interesting though for present purposes. It identified something that the researcher in question, Gerd Gigerenzer, called dread risk. It's interesting because it falls into the silo of natural selection (or, using the popular phrase in its crudest form: survival of the fittest). But, rather than the natural tendency to risk avoidance, as we've seen, that is typical of natural selection evolutionary pressures, this survival instinct leads individuals to make in fact more risky choices. The example of this phenomenon provided by Gigerenzer was the dramatic increase in automobile traffic following the 9/11 attacks. The fact that air travel, despite the death dives of the hijacked planes, remained a far safer mode of transportation than automobiles, meant that this increase of road traffic put many more individuals at greater risk. Furthermore, using past years as a baseline, he demonstrated that there were over 1500 deaths directly related to the dramatic increase of automobile travel following the terrorism incidents of 9/11. This result, he observed, was too a product of evolved human cognition, but it was a misfiring of that cognition, a result of what evolutionary science calls mismatch between evolved cognitions and changing environments.

Avoiding the dread risk casualties, resulting from the misfiring of this evolved risk avoidance mechanism, would have required risk communicators to understand both the actual cognitive mechanism at work, that led so many individuals to avoid the perceived risk of air travel, and how that mechanism was mismatched to the actual world in which an evolved cognitive mechanism no longer provided the risk reduction reflex for which it was evolutionarily selected.

All of this raises the question of how we can better understand the choices that human's make in the face of risk. When are our evolved human intuitions about risk strong and best left undisturbed and when are they likely to go astray and lead to the kind of useless collateral damaged discussed by Gigerenzer? A theoretically sophisticated and academically notorious debate has been taking place for several decades now that gets right to the heart of precisely these questions as they present themselves to risk communication scholars and practitioners. Known under a variety of names, it'll be called here the Kahneman-Gigerenzer, or the biases and heuristics, debate. This debate has been conducted over a long period of time, across a variety of disciplines and sub-disciplines, between great numbers of scholars. The space limits of the current paper will benefit a more narrow and closer reading of the issues as teased out in the work of a couple of the key scholars in this debate. Indeed, it is not unfair to suggest that these two are in fact the most important and influential voices in this debate. On the biases side, the figure to be emphasized will be Daniel Kahneman. And, on the heuristics side, the figure to be emphasized is none other than the previously mentioned above Gerd Gigerenzer.

In the pages to follow, the positions, with some narrowing to specific examples in the interest of space, of each of these two influential scholars will be teased out. In both cases, we want to understand what they believe, why they believe it and how they illustrate the validity of their claim. The paper will conclude with a reframing of this debate through the lens of our earlier established understanding of evolutionary psychology. Some of the key important conflicts between these scholars in their famous debate turn out to be not nearly as vexing as first impressions suggest, once we place these matters in the context of what we know about evolved cognition.

Therefore, before we turn to delineate Kahneman's and Gigerenzer's positions, it will be useful to begin with a review of some of the important dimensions of evolutionary psychology and human cognition established in earlier work by the present author.

The Evolutionary Context

The biases and heuristics discussed in this paper are the products of human cognition. The neural activity of the brain, or nervous system, generates capacities, systems, or mechanisms. That is what is meant here by reference to cognition. Though the vernacular use of the term follows along the lines of "knowing or understanding," in cognitive science circles, during the "cognitive revolution" of the 1960s, it was adjusted to refer to neural functions of informational processing. In a broad sense, it might be characterized as problem-solving, provided the term "problem" is broadly enough defined. This is a computational approach to the functions and purposes of cognition.

To better fit our understanding of cognition to the needs of the present discussion, it is important to emphasize that cognition is not reduced to the rational side of a supposed rational-emotional divide within the operations of the human mind.[3] Cognition is the process by which environmentally relevant information is taken in, and an appropriate behavioural response is generated. From this perspective, cognition has always been the purpose and function of nervous systems, long before the evolutionary emergence of brains. The original, crudest nervous systems regulated the mobility of those early organisms in relation to elements in the environment that presented advantages or disadvantages: e.g., moving away from or toward warmth or cold, depending upon the needs of the organism (Barrett, 2015).

As nervous systems have evolved to become more complex a broader range of relevant information has been accessible from the environment, providing a richer and more finely grained set of behavioural responses. The fundamental function and purpose of nervous systems, though, has not changed with the evolution of the centralized nervous systems that we call brains. In this context, emotions are very much a part of this cognitive process. Fear alerts the organism to dangers that need to be avoided for its survival; love ensures care for the young necessary to perpetuate future generations; jealousy triggers mate guarding instincts that prevent the squandering of resources on offspring unrelated to the jealous individuals. Even less obviously beneficial, emotions like anxiety and depression turn out to have their fitness enhancing functions when understood in proper evolutionary context (Nesse, 2005, 2009, 2011). When evolution is

[3] In the text I want to make a broader, theoretical point, but it's worth noting that even at a technical, functional level claims for this rational-emotional dualism have been found to be groundless (Damasio, 2005).

understood through the lens of what Dawkins calls the selfish gene, or before him what William Hamilton called the gene's-eye-view, the role of emotion as an important part of evolved cognition becomes clear.

Cognition then is an evolved capacity for processing information to solve life problems in the interest of enhancing the organism's effectiveness at getting its genes into future generations. If the human brain is composed of biological material and no supernatural influence is granted as an explanatory possibility, then the human brain must have been molded by evolutionary forces, like everything else biological in the world. If one rejects the supernatural and Cartesian dualism, then this means that the human mind, which can only be the function of neural processes, must be molded by evolution for fitness enhancing purposes (Barkow, Cosmides, & Tooby, 1992; Pinker, 1997).

With this naturalistic explanation of human cognition established, it becomes possible to look more closely at the cognitive functions, which will be discussed under the rubrics of heuristics and biases in the discussion to follow. The core insight of evolutionary psychology, taking its inspiration from the cognitive revolution, and advances of artificial intelligence research in computer science, was that the human mind had to be evolved as a set of highly specialized mechanisms or algorithms, sometimes called modules, which dedicated parts of our neural operations to solving highly specific problems which posed themselves to our ancient ancestors (Barrett, 2015; Kurzban, 2010; Minsky, 1988; Pinker, 1997, 2002; Tooby & Cosmides, 2005).

Following the standard logic of evolutionary processes: problems were posed, those individuals better able to solve those problems were more reliably able to stay alive and find a mate for purposes of transferring their genes into future generations. To the degree their ability to better solve such problems were genetically based, those genes spread through the gene pool, creating a generalized trait within the relevant species. As true as this was for the beaks of finches or the tails of peacocks, so must it be true for all animals' nervous systems, including human brains (Barrett, 2015; Carroll, 2007; Marcus, 2004).

The first such mechanism or algorithm operating in human cognition that was formally identified by the modern evolutionary psychology tradition, and one that provides a valuable illustration to which we will refer later in our discussion of the Kahneman and Gigerenzer debate, is the example of a cheater detection mechanism. A few remarks of the background are necessary, here. It is common among those only exposed to second-hand and popular cultural misunderstandings of Dawkins' selfish gene concept to conclude that because genes always act selfishly that therefore the argument presumes that the organisms to which such genes give rise, such as humans, too must always act selfishly. This interpretation is not merely erroneous; it is egregiously so. As the most social animal on the planet, it is frequently in the interest of human selfish genes that we conduct ourselves with high levels of pro-social behaviour, being caring, cooperative and altruistic. Insofar as such behaviour improves our fitness – advancing the interests of those genetically related to us; cultivating friendships for reciprocity; building the coalitions that give us strength and safety in numbers; and enhancing our social reputation as trustworthy partners, etc. – very much non-selfish phenotypic behaviour can serve our selfish genetic interests.

Recognizing these functions of the selfish gene further informs a more evolutionarily sophisticated assessment of human sociality. The highly social behaviour that our selfish genes can generate provides massive fitness enhancing advantages: safety in numbers, specialization, division of labour, comparative advantage, economies of scale, etc. At the same time, though, the extraordinarily high propensity for sociality among humans also creates opportunities for free riding on that sociality. A little lying and cheating, on the margins, can generate tremendous advantages over the long term. And the evidence is that all humans lie and cheat to some degree, regulated by certain internal measures of self-assessment, though environmental inputs, such as observing blatant cheating of an identifiable out-group member, can dramatically increase the propensity to engage in the same behaviour (Ariely, 2013).

This is the peculiar situation of our amazingly social species. On the one hand, we gain tremendous benefits from our sociality and accordingly have evolved all kinds of adaptations for cementing and enhancing that sociality. Yet, that same sociality provides the opportunity to take advantage of each other. An evolutionary hypothesis would predict, then, that given the benefits and evolutionary investment in our sociality, we would see the emergence of adaptations for protecting against the potential harm to sociality that could arise from that potential free-riding, and obviously to protect individuals from the costs of such cheating by others. A number of general mechanisms have been identified along these lines, including morality and gossip (Alexander, 1987; Dunbar, 1998).

However, the very first mechanism, which was precisely isolated by experimental conditions, for achieving these ends, was the cheater detector mechanism identified by

Leda Cosmides in her doctoral research. Her research built upon the earlier work of Peter Wason, who had shocked the comfortable post-WWII consensus on Rational Choice theory in psychology and economics by demonstrating that the vast majority of subjects failed when trying to solve a basic *p and q* propositional logic problem, requiring them to test a hypothesis by selecting the correct choices from four cards (Wason, 1968).

In the later 1980s, Cosmides revisited this problem. She challenged her subjects to solve the very same *p and q* propositional logic problem, however, instead of using abstract variables (e.g. letters on one side, numbers on the other), she organized the choices as a means of solving a social cheater violation (e.g., age restricted drinks on one side, drinker's age on the other). It turned out that whereas using the abstract variables some 80 percent of subjects got the wrong answer, the very same *p and q* propositional problem, when rendered as the solution of a social problem, resulted in some 80 percent of subjects getting the correct answer (Cosmides, 1989; Cosmides & Tooby, 1992). This experiment has been replicated numerous times, using a variety of different social cheater scenarios.

What Cosmides discovered was a precise cognitive mechanism for solving fitness problems specific to the unique social conditions of human evolution. It could not have been a general computational mechanism, because, going back to Wason's original version, the very same logical proposition stumps the majority of people when presented in algebraic terms. Yet, this exact same logic problem becomes surprisingly simple to solve for the majority of people when rendered into the situation of a potentially fitness-threatening social cheater scenario. The expectation from evolutionary biology is that all such mechanisms and the heuristics they generate will be calibrated along such fitness enhancing lines. This would be the only way for them to be evolutionarily sustainable in a naturalistic conceptual framework.

If these context-setting remarks strike readers with some familiarity of the Kahneman-Gigerenzer debate as tilting the playing field against Kahneman, as will be seen in the discussion of their positions to shortly follow, this is not at all the case. Kahneman, as will be seen, is fully aware of and concedes the central importance of evolutionary pressures in the sculpting of the heuristics, which he discusses. The challenge to Kahneman from Gigerenzer is in his operative disregard of that same evolutionary context, which he acknowledges in passing.

Finally, it is important to remember that, being evolutionarily generated, the mechanisms or algorithms that generate such heuristics are evolved to solve the problems of our ancestors in the evolutionary past. Much that was true about the lives of those ancestors and our own remain consistent, so our adaptations for mating, rivalry within dominance hierarchies, parenting and coalition building remain largely unchanged and the relevant mechanisms continue to work as well as they have for hundreds of thousands and even millions of years. Others, though, such as our preference for sweet, salty and fatty foods, are now environmental mismatches. In the evolutionary settings of our ancestors, these appetites provided the incentives to take the risks necessary to obtain these nutritionally valuable, but difficult and sometimes dangerous to obtain, foods. Today, when such foods are readily available to most of us thanks to modern international markets and supply chains, such appetites arguably have become counter-adaptive.

Such mismatch though is a useful source of empirical evidence for demonstrating the operation of evolved psychology at work. Not only does the evolutionary explanation explain the appetites, but the appetites demonstrate the existence and operation of the mechanisms. Another example of these processes, which was discussed in an earlier paper was childhood fears. Though among the major causes of contemporary childhood death and injury in the industrialized world today are bathtubs, automobiles, and stoves, virtually no children have phobias over such routine encounters. Yet, virtually all children, at some point in their life, experience fear of skeletons, darkness, and snakes (Tooby & Cosmides, 2005).[4] Again, for millions of years, our ancestors gained fitness advantages when children were hyper-sensitive to these manifestations of a serious threat to their health and well-being. Very rarely do children in the modern, industrialized world suffer from such threats; the mechanisms that evolved to protect our ancestors though remain operative parts of our brains and nervous system.

The simple formula then is that these psychological mechanisms generate heuristics that guide behaviour; that behaviour has some impact on reproductive success, also called fitness; depending upon whether fitness is increased or decreased the relevant trait expands or shrinks through the gene pool. Presumably, the extremely rapid change of conditions humans have experienced, first over the last 10,000 years, then even more dramatically over the last couple hundred years, will eventually change our evolved psychology – assuming the current conditions of prosperity are sustainable. However, there has not yet been anything close to enough time to rewire our current cognitive

[4] Indeed, fear of snakes is a pervasive human experience, probably pointing back to an evolutionary arms race that goes a long way in explaining certain aspects of human cognition – especially our acute visual apparatus (Isbell, 2011).

mechanisms, dating back at least hundreds of thousands, in many cases millions, or even in some cases tens of millions, of years.

This discussion has not only provided a review of the state of the art in naturalistic explanation of the cognitive processes that give rise to our heuristics and biases, but it also sketches out some important ideas and events which there will be occasion to refer back to as we now proceed into a review of the Kahneman-Gigerenzer debate.

The Kahneman-Gigerenzer Debate

There is a widespread truism that regards the well-established disputes between what is commonly referred to as Daniel Kahneman's "biases and heuristics" school and Gerd Gigerenzer's "fast and frugal" school as simply a difference of emphasis. Kahneman, in this description, is depicted as focused on the half-empty part of the glass, while Gigerenzer is depicted as focused on the half full part of the glass. As Mark Kelman (2011) observed, in his book describing the intellectual contours of this dispute, there is some validity in these depictions, as clearly each school has tended to cherry pick their examples a little to emphasize their point. From another perspective, though, this depiction does justice to neither of the scholars. As will be addressed below, this depiction has the effect of glossing over the considerable, and considerably important, areas of agreement between the two schools. Furthermore, it is in the areas where they agree that we also find the clues to help resolve some of their differences.

These schools involve many scholars, with considerable academic achievements, and impressive bodies of research and theory. As Kelman demonstrated, one could easily write a book on the topic. The somewhat more limited space constraints of the current paper requires some selective attention. First, the schools are distilled down to single individual scholars: Kahneman and Gigerenzer. Though it is pretty widely acknowledged, these are the two most important scholars in their own schools. Indeed, they are generally regarded as the (or at least among a small number of) pioneers of their schools of thought. However, given the voluminous publishing achievements of each, it has proven still more efficacious to largely restrict reference to their arguments and evidence as presented two books: Kahneman's *Thinking, Fast and Slow* (2013) [orig 2011] and Gigerenzer's *Risk Savvy* (2014).

Both of these books can be thought of as summaries or culminations of the specific scholar's body of work on the topic of the relationship between risk and cognitive processing, up until the time of publication. In the case of Kahneman, this sense of summarizing a life's work more explicitly frames the publication, but effectively it's not unfair to regard Gigerenzer's book as serving a comparable function. Yet, being summarizes of their life work on the topic, some selective focus, emphasizing particularly important ideas and claims are still necessary to generate a manageable discussion. These emphasized ideas and claims are fleshed out in detail in the relevant sections, below. While the discussion that follows is mostly based upon analysis of the arguments in the aforementioned books, occasionally illustrations or clarifications are drawn from Kelman's impressively even-handed treatment of the debate in his book *The Heuristics Debate* (2011).

The section begins with a review of Kahneman's contribution, followed by a review of Gigerenzer's contribution. It concludes with some thoughts on how the two sets of ideas intersect, with the benefit of the insight provided by an understanding of evolved human cognition.

Kahneman: Loss Aversion

For Kahneman, the paper will focus primarily on what has come to be known as prospect theory. This is arguably his most important, and certainly his most famous, contribution to psychology. It is not unreasonably considered the origination of behavioural economics and it is the insight for which he was awarded the Nobel Prize in Economics. It's noteworthy, for purposes of our discussion here, that Kahneman received his Nobel Prize alongside the ecological rationalist Vernon Smith (2009). Much as in their joint-awarding of Gunnar Myrdal and F.A. Hayek, the Nobel committee often has Swedes playing Switzerland on many of economics' most celebrated debates.

In *Thinking, Fast and Slow*, Daniel Kahneman explicitly identifies loss aversion as the spine of prospect theory. He says of the famous graph, depicting changing psychological value of gains and losses, that if prospect theory had a flag, this image would be drawn on it (Kahneman, 2013, pp. 237–238). Consequently, Kahneman's explanation of loss aversion will be the focus of this discussion. Still, it will be useful to put these observations into some kind of context by beginning with an overview of behavioural economics and prospect theory?

Behavioural economics, a tradition of thought closely associated with Kahneman, is largely a response to what the tradition regards as the unrealistic premises of Rational Choice Economics. In his book, Kahneman recalls first learning about the assumptions of the Rational Choice theory, with its economic agent who is presumed to be rational and selfish, with unchanging tastes. This depiction was a world away from what he'd thus far learned about human psychology and he was led to speculate whether his economist colleagues, in the next building over, were studying a different species. Far from this predictable economic agent, behavioural economics discovered one who was predictably irrational in ways that defy classic economic theory.

The consequence of the claim that economic agents did not act as Rational Choice Economics predicted was that markets too would not be as efficient as they would be expected to be when dealing with such rational economic agents. These rejections of Rational Choice theory has led behavioural economists to advocate for heightened market regulation. This was most famously expressed in the Thaler and Sunstein book, *Nudge* (2009), which claimed the virtue in manipulating people's choice in their best interest by way of a so-called libertarian paternalism. This ambition reached its logical conclusion when one of the authors, Cass Sunstein, took the position of Administrator of the White House Office of Information and Regulatory Affairs under President Obama, as means to implement the libertarian paternalist agenda.

One of the backbones of behavioural economics was the focus upon the role of heuristics and how they can go astray. A key contribution in this regard was Kahneman's prospect theory, which describes the way people choose

between probabilistic alternatives that involve risk. And, as noted above, Kahneman considers loss aversion to be the flagship concept of prospect theory, so let's focus on its associated claims. As the famous graph that he'd have on the prospect theory flag (Kahneman, 2013, pp. 238). clearly illustrates, individuals tend to value losses higher than gains of equal value. The graph crosses revealed value preferences, on the vertical scale, with relative gains or losses on the horizontal scale. The squish-topped, S-shaped line demonstrates that the test subjects in Kahneman's experiments valued more a specified sum of money, represented on the graph as $100, over twice as high when faced with the prospect of losing that money (200) than they did when faced with the prospect of gaining it (less than 100). They valued the gain less than half as much as they valued the loss. So, for instance, gaining $100 will make us happy, but losing $100 will make us far more miserable. If our boss informs us we're receiving a $100 raise, this pleases us but told that we'll receive a $100 cut in pay makes us far more displeased. This appears to be economically irrational and thereby contradicts the claims for rationality on the part of economic agents by Rational Choice Economics. The $100 has the same value, in terms of purchasing power, at any point in time: i.e., the loss or gain of it should register with a roughly equivalent emotional evaluation. This though is clearly not the case.

Closely associated with this discovery of loss aversion was another idea: the endowment effect. This idea captured the discovery that it turned out that people tend to value more highly that which they already own. This was illustrated in a famous set of experiments by Kahneman and colleagues, in which the experimental subjects were randomly divided into two groups. The members of one of these groups were given a mug. These were the Sellers. The Sellers were asked at what price they would be willing to sell their mug. The other group, the Buyers, had the opportunity to examine the mugs of the Sellers and determine at what price they were willing to buy a mug from a Seller.

The assumption from classical economics, as they saw it, was that since the mugs were distributed randomly it would be expected that about half of the Buyers would value the mugs more than about half the Sellers. This would suggest about half the mugs being traded and an averaging out of the price between asking and offering. However, this was not the result. Rather, it turned out that the Sellers on average asked twice the price for the mugs compared to what the Buyers were willing to offer on average and the number of actual trades was less than half of what classical theory would predict. In Kahneman's evaluation: "The magic of the market did not work…" (Kahneman, 2013, p. 249)

This endowment effect goes some way to explaining the apparently irrational tendency to loss aversion. After all, the prospect of getting $100 is not the same as the $100 one already has. In this sense, the two $100 sums are not in fact equal in value. Therefore it should hardly be surprising that our emotional reaction to them should be different. However, this explanation can be seen as merely a regression of the argument. After all, regardless of the endowment effect, the two $100 sums still have the same purchasing power. So, why should we put a higher value on keeping the one we have than on the prospect of gaining the one we might get? While the endowment effect explains something of the emotional mechanics of loss aversion, it doesn't necessarily make the tendency any more rational, if we're regarding the $100 sums as dollar and cents purchasing potential.

This then is the core idea in prospect theory that animates behavioural economics. Rational Choice Economics is fundamentally wrong in its regard of economic agents as acting rationally. Furthermore, it seems to be some kind heuristic – some mechanism for quick evaluations of situational choice – that informs these irrational choices. As Mark Kelman observes, while the nature of these heuristics and their irrational outcomes are acknowledged by Kahneman’s school, that school has in fact shown very little interest in actually understanding the nature of these heuristics (Kelman, 2011, p. 23). It is the argument of the other school under consideration, here, associated to Gerd Gigerenzer, that the depiction of these heuristics by Kahneman and his colleagues misrepresents the phenomenon in question precisely through their lack of interest or curiosity in the nature and purpose of those heuristics.

Gerd Gigerenzer: Ecological Rationality

Before looking at Gigerenzer’s critique of the Kahneman School, it is important to note that the tendency among some to overly simplify the debate, along the lines of glass half full or empty approaches, or to regard Gigerenzer as seeing the issues at hand through Panglossian glasses, misrepresents the facts on the ground. By no means does Gigerenzer claim that our fast and frugal heuristics provide some kind of vouchsafed remedy to risky conditions. This should be obvious to the present reader as Gigerenzer’s work on the effects of dread risk following the 9/11 attacks demonstrated how people’s heuristic response to risk in these conditions gave rise to over 1500 additional casualties from road accidents.

In his book, *Risk Savvy* (2014), he provides many further ways in which our immediate heuristic responses can lead us astray. For instance, he points out the dangers of evaluating risk in relative terms rather than absolute terms. This is an error encouraged by the mass media, a point important for risk communication scholars and practitioners, which will be returned to below. However, while one can't be sanguine about the prospect that the mass media play up relative risk for the sensational headlines which generate the audiences which they sell to advertisers,[5] neither can the possibility be dismissed that journalists and their editors are just as prone to heuristic error as their audiences who don't exercise sufficient critical evaluation when faced with such statistics. A case Gigerenzer cites early in his book is that of the thrombosis scare over the birth control pill in England. In the mid-1990s, public health officials and the media publicized a warning that the third generation oral contraceptive increased the risk of thrombosis by 100 percent. Given the potentially life-threatening nature of this condition, the result was a dramatic decline in young women using the pill.

Abortions, which had been on the decline in England for years, increased that year by 13,000. This was a trend reversal that carried on for many years after. Also, there was about an equal number of increased births. These outcomes were particularly high among girls under the age of sixteen. And the terrible irony of the situation was that both pregnancy and abortion are associated with a higher risk of thrombosis than was the third generation birth control pill. But, *it was 100 percent risk increase*. This 100 percent though referred to the relative risk, not the absolute risk. For the second generation birth

[5] This fact about the fundamental economics of the mass media, once well known among those engaged in critical thinking about the topic, seems too often to be forgotten these days (Smythe, 1981).

control pill, one woman out of every seven thousand who used it suffered thrombosis. Under the third generation pill, this number doubled, going up by 100 percent, meaning that out of every seven thousand women taking the pill, it was expected that two would suffer thrombosis.

It seems doubtful that the many tens of thousands of woman in England who abandoned the pill at this time would have done so if they'd understood absolute risk and not been misled by the sensationalist implications of the continual reiteration of the relative risk. While this is a valuable lesson for the responsible exercise of risk communication, it also is another example of Gigerenzer emphasizing that our heuristics are not full proof as risk assessors. So caricaturing his school as Panglossian in its approach is baseless.

However, Gigezenger does make some important points about the shortcomings in Kahneman's emphasis on the irrational character of heuristics. As Gigerenzer has argued, in *Risk Savvy* and elsewhere, the heuristics we use to figure out what to do in a vast array of circumstances, usually operating unconsciously, not only make less demands upon our levels of energy and attention, but turn out to often be far more accurate than our more conscious and deliberate decision processes.

The underlying function of this heuristic economy is captured by what Gigerenzer has called the recognition heuristic. This heuristic allows those with less information to make better informational judgments. For instance, in the famous example that established the operation of this heuristic, it turned out that Germans were better able to distinguish which of two American cities were the larger than were Americans able to do.

And, likewise, Americans were better able to distinguish which of two German cities were the larger than were Germans able to do. It turned out that in each case the test population had more information about the cities in their own countries. Having less information about the cities in the other country, they simply followed the heuristic of choosing the city whose name they recognized. For their own country they recognized, and had access to some association, to each of the cities, so were unable to use the recognition heuristic. Consequently, more errors were made in assessing the relative size of the two cities in one's own country.

Gigerenzer has also demonstrated the power of the recognition heuristic in prediction effects. It turns out that in predicting sporting events, amateurs who have far less information about the competing teams or individuals, using this heuristic, achieve prediction outcomes as good as, and sometimes even significantly better than, those of the experts in the relevant sport. Again, increased information does not necessarily produce superior outcomes and can actually undermine the more effective results from using the fast and frugal heuristic (Gigerenzer, 2008, pp. 112–117).

While it is too easy to fall into the assumption that the best remedy to error is more or better information, Gigerenzer demonstrates that often our heuristics work best – probably because evolved to operate – with less information. Counterintuitive as such a claim seems, the experimental results reveal that at least some significant amount of the time it is true. The point, again, isn't that such a heuristic is full proof. And it's certainly easy enough to design a test context aimed to frustrate the heuristic deliberately, but, operating in a natural setting, it's reliable enough to provide the fast and frugal results necessary for sufficient success. It's in this sense then that Gigerenzer and his school characterized such heuristics as being rational: ecologically rational.

In this light, what seems more interesting in Kahneman's discovery of loss aversion and the endowment effect is not the apparent failure of rationality, but rather what conditions would have had the relevant heuristic operating rationally. And this is precisely how Gigerenzer is framing the discussion when he insists upon regarding heuristics in the context of their ecological rationality. The point isn't that the heuristic identified by Kahneman is, as he'd have it, irrational; but rather that such a heuristic would be only rational in relation to the ecological (and evolutionary) conditions, which gave rise to it. This recalls the discussion above about Leda Cosmides discovery of the human cheater detection heuristic. It worked amazingly effectively when operating in its proper domain, even as it proved about equally ineffective when asked to operate on the foreign territory of algebraic logic and probability.

This was a misfit of the heuristic and the task at hand. And there is a misfit because of the mismatch between the adaptive function of the evolved heuristic and conditions it now confronts in a changed environment. This explanation reveals the importance in Gigerenzer's approach to grounding these cognitive functions in their evolutionary context. Indeed, the apparent incommensurability of Kahneman's and Gigerenzer's assessment of heuristics and their value is resolved by taking the evolutionary conditions of human cognition seriously.

Kahneman and Gigerenzer Compared Through the Evolutionary Lens

The first thing to be emphasized and reiterated in this comparison is that examining these questions through an evolutionary lens is in no way a case of artificially imposing an incompatible analytical framework on either scholar. As mentioned, an evolutionary approach is central to Gigerenzer's analysis, but it is also acknowledged and accepted as the proper grounds for understanding the existence and nature of such heuristics by Kahneman. Over the 400 pages of text in *Thinking, Fast and Slow* the word "evolutionary" only appears seven times, the word "evolution" only appears twice and Darwin appears only once – the latter as a throwaway reference to Darwin's relationship to his cousin, Francis Galton. Nevertheless, despite this sparse set of references, their content is striking. Here are a couple examples in relation to the domain of heuristic thinking, which he calls System 1 thinking:

> The sophisticated allocation of attention has been honed by a long evolutionary history. Orienting and responding quickly to the gravest threats or most promising opportunities improved the chance of survival, and this capability is certainly not restricted to humans. Even in modern humans, System 1 takes over in emergencies and assigns total priority to self-protective actions. (Kahneman, 2013, p. 33)

And:

> System 1 has been shaped by evolution to provide a continuous assessment of the main problems that an organism must solve to survive: How are things going? Is there a threat or a major opportunity? Is everything normal? Should I approach or avoid? The questions are perhaps less urgent for a human in a city environment than for a gazelle on the savannah, but we have inherited the neural mechanisms that evolved to

> provide ongoing assessments of threat level, and they have not been turned off. (Kahneman, 2013, p. 77)

Also, referring to heuristic processes, Kahneman discusses the pattern recognition function of heuristic processes in their evolutionary context:

> Random processes produce many sequences that convince people that the process is not random after all. You can see why assuming causality could have had evolutionary advantages. It is part of the general vigilance that we have inherited from ancestors. We are automatically on the lookout for the possibility that the environment has changed. Lions may appear on the plain at random times, but it would be safer to notice and respond to an apparent increase in the rate of appearance of prides of lions, even if it is actually due to the fluctuations of a random process. (Kahneman, 2013, p. 99)

And, indeed, even loss aversion itself is contextualized by Kahneman as an evolutionary process: “When directly compared or weighted against each other, losses loom larger than gains. This asymmetry between the power of positive and negative expectations or experiences has an evolutionary history. Organisms that treat threats as more urgent than opportunities have a better chance to survive and reproduce.” (Kahneman, 2013, p. 237)

So, in no sense is it accurate to claim that imposing an evolutionary analysis upon Kahneman is artificial or incompatible. Once this is understood, the challenges to behavioural economics and the Kahneman school by Gigerenzer, in *Risk Savvy* and other relevant books (Gigerenzer, 2002, 2014; Todd & Gigerenzer, 2012), hardly seems avoidable: the very processes that are being dismissed by the biases school as irrational are in fact perfectly rational once understood within their ecological context. The quotations from Kahneman above illustrate that he was well aware of this fact.

The problem Kahneman is identifying is that well known to evolutionary biology and psychology as a mismatch, discussed above. The heuristics, or mental modules, or cognitive mechanisms, depending upon one's scholarly tradition, cannot be irrational in their ecological setting or the organism possessing the heuristic not only wouldn't be alive but surely would never have been born. As genes generate all an organism's structure and behavioural templates, by way of the cognitive processes instantiated in its nervous system/brain, only those heuristics that generate fitness-enhancing behaviour are evolutionarily sustainable. An irrational heuristic would be counterproductive in fitness terms and not only lead to death of the organism but would have led to the death of the organism from whom it genetically inherited such cognitive processes.

Gigerenzer and his school do not object to the fact of environmental mismatch; they object to the Kahneman School and behavioural economics setting up the heuristics to fail with mismatched laboratory conditions, then assuming that the outcomes were a reflection of the heuristics, rather than of the experimental conditions (Kelman, 2011, Chapter 4). To this extent, Gigerenzer's school would share the Kahneman School's critique of Rational Choice Economics: it's not biologically realistic to claim that economic agents will always consistently pursue any measure of utility. That critique though they point out does not justify assuming that to be rational behaviour must be symmetrically consistent. Rational Choice assumes rationality is measured in expected utility while behavioural economics assumes rationality is measured in symmetric consistency. But for the biologically informed Gigerenzer School, rationality is measured by the degree of fitness-enhancing behaviour generated within the natural ecological context of the heuristic that gives rise to that behaviour.

The case of loss aversion, Kahneman's own flagship concept, provides a helpful illustration. Remembering that our emotions are produced by our evolved cognition, to push us toward fitness-enhancing behaviour, like everything else molded into our DNA by evolutionary pressures, it is hardly surprising that we would feel greater emotional distress at losing $100 than pleasure in winning $100. And, we certainly, therefore, would not be expected to risk losing $100 for the chance of winning $100 – or anything close to it. Prospect theory, to this extent, is simply a sophisticated reiteration of the old homily that a bird in the hand is worth two in the bush.

The trade-offs inherent in behavioural ecology makes these conditions crystal clear (Stephens & Krebs, 1987). For the hundreds of thousands of years that these emotional responses have been molded by evolutionary pressures our ancestors needed to eat every day, but had no means of preserving food. The bird in the hand is today's meal. Catching two more in the bush might make for a fuller meal, but considering that there was no way to preserve that food for future days, pursuing it at the risk of losing today's meal, and winding up not eating, making us weaker for hunting tomorrow, and opening the door to a dangerous descending cycle into death, a bird in hand would be indeed better than two in the bush. It is these anciently honed emotional responses, prodding us into being conservative about what we already have, identified above as the endowment effect, which motivates us to value the $100 we have over the $100 we might get.

This is the logic of evolved human cognition, asymmetric as it may be. The fitness necessity of genetic replication ensures that nervous systems of all organisms will be sculpted by selective pressures to the kinds of biases over the long duration of evolutionary time that have statistically improved fitness outcomes: loss aversion is part of this same story (Haselton & Nettle, 2006). Furthermore, the reaction range of phenotypic strategies allow for shifts in such biases, provided again they are consistent with fitness enhancement. For instance, it turns out that men primed for mating suddenly lose their loss aversion and are much more willing to risk losses, if the payoffs are sufficiently promising mating opportunities (Li, Kenrick, Griskevicius, & Neuberg, 2012). Furthermore, it seems that, at least at a rudimentary level, judging from the quotations cited above, Kahneman understands this.

So, the Kahneman School, maybe *sotto voce*, acknowledges that really there's nothing inherently irrational about these heuristics. And the Gigerenzer School acknowledges that even these powerful, evolutionarily honed heuristics, once mismatched with an environment inconsistent with the one that produced the relevant evolutionary pressure, could indeed misfire in a manner not unfairly described as irrational. So, at the end of the day, from the perspective of ultimate causes, there's far less fire than smoke in this famous debate. The misguided impression of a raging blaze is largely the result of overly focusing on proximate effects.

What lessons, then, do these insights have for risk communication scholars and practitioners going forward?

Lessons for Risk Communications

Right off the top, simmering in this debate, there is a pretty obvious lesson for risk communication scholars, and especially practitioners. It can be read between the lines of *Thinking, Fast and Slow* and screams off the pages of *Risk Savvy*. This is the importance of risk communicators not making the mistake of thinking that the ends justify the means in resorting to sensationalist claims in the interest of warning people off of particular risks. Leaving aside the ethical questions, as Gigerenzer's book repeatedly demonstrates, the results of such an approach can be not only counterproductive but downright troublesome in its consequences.

In the case of the panic over the 100 percent increase in thrombosis risk from the birth control pill, it seems as though there was something of a public health decision to dramatize the risk by focusing on the relative risk. The troublesome outcome, noted by Gigerenzer, was a dramatic increase of pregnancies and abortions, both of which presented greater thrombosis risk than did the pill. It seems unlikely that there was a deliberate effort to scare people away from air travel following 9/11. However, a more savvy risk communication community would have (and should have) taken concrete, positive interventions to warn the public against abandoning air travel in light of the well-documented greater risks of automobile travel.

These are lessons about the choice of communication strategy. The other important lesson from the same subject area though is the importance of risk communication practitioners themselves being "risk savvy": e.g., knowing the difference between relative and absolute risk and what the implications are for the public. If risk communication scholars and practitioners are just as prone to risk confusion as the general public, they hardly can be expected to provide an ameliorating effect in the face of such panicked overreaction. They would, in that case, be part of the problem, not the solution.

There is of course, though, a deeper lesson for risk communication, baked into the Kahneman-Gigerenzer debate, which gets more to the heart of the originally declared purpose for undertaking this study. Humans are evolved organisms, with a build in risk aversion disposition. While reliance upon proximate mechanisms can work, the strongest risk communication will be that which understands the ultimate conditions of how humans are evolved to respond to risk, how the relevant mechanisms work, and how they can fail in mismatched conditions.

This is not to say that there are not lessons to be learned from the study of proximate effects. Both Kahneman's discovery and explanation of loss aversion and Gigerenzer's discovery and explanation of dread risk are valuable psychological insights. However, limited to that level of analysis they neither provide a deep understanding of the effect nor offer an immediate insight into how these biases come to operate. Without understanding their deeper operation, the application of their lessons is largely restricted to the conditions of direct replication. Insights into how they can be leveraged, may mutate, or not activate at all, require this deeper knowledge of their operation. And that operation, as with all biological entities, finds its ultimate cause in evolutionary biology.

The biological ultimate causes are in fact the common denominator at work in all psychological and cognitive processes. This is why it was possible to easily resolve the apparent fire and brimstone conflict of the Kahneman-Gigerenzer debate once we boiled the discussion down to the level of evolutionary biology. For risk communication to optimize its potential, and meet its social responsibilities, the discipline needs to start becoming literate in the lessons of evolutionary biology and has to start systemically integrating those lessons into its practice. Otherwise, such scholars and practitioners will be endlessly grasping at the straws of partial explanations rooted in proximate effects.

Conclusion & Acknowledgement

The introduction of this paper began with reflection upon some of risk communications' noteworthy failures. The risk communication scholar familiar with evolutionary biology and evolved human cognition is struck by the opportunities to resolve these challenges that have been lost in the absence of greater familiarity with the evolutionary science literature. Much of what went wrong in the aftermath of Katrina could have been remedied with a deeper understanding of the evolutionary role of coalitionary violence (Wrangham, 1999). Likewise, efforts to target smoking cessation in youth could have benefited from understanding the handicap principle and how social recognition of high-risk activity can actually attract increased uptake as part of a highly successful mating strategy, sometimes called the peacock effect (Zahavi & Zahavi, 1997).

It has been the objective of the present author, in this paper, and in the broader scope of her scholarship, to help pave the way for a fuller engagement by risk communication scholarship with the lessons of evolutionary biology and psychology. To effectively intervene in the gap between perception and behavior, risk communication needs to optimize psychology. That effectiveness, though, by necessity is conditional upon the rigor and reliability of the psychology being used. The Kahneman-Gigerenzer debate has served as a case in point that illustrates this claim.

The Kahneman School, famous for decrying the surprising failures of human rationality, and the Gigerenzer School, noted for claiming that in fact our intuitive or instinctual reactions are remarkably successful in providing fast and frugal solutions to life problems, turn out to be largely engaged in a dispute over emphasis, rather than substantive incompatibility. The resolution of their differences hinged upon reducing their arguments to the conceptual common denominator that gives rise to the psychological effects that intrigue each. And this conceptual common denominator was the nature and function of evolved human cognition. Once viewed through the naturalistic lens of an evolved psychology, what, at the more superficial level of proximate causes and events, appears as contradictory claims and premises, turned out to be primarily different angles on the same true north point.

This path to resolution of one of psychology's most celebrated debates has illustrated the explanatory power of evolutionary psychology at a theoretical level. More to the pressing issue at hand, though, it illustrated the importance of risk communication scholars and practitioners – who hope to improve risk communication efficacy through learning from psychology – not being distracted by proximate level effects, but rather drilling down into the foundational psychology in human evolutionary biology for ultimate causes.

If risk communication needs psychology to better understand risk, so that risk communication efforts are effective, then it needs the foundational psychology that explains fundamental causes. Only the biological processes that give rise to all psychology offer this foundation. The analysis of the Kahneman-Gigerenzer debate herein provides a case in point. Like so many other fields in the humanities and social sciences, it is becoming increasingly apparent that risk communication scholarship and practice cannot achieve their highest potential without an integration of the insight into human evolved cognition achieved by the evolutionary theory revolution of the last half-century.

The author acknowledges that the focus and scope of this essay lie virtually exclusively on evolutionary biology and evolved human cognition and the fundamental lessons for risk communicators and practitioners thereof. The author chose not to include a discussion of the role of culture and media, which she recognizes do play an essential role in mediating how the public engages with risk, but which are not examined for the purposes of this present research essay.

References

Alexander, R. (1987). *The Biology of Moral Systems*. Hawthorne, N.Y: Aldine Transaction.

Ariely, D. (2013). *The Honest Truth About Dishonesty: How We Lie to Everyone--Especially Ourselves* (Reprint edition). New York: Harper Perennial.

Barkow, J. H., Cosmides, L., & Tooby, J. (Eds.). (1992). *The Adapted Mind: Evolutionary Psychology and the Generation of Culture* (Reprint edition). New York: Oxford University Press.

Barrett, H. C. (2015). *The Shape of Thought: How Mental Adaptations Evolve* (1 edition). New York: Oxford University Press.

Califano, J. A. J. (2012, March 21). Increase in Youth Smoking: The Surgeon General's Pink Panther Public Health Policy. Retrieved August 3, 2018, from https://www.huffingtonpost.com/joseph-a-califano-jr/increase-in-youth-smoking_b_1362577.html

Carroll, S. B. (2007). *The Making of the Fittest: DNA and the Ultimate Forensic Record of Evolution* (Reprint edition). New York, N.Y.: W. W. Norton & Company.

Cole, T. W., & Fellows, K. L. (2008). Risk Communication Failure: A Case Study of New Orleans and Hurricane Katrina. *Southern Communication Journal*, *73*(3), 211–228. https://doi.org/10.1080/10417940802219702

Comfort, L. K., & Haase, T. W. (2006). Communication, Coherence, and Collective

Action: The Impact of Hurricane Katrina on Communications Infrastructure. *Public Works Management & Policy*, *10*(4), 328–343. https://doi.org/10.1177/1087724X06289052

Cosmides, L. (1989). The logic of social exchange: Has natural selection shaped how humans reason? Studies with the Wason selection task. *Cognition*, *31*(3), 187–276. https://doi.org/10.1016/0010-0277(89)90023-1

Cosmides, L., & Tooby, J. (1992). Cognitive adaptations for social exchange. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The Adapted Mind: Evolutionary Psychology and the Generation of Culture* (Reprint edition). New York: Oxford University Press.

Damasio, A. (2005). *Descartes' Error: Emotion, Reason, and the Human Brain* (Reprint edition). London: Penguin Books.

Dunbar, R. (1998). *Grooming, Gossip, and the Evolution of Language*. Cambridge, Mass: Harvard University Press.

Gigerenzer, G. (2002). *Adaptive Thinking: Rationality in the Real World*. New York; Oxford: Oxford University Press.

Gigerenzer, G. (2008). *Gut Feelings: The Intelligence of the Unconscious* (Reprint edition). London: Penguin Books.

Gigerenzer, G. (2014). *Risk Savvy: How to Make Good Decisions*. New York: Viking.

Haselton, M. G., & Nettle, D. (2006). The Paranoid Optimist: An Integrative Evolutionary Model of Cognitive Biases. *Personality and Social Psychology Review*, *10*(1), 47–66. https://doi.org/10.1207/s15327957pspr1001_3

Isbell, L. A. (2011). *The Fruit, the Tree, and the Serpent: Why We See So Well*. Cambridge, MA: Harvard University Press.

Kahneman, D. (2013). *Thinking, Fast and Slow* (1st edition). New York: Farrar, Straus and Giroux.

Karrass, D. (2017a). Disaster Response Risk Communication and Evolutionary Psychology: Toward an integrated understanding of risk induced behaviour. *Unpublished Manuscript*.

Karrass, D. (2017b). Evolved Human Cognition as Risk Mitigation: Toward a Theoretical Innovation in Risk Communication. *Unpublished Manuscript*.

Kelman, M. (2011). *The Heuristics Debate*. Oxford ; New York, N.Y: Oxford University Press.

Kurzban, R. (2010). *Why Everyone (Else) Is a Hypocrite: Evolution and the Modular Mind*. Princeton, N.J.: Princeton University Press.

Li, Y. J., Kenrick, D. T., Griskevicius, V., & Neuberg, S. L. (2012). Economic decision biases and fundamental motivations: How mating and self-protection alter loss aversion. *Journal of Personality and Social Psychology*, *102*(3), 550–561.

Marcus, G. (2004). *The Birth of the Mind: How a Tiny Number of Genes Creates The Complexities of Human Thought*. New York: Basic Books.

Minsky, M. (1988). *The Society of Mind*. New York: Simon & Schuster.

Nesse, R. M. (2005). Natural selection and the regulation of defenses: A signal detection analysis of the smoke detector principle. *Evolution and Human Behavior*, *26*(1), 88–105. https://doi.org/10.1016/j.evolhumbehav.2004.08.002

Nesse, R. M. (2009). Explaining depression: neuroscience is not enough, evolution is essential. In D. Nutt, L. Wolpert, C. M. Pariante, & R. M. Nesse (Eds.), *Understanding depression: A translational approach* (1 edition). London; New York: Oxford University Press.

Nesse, R. M. (2011). Why has natural selection left us so vulnerable to anxiety and mood disorders? *Canadian Journal of Psychiatry. Revue Canadienne De Psychiatrie*, *56*(12), 705–706. https://doi.org/10.1177/070674371105601201

Pinker, S. (1997). *How the Mind Works*. New York: W. W. Norton & Company.

Pinker, S. (2002). *The Blank Slate: The Modern Denial of Human Nature*. New York: Penguin Books.

Smith, V. (2009). *Rationality in Economics: Constructivist and Ecological Forms* (1 edition). Cambridge ; New York: Cambridge University Press.

Smythe, D. W. (1981). *Dependency Road: Communications, Capitalism, Consciousness, and Canada*. Norwood, N.J: Praeger.

Stephens, D. W., & Krebs, J. R. (1987). *Foraging Theory*. Princeton, N.J: Princeton University Press.

Thaler, R. H., & Sunstein, C. R. (2009). *Nudge: Improving Decisions About Health, Wealth, and Happiness* (Revised & Expanded edition). Penguin Books.

Todd, P. M., & Gigerenzer, G. (Eds.). (2012). *Ecological Rationality: Intelligence in the World* (1 edition). Oxford ; New York: Oxford University Press.

Tooby, J., & Cosmides, L. (2005). Conceptual Foundations of Evolutionary

Psychology. In D. Buss (Ed.), *The Handbook of Evolutionary Psychology*. John Wiley & Sons.

U.S. Surgeon General. (n.d.). Preventing Tobacco Use Among Youth and Young Adults | SurgeonGeneral.gov. Retrieved August 3, 2018, from https://www.surgeongeneral.gov/library/reports/preventing-youth-tobacco-use/factsheet.html

Wason, P. C. (1968). Reasoning about a rule. *Quarterly Journal of Experimental Psychology*, *20*(3), 273–281. https://doi.org/10.1080/14640746808400161

Wrangham, R. W. (1999). Evolution of coalitionary killing. *American Journal of Physical Anthropology*, *110*(29). Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1002/(SICI)1096-8644(1999)110:29%2B%3C1::AID-AJPA2%3E3.0.CO;2-E

Zahavi, A., & Zahavi, A. (1997). *The Handicap Principle: A Missing Piece of Darwin's Puzzle*. Oxford University Press.