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**Introduction**

Aliens visiting planet Earth would find Homo Sapiens a remarkable species. They would discover astonishing examples of human intelligence and ingenuity such as airplanes, skyscrapers, electricity, and the internet. At the same time, they would also witness our miserable failure in preventing poverty, violence, disease, and ecological disasters. Humans are both highly intelligent and highly stupid, the alien anthropologists would probably conclude. It is true, we humans are very good at some things but very bad at others. People are able to recognize the faces of persons they met many years ago, but they easily misremember the telephone numbers of their best friends. People are very patient in accumulating knowledge and training skills through a long period of intense education, but they are not patient enough to save money for their pension or resist the temptation of a Big Mac. And, although most people would be reluctant to steal from shopkeepers, these same individuals have no moral reservations to illegally download music and movies from the net.

Why is it that humans are very good at some things but very bad at others? Why is it that we can learn some things much quicker and easier than others? What does this tell us about human psychology, and what can we learn from this for public policy? Here we argue that the human mind, with all its strengths and weaknesses, follows a logical, predictable pattern. If we are able to uncover these patterns it enables us to design better interventions that take into account the constraints of human nature. So far, public policy programs have been built on the model of Homo Economicus, the idea that humans guide their actions on the basis of a rational calculation of costs and benefits (Fox & Sitkin, 2015; Loewenstein, Bryce, Hagmann, & Rajpal, 2015). However, as we shall see, the behavior of Homo Sapiens is guided by a deeper evolutionary rationality that consists of a set of instincts, or evolved preferences that can depart dramatically from what appears to be rational (Johnson, Price & Van Vugt, 2014; Kenrick, Griskevicius, Neuberg & Schaller, 2010). Take an intervention program for

increasing sign-up rates for post-mortem organ donations. Simply changing the default option from opt-in to opt-out doubles participation (from 42% to 82%) without any change in underlying beliefs or preferences (Johnson & Goldstein, 2003). Such "nudges" have been found to be fairly effective at changing people's behaviors in part because they pay attention to the constraints of human psychology (Baumard, 2015).

The core hypothesis put forward here is that the human mind evolved to solve particular challenges very efficiently. But these challenges were part of a relatively stable environment in which humans lived for many thousands of generations, the African Savannah out of which anatomically modern humans migrated some 60,000 years ago. Yet when environments change quickly – as they increasingly have been doing -- new threats and opportunities emerge to which our minds may not be perfectly calibrated. The result is evolutionary mismatch. In this contribution we will first investigate the concept of mismatch as a core tenet of evolutionary theory and evolutionary psychology and how mismatch affects our preferences and decisions. We also discuss how to find evidence for mismatched behaviors. We will then discuss the implications of the mismatch hypothesis for some core domains of social psychology, from close relationships to work, politics, and health and sustainability. Finally, we note the implications of mismatch for public policy and how to design interventions, such as nudging strategies, that are better aligned with the core psychology of Homo Sapiens.

**Evolutionary challenges and psychological mechanisms**

The mismatch hypothesis is one of the foundational principles of evolutionary psychology (Li, Van Vugt & Colarelli, 2018). Evolutionary psychology considers human cognition, emotion, and decision-making to be the products of psychological mechanisms that evolved to solve recurrent, adaptive challenges concerning survival and reproduction (Buss, 2015; Tooby & Cosmides, 1992). These psychological mechanisms are perfectly calibrated to

the environment in which humans evolved, which is often referred to as the EEA, the environment of evolutionary adaptedness. The EEA for many of the more specialized human traits and their underlying mechanisms such as culture, cooperation, language, leadership, mate and food preferences lies on the African savannah where the human lineage evolved over a period of several million years. Around 6 million years ago the human lineage and that of our closest cousins – what are now bonobos and chimpanzees -- split into separate branches. Over the course of hominid evolution many key features of Homo evolved such as bipedal walking, retractable thumbs, and increased skull size. These physical changes can be easily determined from the fossil record (Kaplan, Hill, Lancaster & Hurtado, 2000). The genus Homo that marks the beginning of our modern Homo Sapiens lineage evolved around 2 million years ago with the withdrawal of forests in East-Africa and the emergence of the savannahs, vast open grasslands. Paleo-archaeological and anthropological evidence supports the idea that our human ancestors lived in relatively small groups, essentially extended families, that were nomadic and migrated with the available food resources (Foley, 1997).

Increased reliance on large game animals for nutrition increased cooperation and enhanced division of labor between hunters (usually men) and gatherers (usually women) (Tooby & DeVore, 1987). Food sharing emerged as a collective insurance system against hunger and language emerged as a way to maintain social networks over increasingly large distances (Dunbar, 2003). Culture formed a buffer against perturbations in the environment which required novel social learning strategies based on imitation and teaching (Henrich, 2015). Prestigious individuals emerged as leaders to orchestrate coordinated group activities for group defense and collective movement (Van Vugt & Ahuja, 2010). The psychological mechanisms underlying these aspects of human behavior evolved over this long period, and were conserved when humans migrated out of Africa some 60,000 years ago. As a result of this transition, humans have begun living in ecologies and climatic conditions that are vastly

different from the EEA. The reliance on intense agriculture that begun after the agricultural revolution, which happened some 10,000 years ago in several places of the world (less than 1% of human evolutionary time), caused further dramatic shifts in the way we live and connect to each other, resulting in a dietary and lifestyle changes to which our bodies and brains are not perfectly adapted (Lieberman, 2013). Similar seismic shifts in our physical and social organization have happened after the Industrial Revolution (some 250 years ago) when machines started to take over human physical work. Currently, more than half of the world's population lives in large, densely populated cities surrounded by millions of (genetic) strangers in tall buildings with little or no access to nature. We are now in the middle of a digital revolution, blurring the distinction between the real world and the virtual world, with the potential to create increasingly more, novel mismatches (Giphart & van Vugt, 2018; Harari, 2014).

The evolutionary mismatch hypothesis asserts that in evolutionarily novel environments the psychological mechanisms that evolved in a long and relatively stable period of human genetic evolution may not be appropriately functioning any more, producing behaviors that are suboptimal for the individual and perhaps for society (Li et al., 2018). If this is true this has far-reaching consequences for human psychology and public policy. Mismatch ideas have been applied before in biology, economics, health, and medicine (Gluckman & Hanson, 2004; Lieberman, 2013; Lloyd, Wilson & Sober, 2011; Nesse & Berridge, 1997). So far, however, there has been little interest in the implications for psychology and public policy, although some scholars in social psychology (Maner & Kenrick, 2010), organizational psychology (Van Vugt & Ronay, 2014), and health psychology (Curtis & Aunger, 2011) have recently started taking an interest in this concept.

Mismatch is a by-product -- and inevitable consequence -- of the way evolution via natural selection works. Evolution produces psychological and behavioral mechanisms that

have been retained via natural selection – and thus are species-typical, heritable, developmentally stable and efficient – because they solved a particular adaptive challenge better than alternative solutions. These mechanisms operate as heuristics, or decision rules that are (a) activated by specific environmental cues acting as inputs and (b) produce adaptive outputs in terms of cognitions, emotions, and behaviors (Gigerenzer, 2007). However, biological evolution is a relatively slow process and therefore these mechanisms may not function properly when environments change. Evolutionary mismatch refers to the adaptive lag that occurs if the environment changes more rapidly than the time needed for the mechanism to adapt to the change and this applies equally to humans and non-humans (Li et al., 2018). The human suite of psychological mechanisms, from culture to cooperation, evolved mainly during the period – 99% of human evolution – when people lived as hunter-gatherers on the African savannah. The subsequent agricultural, industrial, and digital revolutions have produced vast divergences from the past hunter-gatherer lifestyle (Giphart & van Vugt, 2018; Tooby & Cosmides, 1992).

Mismatch problems can arise through various causes. Some of these causes are natural such as when a lack of sunlight exposure in Nordic climates results in vitamin D deficiency and a prevalence of people with seasonal affective disorder (Hidaka, 2012). Oftentimes mismatches are human-induced, such as when industrial pollution affects the air quality such that it increases the number of people suffering from breathing problems. Mismatches can also be distinguished on the basis of whether living in a novel environment forces them upon us, such as our bodies having fewer opportunities to move in a sedentary environment. Alternatively, mismatches can occur when novel stimuli are favored by the mechanism over stimuli that these mechanisms evolved to process, such as when children prefer to eat candy, a sweet and sugary, human-made product, over fruit containing natural sugars (Krebs, 2009). Mismatches can also be distinguished in terms of their impact on our psychological

mechanisms. Some mismatches occur when we try to apply evolved, intuitive psychological mechanisms to evolutionarily novel problems such as assessing the risks associated with airplane travel or saving for a pension scheme. In fact, all kinds of cognitive biases, from the sunk cost fallacy to loss aversion, may be the result of this kind of mismatch. Alternatively, mismatch may occur by approaching evolutionarily old problems such as parenting, mating or eating by utilizing more analytical, evolutionary novel psychological mechanisms, resulting in suboptimal decisions. Thus, using the dichotomy popularized by Kahneman (2011), mismatch occurs when we apply System 1 thinking to evolutionary novel problems or, the reverse, when applying System 2 thinking to evolutionary ancient problems. Mismatch can occur further because of significant changes in either the inputs or outputs of the evolved psychological mechanisms such that these mechanisms are not optimally calibrated. For instance, the lack of a supportive family network nearby may serve as an input into reproductive timing mechanisms causing married couples delay the age at which they get their first child, resulting in suboptimal reproductive outcomes (Li et al., 2018). Or, the availability of internet porn may replace the search for romantic partners as inputs into mechanisms that trigger sexual excitement and induce reproductive activity. In terms of outputs, evolved mechanisms that capitalize status and wealth into reproductive success may not be functioning properly in a world with frequent and intense competition for jobs.

Although the focus here is on evolutionary mismatches, developmental and cultural mismatches are also possible. Developmental mismatches may occur when the predicted state of the environment of a fetus or new-born turns out not to be the actual adult environment. For instance, one of the factors causing adult obesity is when a prenatally under-nourished individual grows up in an environment with abundant food resources (Gluckman & Hanson, 2004). Cultural mismatches occur when individuals are spatially dispersed such that the psychological mechanisms that function well in one cultural environment, say a culture-of-

honor, produces behaviors that are detrimental in a new environment, for instance honor-killings in a culture of dignity.

**Finding evidence for evolutionary mismatch**

Finding evidence for evolutionary mismatches is not an easy feat and although it is possible that some of the social, psychological, and physical problems that humans experience in the modern post-agricultural, post-industrial world may be the result of mismatch it is in many cases still a working hypothesis (Giphart & Van Vugt, 2018). We should also note that not all negative behaviors or psychological states are the result of mismatch. For instance, negative emotions like anxiety, fear, sadness and anger may be adaptive in the sense that they are the result of properly functioning psychological mechanisms responding to real threats (e.g., the loss of a job or a loved one, fear of strangers, a threat or provocation).

To attribute a problem to mismatch we must first show (a) what an evolved mechanism is supposed to do, its function, (b) what are the underlying decision-rules the mechanism uses and (c) what are the kinds of inputs (cues) and outputs the mechanisms evolved to process and produce. The mechanism itself must show evidence of adaptation, that is: Is it designed to solve a recurrent survival or reproductive challenge? Second, we should be able to describe how the mechanism operates in an ancestral environment and, third, how it operating in the modern environment. We must then show evidence of a discrepancy between the ancestral environment and the modern environment in terms of a change in the inputs to which the mechanism responds (e.g., missing cues, a higher intensity of cues), or a change in the consequences of the outputs it produces (Li et al., 2018). Ultimately, we must show, or at least make a persuasive case, that the mechanism, as a result of mismatch, affects personal health and psychological well-being in a way that is not designed to do.

Testing a mismatch hypothesis, like any evolutionary psychology hypothesis (Schmitt & Pilcher, 2004), requires building up a nomological network of findings from different disciplines that have something to say about human evolved psychology, from the knowledge gathered from experiments on psychological mechanisms (psychology and neuroscience) and insights into the small-scale societies in which humans evolved (anthropology) to genetics and measures of fertility, health and well-being in modern populations (medicine, epidemiology). For instance, a well-documented mismatch is obesity, which occurs with food choices (Figure 1; inspired by Sbarra, Briskin, & Slatcher, 2019). Humans likely have evolved psychological mechanisms for preferring sweet and fatty foods, because these high-calorie foods were important for survival in ancestral environments. In ancestral environments – as in current hunter-gatherer societies – these tastes are associated with natural foods like fruits, honey and meat and these are scarce and highly prized, according to anthropologists. Today, however, the sweetest, fatty foods are manufactured and processed with great amounts of sugar and salt (a bag of Lays crisps). Showing that adults and children prefer eating such processed foods (inputs) over natural foods like fruits and honey is not enough. We also need to show that (a) these mismatched preferences produce health problems and (b) that these problems are considerably less prevalent in hunter-gatherer societies. In the case of food there is clear evidence that our evolved preferences produce many maladies from obesity to diabetes 2 and cardio-vascular problems, because the physiological mechanisms involving insulin and glucagon did not evolve to repeatedly metabolize unnaturally large amounts of sugar (Gluckman & Hanson, 2006). Further, these diseases are virtually non-existent in hunter-gatherer societies (Lieberman, 2013).

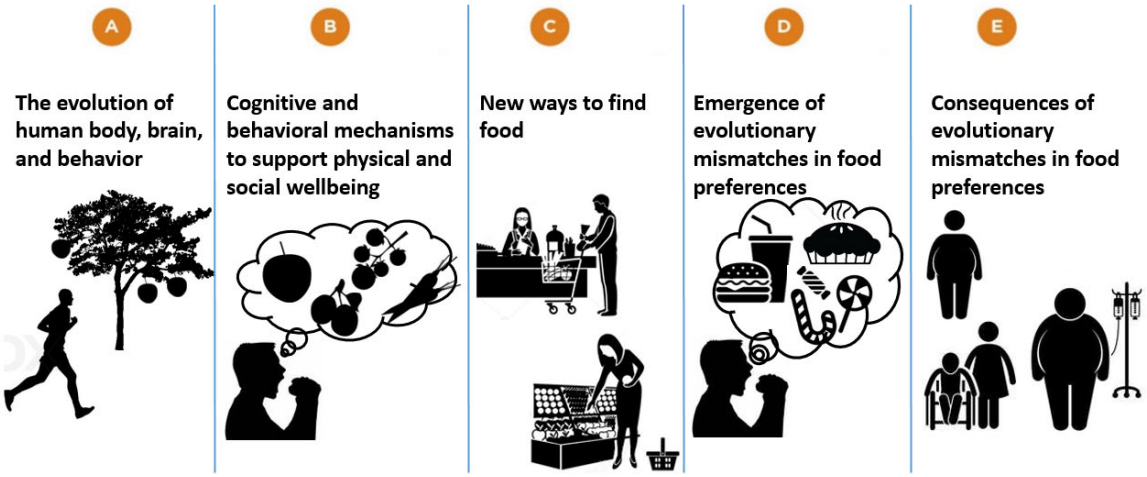


**Figure 1.** Obesity as a consequence of mismatch.

## Studying potential mismatches in social psychology

What is the evidence for mismatch in applied social psychology? Are there mismatched conditions that result in a failure of our evolved psychological mechanisms to function properly in the modern human social context such as in our relationships, work, economics, politics, and health and sustainability? Here we review evidence from some of these domains that are aligned with, or at least can be interpreted in terms of mismatches operating in novel, modern environments.

### *Relationships*

Some challenges associated with initiating and maintaining close relationships in the modern world may result from, or be aggravated by mismatch (Figure 2). Modern adolescents grow up living in areas with high population densities and the presence of a vast number of potential sexual partners and rivals – factors that increase both the intensity of intra- and intrasexual competition. What does this do to our mating psychology? We predict that this results in increased difficulty in initiating and maintaining long-term committed relationships, which were the norm for ancestral humans. Social psychologists showed men and women ten

pictures of physically attractive female faces and found that this prime reduced men's commitment to their current long-term mate (Kenrick et al., 1994) as well as women's self-perceived desirability as romantic partner (Guttieres et al., 1999). This is consistent with various studies suggesting a link between frequent media consumption and social media use (e.g., Facebook) and particularly women's devaluation of their self-esteem and body image, resulting in problems associated with depression and eating disorders (like anorexia) (Li, Smith, Griskevicius, Cason, & Bryan, 2010). In addition, frequent use of internet porn has been linked to an inability of young men to seek and develop close intimate relationships with women (Short, Black, Smith, Wetterneck, & Wells, 2012). Divorce rates are much higher in modern, developed nations than in traditional, small-scale societies (Takyi, 2001).

A different consequence of high population density and intense sexual competition is the current fertility crisis in the modern world. Paradoxically the wealthiest countries in the world – European and East-Asian countries -- are now reproducing the least with fertility rates well below population replacement levels. High population densities may lead to mismatched inputs into mating mechanisms because they point to an intense competition for resources. Both human and animal studies show that high population densities lead organisms to adopt a slower life-history strategy, an inclination to invest in building up physical (nutrition), mental (education) and social capital (friendship networks) at the expense of immediate reproductive success (Brumbach, Figueredo & Ellis, 2009). Consistent with these ideas, a set of social-psychological experiments primed people with cues of high population density (e.g., images and noises of densely populated areas) and discovered that these cues reduced people's estimated age at which to get married and have kids (Sng, Neuberg, Varnum & Kenrick, 2017).

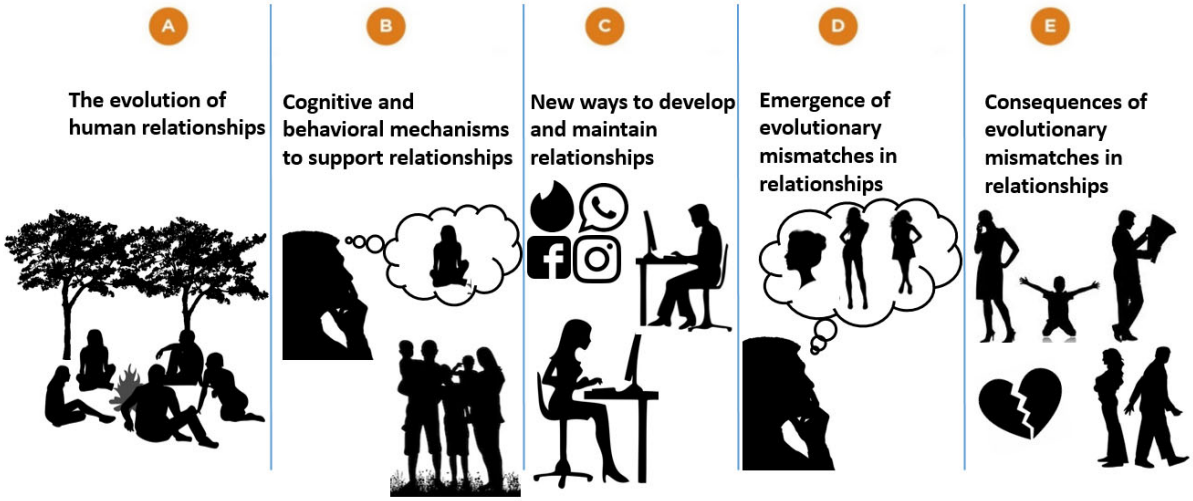


**Figure 2.** Relationship problems as a consequence of mismatch.

*Work*

The modern work place also offers various social and physical challenges that may be exacerbated by mismatch (Figure 3). Modern-day work organizations bear little resemblance to the organizational structures of hunter-gatherer societies that have no hierarchy, limited division of labor, high degrees of kinship, no real distinction between one's work life and private life and a continuous physical engagement with the natural environment. Indeed, the design of many workplaces offers limited room for engaging actively with nature. Interventions that offer work spaces more green elements such as plants, natural sounds, and the presence of nearby parks for physical movement were found to increase job satisfaction and reduce absenteeism, and turnover intentions among employees (An et al., 2016). Being exposed to natural rather than urban spaces increased people's self-control and reduced their temporal discounting suggesting an attention-restoration function of nature (Van der Wal, Schade, Krabbendam & Van Vugt, 2013). Relatedly, an educational field experiment found that by inducing more play, interventions to green-up schoolyards have a positive impact on the attention and concentration levels of primary school children (van Dijk-Wesselius et al., 2018).

Modern work contexts may also induce chronic work-related stress, increasing the prevalence of modern diseases such as burnout and depression that are relatively rare in hunter-gatherer societies (Jacobsson, 1988). Our psychological mechanisms evolved in small-scale societies where humans lived and worked surrounded by family and friends on relatively simple production tasks. In contrast, modern work contexts present many novel inputs to evolved mechanisms, including intense social competition with genetic strangers that causes evolved status mechanisms to produce chronic feelings of insecurity, anxiety and emotional exhaustion. Modern work also creates disconnects between inputs and outputs. Due to ambiguous and non-salient work outputs (e.g., electronic pay-checks, extended deadlines, uncertain promotion criteria), the relation between effort expended and rewards received is blurred. As such, our inbuilt information-gathering mechanisms are constantly on alert, perceiving uncertainty on what to work on, unfairness in the way we are treated, and frustration in choice of tasks. In addition, modern organizations contain steep hierarchies that are highly stratified, with individuals at the top earning thousands of times more than those at the bottom, leading our psychological mechanisms to perceive inequality and unfairness and reducing our sense of autonomy, competence, and relatedness. One of the consequences of these work-related mismatches is chronic work stress. Over 80% of Americans report being stressed by their work (Work Stress Survey, 2013). Although some stress is beneficial to work performance, chronic stress can lead to various negative outcomes, including impairments to immune, cardiovascular, and metabolic functioning, as well as disease, psychological disorders, and mortality (Gluckman & Hanson, 2006). Chronic work stress also leads to job burnout – exhaustion, feelings of cynicism, and a sense of ineffectiveness (Maslach, Schaufeli, & Leiter, 2001).

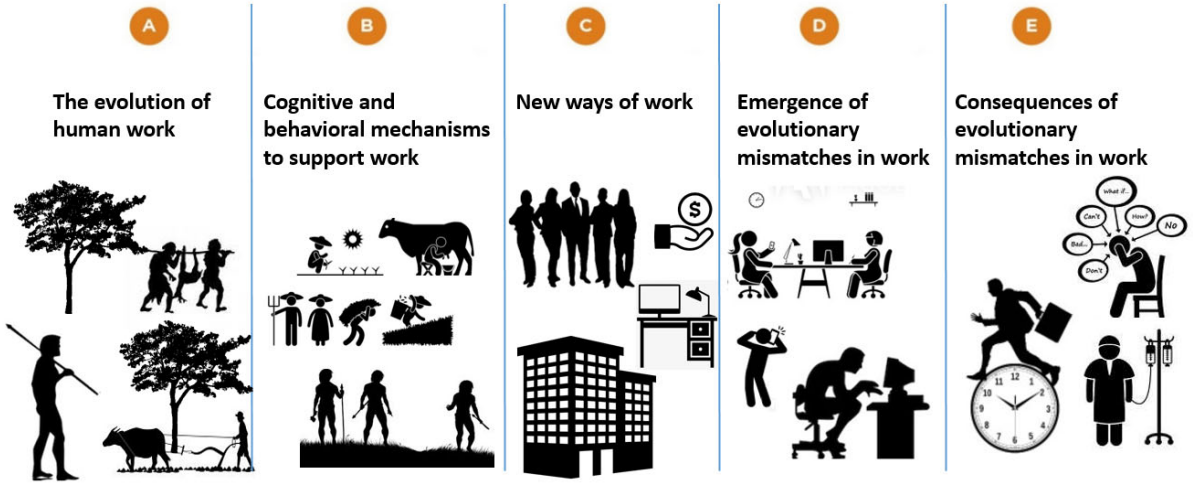


**Figure 3**. Work stress as a consequence of mismatch.

*Politics*

Some challenges associated with modern-day politics may also be amplified by mismatch. Humans evolved in small-scale societies with small-scale politics (Petersen, 2015). There was little or no hierarchy and conflicts were settled through informal leaders who had no authority beyond their domain of expertise. Excellent hunters, diplomats, warriors, and shamans offered valuable services and in return they received prestige, which culminated in some reproductive gains for these prestige leaders (Von Rueden & Van Vugt, 2015). Ancestral humans knew their leaders intimately and so there was a tight relationship between someone's competence and their prestige as leader. This may not necessarily be the case in modern politics in which there is a vastly increased distance between leaders and followers (Van Vugt & Ronay, 2014). As a consequence, political voting decisions are made with a great degree of uncertainty in an information-poor environment in which reliable competence cues are lacking. As a consequence, our psychological mechanisms are missing relevant inputs to make good judgments about which leaders to choose. Because much leadership in ancestral groups was based on physical properties such as physical formidability these cues get increasing weight in our political decisions. Thus, voters have a preference for tall and dominant-looking leaders especially in contexts that resemble ancestral threats such as intra-

or intergroup conflicts (Laustsen & Petersen, 2015; Van Vugt & Grabo, 2015). Further supporting this idea, voters who watch more television pay more attention to physical cues in choosing political candidates (Lawson, Lenz, Baker & Myers, 2010).

Support for party policies is another domain that may suffer from mismatch. In small-scale systems political decisions about the distribution of resources are often made on the basis of simple heuristics such as deservingness: who deserves to receive our help (Petersen, 2015). Our psychological mechanisms have evolved to be constantly on the lookout for cheaters, individuals who free-ride on the efforts of others or are otherwise unable or unwilling to contribute. This has implications for the way we view disadvantaged groups in society. We are more likely to support the temporary ill than the chronically ill, we are more likely to help the ill rather than people who are unemployed, and we are more likely to support policies to give aid to members of ingroups rather than outgroups (McDonald, Navarrete, & Van Vugt, 2012). Cues of physical formidability also matter in how people apply the deservingness heuristic. In ancestral groups resource conflicts were often decided based on physical force. Surveys and experiments find that physically formidable men are (a) more prone to anger and (b) are less supportive of welfare policies unless they are a member of a disadvantaged group themselves in which case they are more supportive (Petersen et al., 2013). Thus, various cues, external and internal, activate our evolved political psychological mechanisms, resulting in preferences that may have detrimental consequences for our well-being, such as supporting dominant, aggressive leaders.

A final arena for political mismatch derives from our susceptibility to conspiracy theories which inform political preferences (Van Prooijen & Van Vugt, 2018). Humans are coalitional animals and we have likely evolved various psychological mechanisms to detect coalitional threats. Being watchful for dangerous coalitions may have served us well in environments in which these threats were particularly lethal. This seems to be the case in

ancestral environments in which killings were common. Through media exposure we now receive constant information about potential conspiracies and we are highly susceptible. For instance, almost half of Americans believe that the US-government knew in advance of the 9/11 attacks although there is no evidence for this. A significant portion of religious people believe that vaccinations are a conspiracy of Western governments liaising with the pharmaceutical industry to damage children's health. Our psychological mechanisms are biased to avoid dangers and so they are calibrated to avoiding costly errors (error management). Because it is costlier to ignore a conspiracy when there is a genuine one rather than recognize a conspiracy when there is nothing, our conspiracy detection mechanisms are very sensitive and on high alert. As a result, individuals make irrational decisions about their health and the well-being of close ones (Van Prooijen & Van Vugt, 2018).

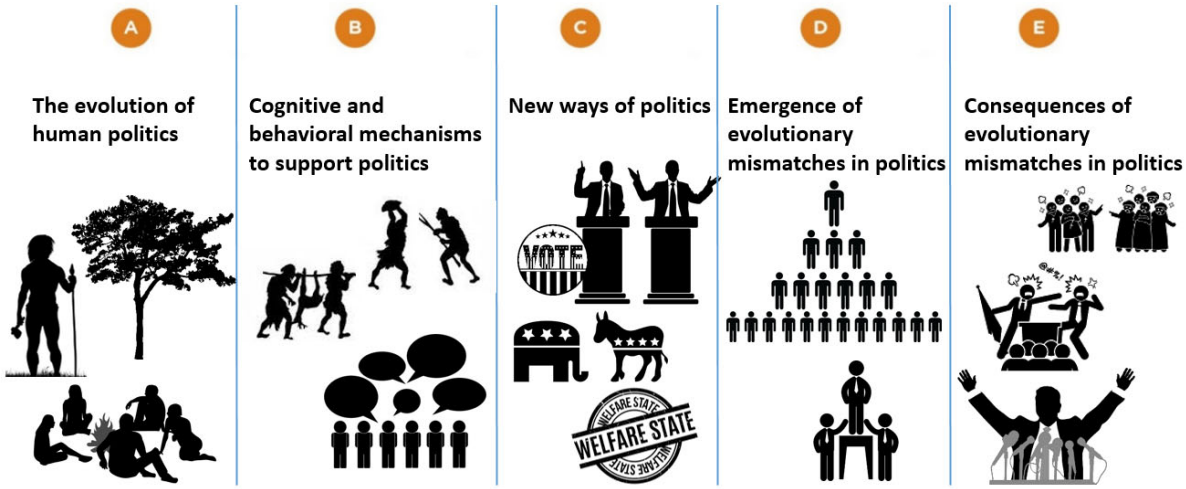


**Figure 4.** Emergence of mismatches in politics.

*Sustainability and Health*

Finally, the global environmental challenges that modern humans face may be intensified by mismatch (Van Vugt, Griskevicius & Schultz, 2014). For instance, climate change is something that humans have difficulty comprehending and responding to because the consequences are delayed in time and dispersed geographically. Ancestral humans may have

struggled with local environmental problems such as water or food shortages but these problems were both immediate and visible. The problem is that our psychological mechanisms are not activated by inputs about global delayed environmental challenges. This is particularly true when information is presented in probabilistic terms (e.g., the chances of pollution in the 5-day weather forecast are 40%) rather than in frequentist numbers (e.g., in 2 out of 5 days there will be pollution). The latter is easier to comprehend. In order to tackle environmental mismatches it is important that our psychological mechanisms receive the right input. For instance, associating meat consumption with disease and disgust cues (Palomo-Velez, Tybur & Van Vugt, 2018) is more effective than accentuating the long-term health (colon cancer) or environmental consequences (deforestation). The idea is that humans respond more strongly to immediate sensory cues that something is wrong. In addition, humans have not evolved to be motivated by a concern for the planet. They are more likely to cooperate for a better environment if the consequences of their efforts benefit themselves and their children and grandchildren. Indeed, priming people with images of their own children helps increase their environmental intentions (Palomo-Velez et al., 2018). Finally, our prosocial psychological mechanisms are triggered by social cues, that is, what we see others doing and by reciprocity cues – what they get in return. This can be used effectively in environmental campaigns. In one study hotel guests were asked to re-use their towels either for the sake of the environment or to benefit themselves (a small discount on their hotel bill). The latter message was more effective than the first. The most effective message, however, when information was provided that the majority of hotel guests were already re-using their towels (Goldstein, Cialdini & Griskevicius, 2008).

Taken together, an understanding of the evolved social-psychological mechanisms that produce various human social behaviors, from close relationships to political preferences, along with insights into the relevant mismatched conditions – in terms of inputs and outputs --

can lead to predictions about the consequences of mismatch for our behavior and contribute to an understanding of seemingly irrational, maladaptive human behaviors. We have reviewed evidence for mismatched behaviors is in domains of relationships, work place behavior, politics and health/sustainability (Figures 2 and 3).

**Implications for Public Policy**

So how can the knowledge about human evolution and mismatch help to inform public policy? First, some cautionary comments are needed. Although in the previous sections we provide considerable support for the idea that mismatch plays a role in various applied social psychology domains, further research is needed. For instance, is internet porn indeed causally related to relationship dissatisfaction and the ability to maintain a healthy partner relationship or are there other confounding factors? Are preferences for physically formidable leaders in modern societies indeed mismatched such that having these leaders in charge is bad for the followers? Does frequent social media use lower people's self-esteem and makes them invest less in meaningful relationships (Sbarra et al., 2019)? The answer is that we need more research that explicitly starts from an evolutionary perspective, for instance, by examining factors that increase people's sensitivity to mismatch and treating this as an individual difference. Additional evidence for mismatch should come from (a) comparing modern societies to the small-scale societies in which humans evolved and (b) showing that environmental factors, rather than genetics are causing these behaviors. In the absence of a time machine we have to rely on historical evidence (e.g., from ethnographies) and evidence from current small-scale societies such as the Hadza, Kung-San, or Tsimane. But: these societies are increasingly rare and many of them have interacted with modern societies for a while now (Von Rueden & Van Vugt, 2015).

From an evolutionary perspective there are, in principle, three options available to deal with mismatches. The first option is to do nothing, just wait and see. Biological evolution ultimately catches up with environmental changes and if there are profound negative selection consequences of certain traits or behaviors then they – and the individuals that carry these traits – will eventually disappear. For instance, delaying the age of motherhood creates a selective disadvantage for women who are unable to remain fertile at a later age and positive selection for women who do. Many mismatches are aggravated among people who are lacking in self-control, for instance, in what they eat or drink, how much physical risks they take, or how much they invest in an education to achieve a high-status position. By doing nothing, there will be positive selection for individuals who are able to control their impulses such that their genes can proliferate. Naturally, there will be selection consequences only when the mismatched behaviors affect someone's reproductive success; thus, lifestyle diseases that manifest themselves at an old age (e.g., certain forms of diabetes) are not likely to disappear via natural selection (Lieberman, 2013).

Doing nothing may be undesirable from a societal viewpoint, however, as there may be excessive costs placed upon individuals or societies if people do not change bad lifestyle choices. Therefore, society may decide to eliminate behavioral options that cause mismatch because they are too costly for society. Smoking addiction, a mismatched habit, is an example. Smoking clearly has a negative effect on one's health and costs society many billion dollars in terms of disease treatment. The effects of passive smoking are also non-negligible. Accordingly, many modern societies have imposed fairly draconic measures to reduce people's freedom to smoke in public places. Constraining measures are also increasingly applied to limit unhealthy food options in sport canteens and schools, the use of smartphones in classrooms, and the access to day care centers of children who have not been vaccinated against infectious diseases. Yet for many of the other mismatched problems we discussed

here, from relationships to politics and the workplace, there is probably little public support for coercive measures.

Therefore, an alternative solution to reduce mismatch is to make alternative options more attractive, options that are ultimately better for them and for society. This can be done by applying nudging strategies to evolutionary mismatched behaviors. Nudges are low-cost interventions that change people's behaviors through altering the choice architecture of the environment without removing their freedom to choose. For instance, climate change is an abstract problem for the human mind. Humans have evolved to pay attention to problems that are associated with direct sensory cues, what they can see, hear, or smell. So if we want people to behave in a more environmentally desirable manner there is not much point in providing them with more education about the state of the environment ("The earth temperature will rise by 2 degrees"). Yet, by making some of these problems visual and directly noticeable people may be persuaded to do something. So, for instance, providing households or offices with heat maps from their own buildings gives people a direct visible cue to what is needed to save more energy. Similarly, installing energy meters inside personal dwellings so that people can see their prepaid credits dwindling faster when air conditioners kick in, may be more effective than making general pleas to conserve energy.

As another example, humans have evolved bodies to engage in moderate physical exercise at late age (Lieberman, 2013). At the same time, humans have evolved not to waste calories by unnecessarily expending energy. Hence, it can be difficult to get people to engage in regular physical exercise when there is no immediate need. Changing the choice environment through nudges can help. Elevators can be placed at the backside of buildings such that taking the stairs becomes more attractive. Closer to home, the staff rooms in our university building have been recently equipped with table tennis tables, pool tables and high-quality coffee machines so that people are motivated to physically move during the working

day. Finally, to solve the retirement savings issue identified at the beginning of this chapter, companies can enroll employees in default savings plans and to place the burden on employees to opt out rather than requiring them to opt into such a program (Thaler & Sustein, 2008).

In general, generating more effective solutions to important modern problems at both the individual and societal level will require knowledge of our evolved psychology and working with, rather than against or in ignorance of, the various mechanisms comprising that psychology.

*Conclusion*

In sum, mismatch is an important concept in evolutionary psychology and it likely plays a substantial role in explaining various maladaptive behaviors and choice preferences of modern humans living in evolutionary novel environments. When we think of interventions to deal with various mismatched behaviors, such as restrictive or nudging strategies, it would be wise to consider the evolved psychological mechanisms that characterize Homo Sapiens.

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