Ordinaries

Strangers in a strange land: mismatch and economics

Terence C. Burnham¹ · Jay Phelan²

Published online: 23 March 2020

© Springer Science+Business Media, LLC, part of Springer Nature 2020

Abstract

People who live in industrialized economies suffer from a mismatch between evolved human nature and the environment. This mismatch is the primary cause of many deleterious human behaviors. Neither of the two major schools of economic thought incorporate mismatch. Natural selection does not support the neoclassical economic assumption that people will solve novel problems easily and intuitively. Conversely, behavioral economics sets a low bar for itself in documenting failures to maximize.

Ordinary: “With no special or distinctive features; normal. Not interesting or exceptional; commonplace.”

–Oxford English dictionary.

1 Economics without biology: a lost field

Heart disease is the leading cause of death in the United States (Mensah and Brown 2007). In Europe, 45% of all deaths are caused by cardiovascular disease (Townsend et al. 2016). Most of these deaths are avoidable because they are caused by eating too much of the wrong kinds of food and by leading sedentary lives.

Numerous personal choices that we make influence our risk of cardiovascular disease. How does economics view these decisions? Recall that economics is a field divided upon itself, with neoclassical and behavioral schools that agree on almost nothing. So we summarize the two main branches of economics separately.

Mainstream, neoclassical economics is untroubled by cardiovascular disease. In fact, early and unnecessary death are considered to be optimal. By neoclassical assump-

✉ Terence C. Burnham
burnham@chapman.edu

Jay Phelan
jay@ucla.edu

¹ Chapman University, Orange, CA 92866, USA

² Department of Life Sciences Core Education, UCLA, Los Angeles, CA 90095, USA

Table 1 Economics and Heart Disease circa 2020

Phenomenon	Cardiovascular disease is endemic in the United States, Europe, and other parts of the world. Lifestyle choices regarding diet and exercise lead to avoidable morbidity and mortality.
Neoclassical economics	Cardiovascular disease is optimal. The outcome for each person reflects a rational trade-off between desire to live a long life, with a preference for eating pizza while watching TV on the couch (or better still while lying in bed).
Behavioral economics	The lifestyle choices that lead to cardiovascular disease are mistakes. People are flawed vessels who blunder from one error to the next.

tion, each individual makes the best of their personal circumstances. Most people would prefer to live long, healthy lives. Many of these people, however, also hate exercise and love the foods that kill us. Thus, viewed under the assumptions of neoclassical economics, a death by heart attack at age 45 is an acceptable outcome and expected for some people. Those who suffer early death from heart disease are assumed to have evaluated and elected to make a trade-off between expected lifespan and their desires for leisure and food.

Behavioral economics, in sharp contrast, views such detrimental lifestyle choices as one of many types of mistakes that people commit. The behavioral economic view of human nature is of bumbling buffoons who struggle with math, lose money in financial markets, and make costly, emotional decisions in many areas, with little rhyme or reason to explain them. It may be unfortunate that people make poor decisions about diet and exercise, but to behavioral economists it is not surprising. Table 1 summarizes the current state of economics with regard to cardiovascular disease.

The Ordinaries column is dedicated to viewing economic behavior from the perspective of evolutionary biology (Burnham and Phelan 2019). The goal is a better understanding of human behavior, and, consequently, better outcomes for individuals and for groups of people.

2 Neoclassical economics and the “as if” maximization

Neoclassical economics assumes that every person makes optimal decisions. This optimizing view of human nature may seem peculiar, as it requires people to solve difficult mathematical problems. For example, the question of how much money to save is the subject of the Nobel Prize winning Life-Cycle Hypothesis by Franco Modigliani (Ando and Modigliani 1963).

The Life-Cycle Hypothesis concludes that, “current consumption is a linear and homogeneous function of current income, expected average income, and initial assets, with coefficients depending on the age of the household.” The optimal savings is captured in this equation.

$$s = y - c = \frac{L - t}{L_t} y - \frac{N - t}{L_t} y^e - \frac{1}{L_t} a$$

What portion of a paycheck should a person save? Neoclassical economists assume that each person saves the correct amount, in accordance with the Life-Cycle Hypothesis equation above and other related mathematics. Similarly complicated computations underlie every individual decision. The choice, for example, between staying home and watching TV rather than going for a walk requires solving a complex set of equations involving the consequences over multiple decades.

While neoclassical economics assumes that people solve complicated math perfectly and behave in accordance with those solutions, abundant evidence supports a different reality: people cannot solve even simple problems. Consider the cognitive reflection task (CRT), invented by Shane Frederick of Yale. The CRT consists of three questions, each of which has an intuitive, incorrect answer (Frederick 2005).

- (1) A bat and a ball cost \$1.10 in total. The bat costs \$1.00 more than the ball. How much does the ball cost? _____ cents
- (2) If it takes five machines 5 min to make five widgets, how long would it take 100 machines to make 100 widgets? _____ minutes
- (3) In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? _____ days

In the original CRT paper, 3428 subjects completed the task and scored an average of just 1.24 questions correct out of three. MIT students performed best, with an average of 2.18 correct. How can neoclassical economics assume that every person correctly solves the complicated Life-Cycle Hypothesis equation, yet (even MIT students) cannot solve the simple CRT questions?

[Here are the correct and intuitive-but-incorrect answers to the CRT. The ball costs five cents, while the intuitive answer is ten cents. The 100 widgets can be made by the 100 machines in 5 minutes as opposed to the intuitive answer of 100 minutes. The pond is half-covered the day before it is fully covered—47 days—versus the intuitive answer of 24 days.]

“People are too dumb to do neoclassical economic math” is an old objection, predating the CRT and the entire field of behavioral economics. Milton Friedman and Leonard Savage summarized this criticism in 1948 as follows,

“Is it not patently unrealistic to suppose that individuals consult a wiggly utility curve before gambling or buying insurance, that they know the odds involved in the gambles or insurance plans open to them, that they can compute the expected utility of a gamble or insurance plan, and that they base their decision on the size of the expected utility?” (Friedman and Savage 1948) p. 297.

Friedman and Savage answer this critique by arguing that people solve challenging problems intuitively, without doing any math directly, “individuals behave as if they calculated and compared expected utility and as if they knew the odds.” p. 298.

The “*as if*” argument is clarified with the analogy to a billiards player who can make complicated shots without doing any math at all, “the billiard player made his shots as if he knew the formulas, could estimate accurately by eye the angles, etc., describing the location of the balls, could make lightning calculations from the formulas.” p. 298.

Friedman reuses the billiards player analogy in his 1953 opus, *Essays on Positive Economics*, adding a justification that is not present in the 1948 article: that maximization is the product of natural selection.

The process of “natural selection” thus helps validate the [maximization without math] hypothesis—or, rather, given natural selection, acceptance of the hypothesis can be based largely on the judgement that it summarizes appropriately the conditions for survival. (Friedman 1953) p 22.

Two caveats regarding natural selection and the “*as if*” maximization are warranted. First, Friedman’s 1953 version explains the justification for the billiards player maximization in the context of business behavior, whereas the 1948 work applies to individuals’ decisions. Second, Friedman’s version of natural selection is not aligned with Darwin’s; rather, Friedman’s (1953) use of the term is more akin to competition.

Neoclassical economics, however, still relies upon Friedman and Savage’s “*as if*” justification. People are incapable of solving complicated math problems explicitly, but a process of trial and error and selection—natural or otherwise—produces maximizing behavior.

3 “Trust your instincts” can be a good strategy

Evolutionary biology does provide a form of support for the neoclassical economic view of natural and intuitive optimization. Consider the lack of heart disease in an indigenous population of South American foragers and farmers called the Tsiname.

The Tsiname are reported to have the “world’s healthiest hearts” (Kaplan et al. 2017), exhibiting low glucose levels, low cholesterol levels, a small likelihood of elevated blood pressure, and scoring well on a variety of other heart disease risk factors. For the Coronary Artery Calcium (CAC) measure—an excellent predictor of future cardiovascular disease (Pletcher et al. 2004)—the median value for the Tsiname is zero: “no indication of heart disease.”

How do the Tsiname achieve their tremendous heart health? Weight management programs? Hot Yoga? An app to set goals for number of steps taken per day? Or do the Tsiname consume some secret dietary supplement that shields them from disease?

The answer to these questions is no. The Tsiname simply live their lives, and one result is super healthy hearts. Paraphrasing Milton Friedman, we can say that the Tsiname choose their food and activity patterns *as if* they can solve the equations regarding cardiovascular disease.

The Tsiname achieve the healthy hearts without overt calculations, but simply by choosing behaviors that make them feel good. Trusting their instincts, the Tsiname achieve success through seeking pleasure. For people living in industrialized societies, conversely, following a strategy of seeking short-term pleasure often leads to very bad outcomes.

Here is a question that provokes laughter among our students. “What would you do right now if you knew the world would end in a week?” The laughter comes from the behaviors that students would seek in the shadow of Armageddon but will not share publicly. In college, success requires deferring short-term pleasure to achieve

long-term goals. The better we can defer gratification and channel our behavior toward long-term goals, the more likely we are to be successful.

Walter Mischel's famous marshmallow experiments document the life-long increased success of children better able to resist short-term temptation. In Mischel's experiments, children were told not to eat a marshmallow, and those who waited longer went on to live healthier, wealthier, and better lives (Mischel, Shoda et al. 1989). In a modern city, a good life requires choosing an almost endless series of less-than-optimal moments; perpetual discipline to avoid the pitfalls of passion.

Throughout the natural world, however, organisms from populations in sync with their environment experience no conflict between short- and long-term payoffs. Consider the decision of a blue jay or woodpecker feeding on nutritious nuts and acorns. Rather than consuming everything they find, these birds store large amounts of food for future consumption—burying some and hiding some in tree crevices.

What is occurring in the pleasure center of the birds' brains? Is there an internal battle between the joy of eating a nut now, and the hard, disciplined work of digging a hole and burying the nut? No. Because birds that store and retrieve nuts have had higher evolutionary success than those that ate everything today, the preferences of those birds have evolved to yield maximum "happiness" from saving the correct amount for the future.

Consider, too, that most people enjoy the taste of maple syrup, but do not enjoy eating the wood in maple trees. Termite preferences, on the other hand, are reversed; the insects ignore the viscous syrup and instead consume delicious maple wood.

Human and termite disparate preferences were shaped by the same force of natural selection. Individuals in both species today derive pleasure from those behaviors that led their ancestors to have higher levels of biological success. Humans enjoy maple syrup because we derive energy from the carbohydrates contained within. Termites—thanks to their gut microbes that break down the cellulose in wood—thrive on the energy they get from the sugar by-products.

Charles Darwin described the process by which natural selection shapes preferences in *The Origin of Species* (Darwin 1859):

[in the] Struggle for Existence, we see the most powerful and ever-acting means of selection... More individuals are born than can possibly survive. A grain in the balance will determine which individual shall live and which shall die,—which variety or species shall increase in number, and which shall decrease, or finally become extinct... The slightest advantage in one being, at any age or during any season, over those with which it comes into competition, or better adaptation in however slight a degree to the surrounding physical conditions, will turn the balance.

Darwin explains that selective pressures can be very fine-tuned, "the slightest advantage ... a grain in the balance," producing populations of organisms that are exquisitely matched to the environment. We find supporting evidence in adaptations in the fossil record (Morris 1979), in the beak of the finch (Grant and Grant 1993), and in the laboratory in the form of experimental evolution (Rose 1984; Phelan, Archer et al. 2003; Garland and Rose 2009; Burnham, Dunlap et al. 2015; Burnham and Phelan 2018).

Natural selection works on behavior as well as morphology. Consider the fights for dominance among male elephant seals. At full maturity, a male elephant seal can exceed thirteen feet in length and weigh over two tons. These SUV-sized males engage in bloody battles to control beach territory occupied by fertile females. The winners typically get one season of mating dominance before dying, while losers incur serious—and sometimes fatal—wounds, with little or no reproductive success (LeBoeuf and Laws 1994).

Why do male elephant seals engage in costly fights for transitory victory or worse? Daly and Wilson (1983) explain that the answer is natural selection:

Imagine a bull elephant that has no stomach for the dominance battles of the breeding beach. Very well. He can opt out: remain at sea, never endure the debilitating months of feast and battle, outlive his brothers. But mere survival is no criterion of success. Eventually he will die, and his genes will die with him. The bull seals of the future will be the sons of males that found the ordeal to be worth the price (p. 92).

The male elephant seals that win the dominance battles sire the next generation. Four percent of the males—those at the top of the dominance hierarchy, who control the beach—get about 85% of the matings, and so father the vast majority of the offspring (LeBoeuf and Laws 1994). Consequently, the route to evolutionary success for male elephant seals is through combat, and thus they engage in costly battle. It is possible, even probable, that male elephant seals experience brain states resembling pleasure when fighting.

An organism adapted to its environment undertakes only those voluntary behaviors that lead to evolutionary success. Furthermore, we expect such organisms to derive maximal pleasure from evolutionarily-favored behaviors. Table 2 summarizes the impact of natural selection on human behavior. The specific behaviors are speculative, while the evolutionary pressure is clear.

Table 2 Natural selection favors increased reproductive success relative to other individuals

		Feels	
		Good	Bad
Outcome in evolutionary terms of survival and reproduction	Good	Having babies, helping genetic relatives, engaging in mutually advantageous cooperation, consuming nutritious foods, making good decisions regarding risk, having appropriate concern for the future	None
	Bad	None	Suicide, consuming life shortening foods, living only for today, living only for the future, taking bad risks. Not engaging in advantageous risky behaviors

Preferences are tools that our genes use to induce us toward behaviors benefiting them. In equilibrium, human preferences will produce pleasure from behaviors that lead to survival and reproduction. As a consequence, we expect people to derive pleasure from eating food, staying warm, and avoiding unnecessary physical dangers. Conversely, we expect people experience displeasure when evolutionary costs exceed the benefits—eating excrement, touching fire, giving away resources indiscriminately.

An important feature of Table 2 is that two sections are empty. This is because when populations of organisms are in equilibrium—that is, they are in the environment to which they are adapted—there will be no behaviors that feel good but are evolutionarily costly. And there will be no behaviors that feel bad yet are evolutionarily beneficial.

Put another way, in equilibrium, there is alignment between pleasure and evolutionary outcomes. Birds enjoy caching nuts, male elephant seals enjoy combat, termites love cellulose, and humans get pleasure from consuming sugar.

The Tsingame have healthy hearts because they are in sync with their environment, or at least more so than people living in big cities. And while no species or population of individuals is likely to be in perfect equilibrium with their environment, we hypothesize that the behaviors necessary to produce healthy Tsingame hearts require less deferral of gratification than those necessary to produce healthy hearts in Western urban environments.

4 Mismatch occurs when the environment changes

Charles Darwin and Milton Friedman therefore agree. Under certain conditions, it is reasonable to predict that organisms—including humans—will exhibit sophisticated behavior that is consistent with maximization. Darwin's 'slightest advantage,' a grain in the balance, aligns with neoclassical economics' rationale for the assumption of optimization.

Natural scientists frequently begin observations of organisms living in their natural environment precisely by hypothesizing a biological advantage. Q: Why do male elephant seals fight? A: Because doing so increases their chances of obtaining evolutionarily valuable mating opportunities. Q: Why does a female Australian social spider allow her hundred tiny offspring to bite her body and suck out all of the juices, ending her life? A: Because that nutritious meal at such a critical juncture significantly improves her offspring's survival; it also increases the mother spider's reproductive success relative to other individuals.

Furthermore, not only does natural selection favor optimization, it requires no conscious calculation. Humans eat maple syrup, termites eat wood, blue jays love hiding nuts, and elephant seals enjoy a vicious tussle—not because they have calculated the impact on long-term genetic survival, but simply because these behaviors feel good. Human likes and dislikes, too—labeled as preferences by economists—simply represent genetic-based incentives nudging organisms toward successful evolutionary outcomes.

Is it reasonable then to conclude that neoclassical economics is correct in assuming maximizing behavior for all people? Absolutely not.

Preferences push organisms toward behaviors that result in successful evolutionary outcomes in the environment in which those preferences evolved. But here's the problem: we do not live in that environment anymore. And to the extent that our modern industrialized world differs from that ancestral environment, the preferences that led our ancestors to success, may now lead us to failure.

Mismatch is the idea that an organism can be out of sync with the environment. Mismatch can cause pathological behavior. For example, sea turtle hatchlings have adaptations to emerge from the egg at night and to crawl to the ocean, using light cues to orient themselves to the relative safety of the ocean (Lohmann and Lohmann 1996).

In the presence of too much human-created light, however, sea turtle hatchlings may crawl in the wrong direction and die (McFarlane 1963). Indeed, because biological systems are importantly organized by light, artificial lighting has a broad impact on many species including humans (Gaston, Bennie et al. 2013).

Mismatch is a widespread phenomenon in which the organisms in a population are out of sync with their environment. Mismatch occurs when the environment changes more rapidly than natural selection's effect on the population. In their ancestral environment, sea turtle hatchlings utilized sophisticated adaptations to find the sea. In some modern environments, these same adaptations lead baby turtles to move away from the water, causing them to die from motor vehicles, dehydration or predators. The consequence of mismatch can be disastrous maladaptive and pathological behavior.

Mismatch occurs because environmental change can happen quickly, while adaptation—which requires changes in the gene pool over sequential generations—often is slower. Over evolutionary time, dramatic change can occur via the accumulation of smaller changes, Darwin wrote, “The great effect produced by the accumulation in one direction, during successive generations, of differences absolutely inappreciable by an uneducated eye.”

Mismatch represents an existential problem for neoclassical economics. This is because neoclassical economics assumes optimization of all decisions, irrespective of evolutionary history. Natural selection provides no support for “*as if*” optimization in novel environments.

5 Strangers in a strange land

Mismatch is central to understanding human behavior because we are living in a very rapidly-changing world. Just as mismatch causes ancestral adaptations to lead turtles and other animals to bad outcomes, it can have similar deleterious effects for people.

The rapidly changing nature of the world for humans is obvious. Steve Jobs introduced the original iPhone in 2007. Looking at one's phone, “screen time,” is hypothesized to have a variety of negative effects (Bauerlein and Walesh 2009; Stiglic and Viner 2019). In contrast to the effect of screen time, consider the American Heart Association's summary of what we know about the impact of physical activity: “Regular physical activity decreases the risk of cardiovascular disease, type 2 diabetes

mellitus, osteoporosis, depression, obesity, breast cancer, colon cancer, and falls in older adults” (Marcus et al. 2006).

So physical activity is great for people, while screen time may be bad. In 2018, the average American spent 20 h per week looking at their phones, yet becomes only 32% of adult Americans engage in any leisure physical activity. The 32% figure implies that the median time spent on physical leisure activity is zero (Marcus et al. 2006).

Given that a human generation is approximately 20 years, it is impossible for our genes to have evolved to produce optimal behavior for iPhones and the myriad ‘labor-saving’ modern technologies that fill our world; many such items have existed for less than a generation.

The smart phone is just the tip of the mismatch iceberg. While natural selection definitely has not had sufficient time to produce adaptive responses to smart phones, we experience even more significant longer-term mismatch from urbanization, industrialization, and the invention of agriculture. In 1800, less than 1% of the world’s population lived in cities with over 100,000 people (Davis 1955). Agriculture was invented by people in some parts of the world 10,000 years ago (Rindos 2013). Prior to agriculture—and for millions of years of evolution—humans foraged for plants and hunted animals.

Humans have had less than a single generation to adapt to some important modern technologies and about ten generations to adapt to living in big cities. We have had only about 500 generations to adapt to the radically different environment resulting from agriculture.

Under conditions of mismatch, preferences can lead us toward costly behaviors. Just as turtles get killed by artificial lighting, humans can lose their way in modern cities. To be fair, the long-term reproductive payoffs of specific behaviors are rarely, if ever, known. For example, smoking almost certainly decreases expected lifespan. But, perhaps, cigarettes in the 1950s made people more attractive and thus produced reproductive benefits that exceeded the costs.

Although we do not know the long-term impact of many behaviors, we can speculate. Specifically, we believe there are hundreds of behaviors for which humans are out of sync with the environment. In such cases, mismatch can result in bad behaviors that feel good and good behaviors that feel bad. Table 3 includes a few of our speculations.

Table 3 In novel environments, being bad can feel good, and being good can feel bad

		Feels	
		Good	Bad
Outcome in evolutionary terms of survival and reproduction	Good		Colonoscopy, dental visits, flossing, saving money, college, vaccines, helmets, prudence
	Bad	Crack cocaine, Big Macs, TV, motorcycle, pizza, trans fats, cigarettes	

Table 4 Mismatch impacts every axiom of economics

	Human environment before the invention of agriculture	Industrialized economies
Products we encounter in our environment	Persistent for entire lifetime, relatively slow introduction of novel items	Rapid, novel product proliferation
Savings	Fat stored on our body, family assistance, and relationships with friends	Financial instruments, stocks, bonds, real estate, currency, bitcoin
Food availability	Variable, unpredictable, and generally limiting	Overabundance for people with sufficient wealth
Risk	Physical, biological, and social risks	Physical, biological, social, and novel financial, technological, and pharmaceutical risks
Social interactions	Public and repeated, most frequently with same relatively small number of people	Anonymous and public. Repeated and one-time interactions with large number of people
Decision making	“ <i>As if</i> ” maximization leads to good outcomes	Naively doing what feels good often leads to terrible outcomes

Mismatch has implications for every aspect of economics (Burnham 2016). Table 4 contains a short summary of the axioms of economics juxtaposed with the divergence between the human ancestral environment and the modern, urban environment.

Future Ordinaries articles will consider each axiom individually. For now, we summarize by saying that in the ancestral human environment there was selection to make optimal, neoclassical-style decisions. In the modern environment, mismatch causes people to make systematically bad decisions including choices that lead to cardiovascular disease.

6 Lumbering robots with free will

What about free will? Are humans doomed to blindly follow our ancient preferences into cardiovascular disease and a host of other terrible outcomes? No.

Before returning to economics and cardiovascular disease, we briefly address the notion of genetic determination. We—Terry and Jay—wrote *Mean Genes*, which we label as the first Darwinian self-improvement book (Burnham and Phelan 2000).

Mean Genes elucidates strategies and tactics for navigating an alien environment in which naively doing what feels good today often leads to bad outcomes. We describe (and follow ourselves) methods to alter behavior, informed by evolutionary biology. Ample evidence attests to the fact that people can change behavior and obtain better outcomes. Genetic influences on human behavior do not inevitably lead to particular outcomes. It is possible to *tame* our primal instincts.

In our experience, some people fear that acknowledgement of a genetic influence on human behavior negates free will. One poignant example comes from the *Mean Genes*’ book tour, circa 2000. On the tour, we did a very early morning public radio interview in Berkeley, California. Rising before dawn, we traveled in the dark from San Francisco by the BART system and began the interview. When the phone lines opened up, we feared silence. Who is up at 5:30am and has time to call public radio? Thus, we were excited to hear a call come in from a listener.

“What about FREE WILL?” We use all caps because the caller was yelling. She accused us of justifying horrible human behaviors with a blanket excuse of “my genes made me do it.” As the call proceeded, we noticed that the person making the call was the next guest on the radio show! We could see her through the window from the sound-proof interview room. Waiting in the green room to promote her own book, she heard our interview and became so enraged that she had to call immediately.

Richard Dawkins’s book *The Selfish Gene* has created strong visceral hatred in many people—particularly this brief section criticized for implying a lack of free will (Dawkins 1989):

What weird engines of self-preservation would the millennia bring forth? Four thousand million years on, what was to be the fate of the ancient replicators?

They did not die out, for they are past masters of the survival arts. But do not look for them floating loose in the sea; they gave up that cavalier freedom long ago. Now they swarm in huge colonies, safe inside gigantic lumbering robots, sealed off from the outside world, communicating with it by tortuous indirect routes, manipulating it by remote control.

They are in you and in me; they created us, body and mind; and their preservation is the ultimate rationale for our existence. They have come a long way, those replicators. Now they go by the name of genes, and we are their survival machines.

Critics interpret Dawkins’s phrase, ‘gigantic lumbering robots,’ to imply predestination and a lack of individual responsibility for behavior. The critique, in caricature, says: “I am a robot, and my genetic programming controls me. Do not blame me if I commit murder or endorse injustice. And do not thank me if I help you.”

Is there a genetic component to human nature? Absolutely. Consider the life of Chantek the orangutan who died in 2017 at the age of 39. Chantek was brought up by the anthropologist and animal rights advocate Dr. Lyn Miles. Chantek had a human-like upbringing including wearing diapers inside the home with Dr. Miles, being taught sign language, and sometimes eating human food, including Big Macs (Miles 1994).

How does Chantek’s life inform the joint role of genes and environment in human behavior? If Chantek were a gigantic lumbering robot constrained to blindly follow genetic programming, he would have acted in the same manner as jungle orangutans. In contrast, if behavior were independent of genes, then Chantek would have become human-like.

What happened? Chantek remained an orangutan, but exhibited some profound human qualities learned from his environment. Chantek was able to communicate

very well in sign language (his favorite sign was “candy”). As with many Americans, Chantek struggled with his weight—which reached more than double the weight of a wild orangutan—and was grumpy when placed on a diet.

We are Chantek. Chantek demonstrated tremendous behavioral flexibility because the genes that built his brain constructed an environmentally-sensitive learning machine. Almost all animals beyond the most simple are Chantek in the sense of combining tremendous behavioral flexibility with a genetically-constrained core that is species specific. Human beings are extremely flexible, and able to learn and adapt in myriad ways.

People have the freedom to choose and we are each responsible for our own actions.

7 Toward a neo-Darwinian economic synthesis

Cardiovascular disease is a leading source of morbidity and mortality. It appears puzzling because, in most cases, the disease is caused by voluntary decisions regarding food consumption and physical activity. Neoclassical economics argues that cardiovascular disease reflects an optimal trade-off between preferences for long-life and lifestyle choice. Behavioral economics includes costly lifestyle choices in its litany of human mistakes.

The Ordinaries column is dedicated to viewing “economic behavior from the perspective of evolutionary biology.”

Cardiovascular disease is caused—from an evolutionary perspective—by the mismatch between ancestral and modern environments. Ancestral humans generally benefited from eating more and moving around less, while for most of us today, we would live longer if we ate less, and moved around more (Table 5).

What does an evolutionary perspective imply for economic views of cardiovascular disease?

There is no support for the neoclassical “*as if*” assumption that people will naturally solve novel problems well. Neoclassical economics can find comfort in the fact that there is selective pressure for optimization. But selective pressure requires time in

Table 5 Does evolutionary biology improve economic understanding of cardiovascular disease?

Phenomenon	Cardiovascular disease is endemic in the United States and Europe. Lifestyle choices regarding diet and exercise lead to avoidable morbidity and mortality.
Neoclassical economics	Cardiovascular disease is optimal. The outcome for each person reflects a trade-off between desire to live a long life, with a preference for eating pizza while watching TV on the couch (or in bed).
Behavioral economics	The lifestyle choices that lead to cardiovascular disease are mistakes. People are flawed vessels who blunder from one error to the next.
Evolutionary biology	Ancestral humans benefited from consuming additional calories and from decreasing physical activity. Our preferences for food and physical activity reflect what was good for our ancestors. The mismatch between the ancestral and modern worlds is the source of much cardiovascular disease.

the form of multiple generations. Much more time than is possible in the context of rapid technological change. And so the notion that people will automatically and unconsciously make good choices is, from a practical perspective, fatally flawed. The neoclassical economic view that premature cardiovascular deaths are optimal is misguided.

Behavioral economics, too, receives a mixed judgment from evolutionary biology. Animals in novel environments should be expected to make terrible decisions. To that extent, behavioral economics sets a very low bar in documenting human mistakes and labeling them “anomalies.” On the brighter side, the behavioral economics school is correct in criticizing the “*as if*” assumption of neoclassical economics.

Does evolutionary biology help understand cardiovascular disease and human behavior more broadly? The answer will vary for different people. For us, Terry and Jay, knowing that we are battling our very human nature in seeking a good life is important and useful. Behavioral improvement requires making choices that may feel bad today, guided by an understanding of the mismatch between preferences and longer-term outcomes. Simply doing what comes naturally will lead to unhappiness and bad outcomes.

Finally, we find grandeur in the fact that our opponent in self-control battles is precisely the aspects of our personalities that allowed our ancestors to survive, reproduce, and ultimately produce us.

References

- Ando, A., & Modigliani, F. (1963). The “life cycle” hypothesis of saving: Aggregate implications and tests. *The American Economic Review*, 53(1), 55–84.
- Bauerlein, M., & Walesh, S. G. (2009). The dumbest generation—how the digital age stupefies young Americans and jeopardizes our future. Jeremy P. Tarcher/Penguin, New York, 2008; 978-1-58542-639-3, American Society of Civil Engineers.
- Burnham, T. C. (2016). Economics and evolutionary mismatch: Humans in novel settings do not maximize. *Journal of Bioeconomics*, 18(3), 195–209.
- Burnham, T. C., & Phelan, J. (2000). *Mean Genes. From sex to money to food, taming our primal instincts*. Cambridge, MA: Perseus.
- Burnham, T. C., & Phelan, J. P. (2018). Fair is foul, and foul is fair: experimental evolutionary studies of mismatch. *Journal of Bioeconomics*, 20(1), 153–157.
- Burnham, T. C., & Phelan, J. (2019). Ordinaries. *Journal of Bioeconomics*, 21(3), 145–155.
- Burnham, T. C., Dunlap, A., & Stephens, D. W. (2015). Experimental evolution and economics. *Sage Open*, 5(4), 2158244015612524.
- Darwin, C. (1859). *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life*. London: John Murray.
- Davis, K. (1955). The origin and growth of urbanization in the world. *American Journal of Sociology*, 60(5), 429–437.
- Dawkins, R. (1989). *The selfish gene*. New York: Oxford University Press.
- Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic Perspectives*, 19(4), 25–42.
- Friedman, M. (1953). *Essays in positive economics*. Chicago: University of Chicago Press.
- Friedman, M., & Savage, L. (1948). The utility analysis of choices involving risk. *Journal of Political Economy*, 56(4), 279–304.
- Garland, T. J., & Rose, M. R. (2009). *Experimental evolution: Concepts, methods, and applications of selection experiments*. Berkeley: University of California Press.

- Gaston, K. J., Bennie, J., Davies, T. W., & Hopkins, J. (2013). The ecological impacts of night time light pollution: a mechanistic appraisal. *Biological Reviews*, 88(4), 912–927.
- Grant, B. R., & Grant, P. R. (1993). Evolution of Darwin's finches caused by a rare climactic event. *Proceedings of the Royal Society of London*, 251, 111–117.
- Kaplan, H., Thompson, R. C., Trumble, B. C., Wann, L. S., Allam, A. H., Beheim, B., Frohlich, B., Sutherland, M. L., Sutherland, J. D., Stieglitz, J. (2017). Coronary atherosclerosis in indigenous South American Tsimane: A cross-sectional cohort study. *The Lancet*, 389(10080), 1730–1739.
- LeBoeuf, B. J., & Laws, R. M. (1994). *Elephant seals*. Berkeley: University of California Press.
- Lohmann, K., & Lohmann, C. (1996). Orientation and open-sea navigation in sea turtles. *Journal of Experimental Biology*, 199(1), 73–81.
- Marcus, B. H., Williams, D. M., Dubbert, P. M., Sallis, J. F., King, A. C., Yancey, A. K., Franklin, B. A., Buchner, D., Daniels, S. R., Claytor, R. P. (2006). Physical activity intervention studies: What we know and what we need to know: A scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity); Council on Cardiovascular Disease in the Young; And the Interdisciplinary Working Group on Quality of Care and Outcomes Research. *Circulation*, 114(24), 2739–2752.
- McFarlane, R. W. (1963). Disorientation of loggerhead hatchlings by artificial road lighting. *Copeia*, 1963(1), 153.
- Mensah, G. A., & Brown, D. W. (2007). An overview of cardiovascular disease burden in the United States. *Health Affairs*, 26(1), 38–48.
- Miles, H. (1994). Me Chantek: The development of self-awareness in a signing orangutan. In S. T. Parker, R. Mitchell, & M. L. Boccia (Eds.), *Self-Awareness in Animals and Humans: Developmental Perspectives*. Cambridge: Cambridge University Press.
- Mischel, W., Shoda, Y., & Rodriguez, M. (1989). Delay of gratification in children. *Science*, 244, 933–938.
- Morris, S. C. (1979). The Burgess Shale (Middle Cambrian) fauna. *Annual Review of Ecology and Systematics*, 10(1), 327–349.
- Phelan, J. P., Archer, M. A., Beckman, K. A., Chippindale, A. K., Nusbaum, T. J., & Rose, M. R. (2003). Breakdown in correlations during laboratory evolution. I. Comparative analyses of *Drosophila* populations. *Evolution*, 57(3), 527–535.
- Pletcher, M. J., Tice, J. A., Pignone, M., & Browner, W. S. (2004). Using the coronary artery calcium score to predict coronary heart disease events: a systematic review and meta-analysis. *Archives of Internal Medicine*, 164(12), 1285–1292.
- Rindos, D. (2013). *The origins of agriculture: an evolutionary perspective*. New York: Academic Press.
- Rose, M. (1984). Laboratory evolution of postponed senescence in *Drosophila melanogaster*. *Evolution*, 38, 1004–1010.
- Stiglic, N., & Viner, R. M. (2019). Effects of screentime on the health and well-being of children and adolescents: A systematic review of reviews. *British Medical Journal Open*, 9(1), e023191.
- Townsend, N., Wilson, L., Bhatnagar, P., Wickramasinghe, K., Rayner, M., & Nichols, M. (2016). Cardiovascular disease in Europe: Epidemiological update 2016. *European Heart Journal*, 37(42), 3232–3245.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.