The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Climate Change, Sabre Tooth Tigers and Devaluing the Future

Posted by nate hagens on February 23, 2007 - 9:30am

The debate on the realities of both climate change and Peak Oil has moved from 'are they real?' to questions concerning timing, magnitude and impact. At the same time, expanding research in *'temporal discounting'* in economics (called *'impulsivity'* in psychology), is shedding light on how steeply we value the present over the future, a trait that has ancient origins. Knowing this tendency, how can we expect factual updates on peak oil and climate change to behaviorally compete with Starbucks, sex, slot machines, and ski trips?

Science is rapidly increasing our knowledge about the planet. To affect change however, we must become equally knowledgeable about ourselves. The time has come to integrate ecological science with insight about human behavior derived from new findings in anthropology, hunter gatherer studies, evolutionary psychology and the neurosciences. Below the fold is an overview on human discount rates, their evolutionary origins, and their relevance to the mitigation and adaptation to climate change and peak oil.

"Dumbo, caught obsessing about higher planetary CO_2, did not leave any descendants"

INTRODUCTION

Much analysis and effort is being made in environmental science, ecological economics, energy analysis, and grassroots blogging (including and especially on theoildrum.com) to improve and refine data on our natural resource problem. But is "education" enough? Can reading Khebab's and Euan's posts about the upcoming peaking in world oil production push us to make forward thinking policy choices while we are still buying $2 gasoline? Would a report raising the value of

the Amazon basins ecosystem services from $1 trillion to $10 trillion make a difference to those who read it? Why or why not?

The understanding and application of behavioral economics and evolutionary psychology will play an integral role in the battle with the two-headed monster Peak Oil / Climate Change. This first of several 'demand related' posts will highlight our innate bias to place more weight on the present than the future via *steep discount rates*.

Before some definitions, lets start with an example.

AN INTERVIEW

Following the release of the initial segments of the recent IPCC report, I called a good friend to get his reaction. (After I told him I would post his responses, he requested anonymity – lets just call him Thomas)

> Nate: What do you think about the IPCC report that came out today stating by the year 2100 global temperatures will rise between 3-7 degrees? And sea levels will rise by between 17-34 inches?
>
> Thomas: I read "State of Fear" by Crichton – most of those scientists are just playing with models – they really have no idea how its all going to play out. Plus we are in a general warming trend anyways.
>
> Nate: I disagree with that, but let's assume the scientists are right, even conservative, would you change your behaviours or view of the world.
>
> Thomas: Dude that's 100 years from now. I'll be dead. My kids will be dead. Its someone else's problem.
>
> Nate: Ok – what if instead of 17 inches, there would be a 17 foot sea rise by 2100?
>
> Thomas: Well, I'll still be dead and it will still be someone else's problem. Though I imagine the world would be a wild place were that to happen. That's alot of water.
>
> Nate: Ok – what if instead of 2100, the 17 foot sea level rise would happen by 2050, maybe not in your lifetime but definitely in your childrens? And what about their children?
>
> Thomas: It depends if it happened all at once or was gradual. If it was all at once, I'd either be prepared or deal with the consequences. I'd certainly tell my boys to buy land inland Oregon and California around 2045 though. Still - a long way off for me to worry about it.
>
> Nate: Ok – imagine that it happened in 2015 – a 21 foot sea level rise.
>
> Thomas: Dude – you do realize that Dennis Quaid movie was fiction right?
>
> Nate: I know – just hypothetically
>
> Thomas: Well, I'd probably move pretty soon from New York somewhere to the Rockies. I'd start moving my retirement assets out of stocks and into bonds because 17 feet is going to cause a hell of a recession, not to mention global upheaval. I wouldn't change my job or anything but probably would prepare my children a little better to face a chaotic world. Would everyone know it was going to happen or just me?

> Nate: Ok what if the Greenland ice sheet melted this summer and there was a 17 feet sea level rise this August?
>
> Thomas: Well now youre getting plain nutty. But if that happened, I'd liquidate all of my investments, take my wife and kids on some expensive trips to Africa and other places that might be changed forever, then hunker down. Probably get stocked up Y2K like, just in case, and just enjoy life as best I could - what can I do anyways? These things all have a momentum of their own – nothing me or my family could do would make much of a difference. I like eating meat and I like my SUV. Nate you should work for Greenpeace or something.

Though the above conversation is of course only a sample size of one, it effectively highlights two prevalent evolutionary concepts that are related to climate change and oil depletion. The first is the biological concept of inclusive fitness popularized by Richard Dawkins in "The Selfish Gene" and related to ecology in the famous "Tragedy of The Commons" by Garret Hardin. This concept of individual selection over group selection in a world of declining resources and sink capacity will be covered in my next post. The interview also highlights how distant events seem not to intrude on ones daily thought process, until they become close enough in time to affect our normal routines. I assure you my friend Thomas is not losing sleep over Peak Oil or global warming.

THE EVOLUTION OF THE HUMAN BRAIN

> *"In the distant future I see open fields for far more important researches. Psychology will be based on a new foundation, that of the necessary acquirement of each mental power and capacity by gradation."*
> -- Charles Darwin, *The Origin of Species*, 1859

Just a decade ago, an observant generalist could see cracks in the foundation of the standard social science model(SSSM) (and for that matter standard neoclassical economics). It is now apparent these models have fatal flaws and that we are in the liminal space defining what will supercede them. The SSSM posits that we are born a blank slate and during our lives culture infuses us with our language, instincts and behaviours. We now know that we have been shaped through millions and millions of years of mutation, migration, genetic drift and natural selection and that we are not born a blank slate but a creature optimized for activities leading to resource acquisition and reproduction. Culture is very important, but it is the mortar, not the bricks. Nature and nurture are inseparable, and both play a role. But we unequivocally posess genetic leashes - some are long (what do I want to eat for lunch?) and some are short (if Jennifer Garner kisses me, I will *like it*.). This post will attempt to go beyond economics and psychology and first look at *why* we so strongly value the present, an answer found in biology, Darwinian ecology and evolutionary psychology.

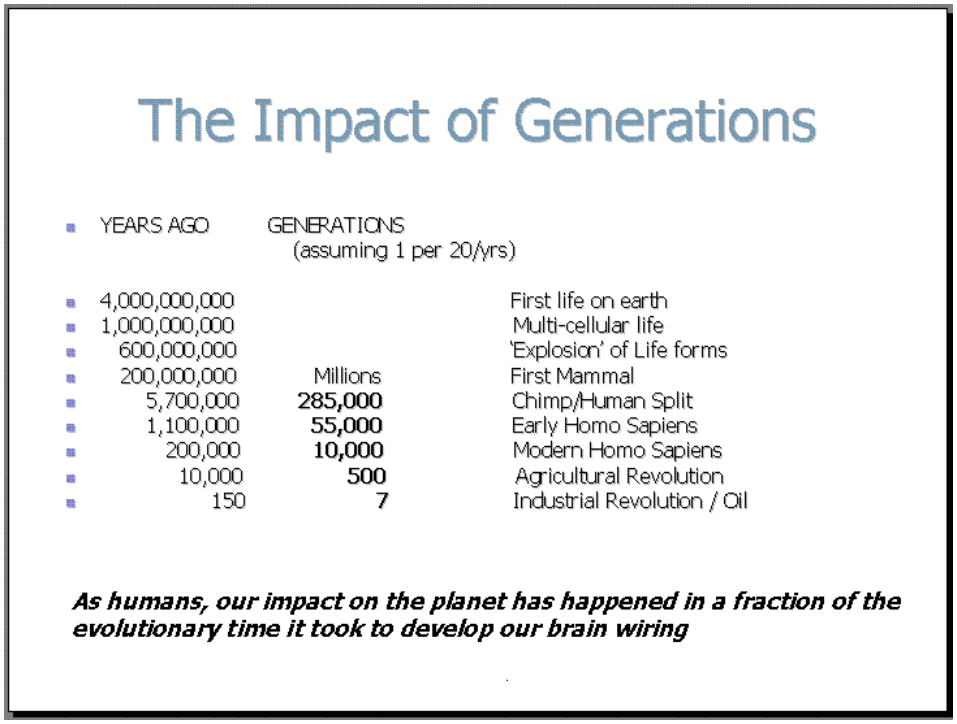
In "The Adapted Mind", Leda Cosmides lays out 5 core principles of Evolutionary Psychology:

> 1. The brain is a physical system. It functions as a computer. Its circuits are designed to generate behavior that is appropriate to the environmental circumstances.
>
> 2. Our neural circuits were designed by natural selection to solve problems that our ancestors faced during our evolutionary history.
>
> 3. Consciousness is just the tip of the iceberg; most of what goes on in your mind is

> hidden from you. As a result your conscious mind can mislead you into thinking that our circuitry is simpler than it really is. Most problems that you experience as easy to solve are actually very difficult to solve-they require very complicated neural circuitry.
>
> 4. Different neural circuits are designed for solving different adaptive problems.
>
> 5. (and the famous one) Our modern skulls house a stone age mind.

Though the revolution started with Darwin, the last decade has put the finishing touches on explaining who and what we are as humans. There are still some periods with missing links, but from the small mammals that survived the Chicxulub meteor 65 million years ago, through Proconsul 20 million years ago, to the chimp/human split over 5 million years ago, the compounding of slight changes that improved mating, reproduction, and survival of offspring success have honed us into the most successful species on the planet (by some measures in any case). I'm not sure what is more amazing, the fact that we evolved from common ancestors of tarsiers, or that we have managed to figure out we evolved from common ancestors of tarsiers.

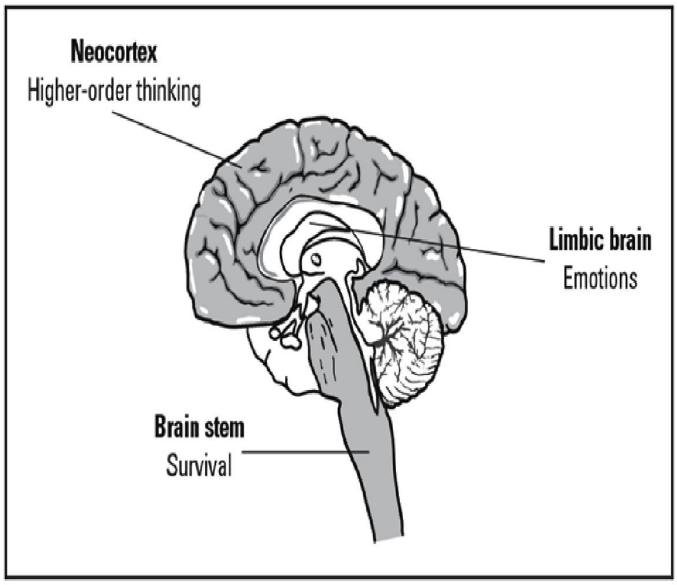
The ancient civilizations of our history books are only 5000 years old, a time period of 1/5th of 1% of the time since our ancestors first sharpened stones (2.5 million years ago). Genetic data suggest that our species was once as endangered as the mountain gorilla today (Stringer/Mckee). At that bottleneck and others, what stood between human extinction and the 6.5 billion of us today? What behaviours were selected for and selected against? Everyone reading this post today is descended from the survivors of that and subsequent periods.



The relentless progress of brain and behaviour

We actually have 3 'brains' within one (termed the Triune brain, shown below). About 1,000,000,000 years ago, multicellular life started to form on the planet. Simple 'brains' that responded by moving towards or away from stimuli gradually evolved into more and more complex forms until they reached the stage of reptiles and amphibians, about 600 million years ago. Since the brain never sleeps, each subsequent mutation or new species added layers (through the 4 mechanisms of natural selection) on top of what existed before it. The 'reptilian' or primitive brain controls basic instinctual survival behaviour and thinking. It is here that our

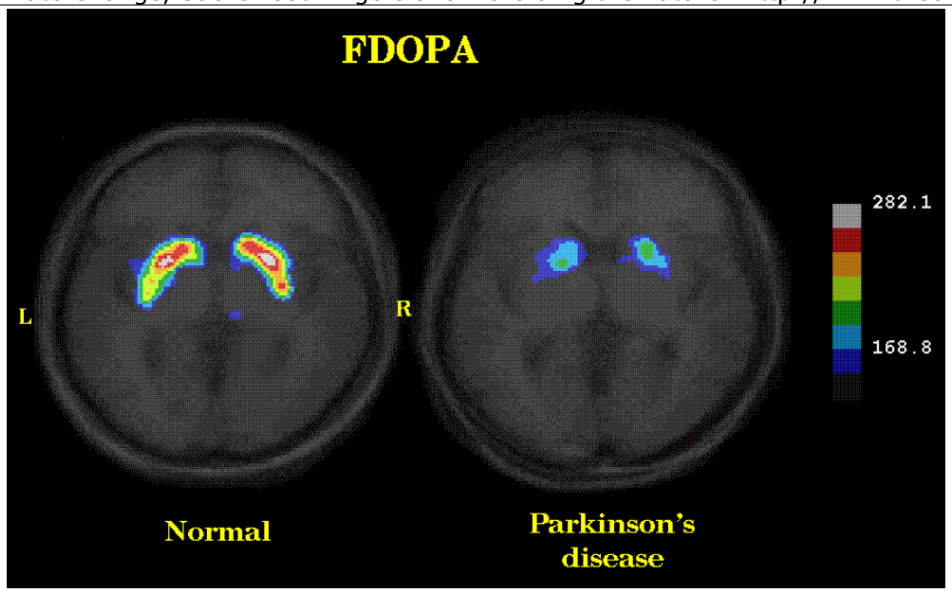
'board of directors' reacts to fight or flight stimuli, without us consciously being aware of it. (Indeed, research by Benjamin Libet has shown that our decisions are made 500 milliseconds (1/2 second) before we are consciously aware of them. "Culture" presumably has the remaining 400 milliseconds to veto the decision since we need 1/10 of a second to process the behaviour). With the eventual arrival of what we now call mammals 200 million years ago, new structures had been 'added on' to brains - the amygdyla, the hippocampus and hypothalumus. With the emergence of this mammalian brain (also called the limbic system) organisms showed emotion, memory and feelings that led to associated behavioral response patterns. Finally, in the higher mammals, apes and humans, the neo (or new) cortex developed. This is where 'rational' thought is processed. This brain region controls higher order functions like reason, speech and Hubbert Linearization. But human emotional response patterns depend on the neural pathways that link the right hemisphere of the neo-cortex to the mammalian brain which in turn links to the reptilian brain.



The Triune Brain (Mclean 1959)

THE MECHANISM

The mechanism between brain and behaviour is the pursuit of a similar mixture of neurotransmitters that allowed our ancestors reproductive success in periods of privation. Dopamine, a core neurotransmitter plays an integral role in our short term desires. If you've ever bought a pair of shoes you'd been wanting for 6 months or hit three 7s on a slot machine, or been the first customer at a Starbucks when they opened, you know what dopamine activation feels like. A relevant medical story has been in the news of late. Parkinsons disease results from not enough dopamine in certain areas of the brain - a drug Mirapex is given to Parkinsons patients that increases dopaminergic activity. In the last few years however, dozens of Mirapex patients have checked in to Mayo Clinic with bizarre symptoms - church pastors were having extramarital affairs, normallly conservative people became compulsive gamblers - one person lost $100,000 gambling in a very short time. Apparently, it is not easy to find the right dosage of Mirapex and many of these patients were now receiving *too much* dopamine.

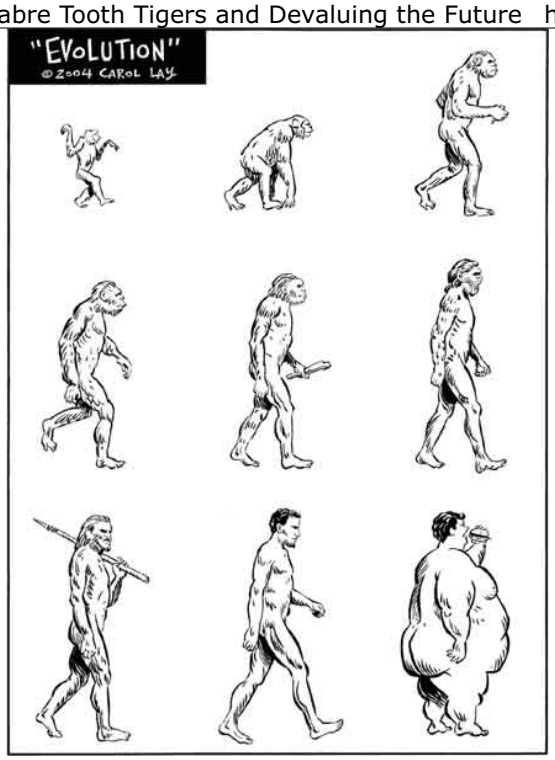


Functional MRI showing dopamine activation in normal patient vs Parkinsons patient

This is concerning, considering Dr. Peter Whybrow, one of my thesis advisors, and the author of American Mania, suggests Americans, due partially to a genetic bottleneck favoring ambitious migrants, and leveraged by our frenetic culture are becoming 'dopamaniacs'. The dopaminergic system is clearly is one of the drivers of our short term behavior. In short, more dopamine craving means less concern about Peak Oil and climate change.

MALADAPTATION?

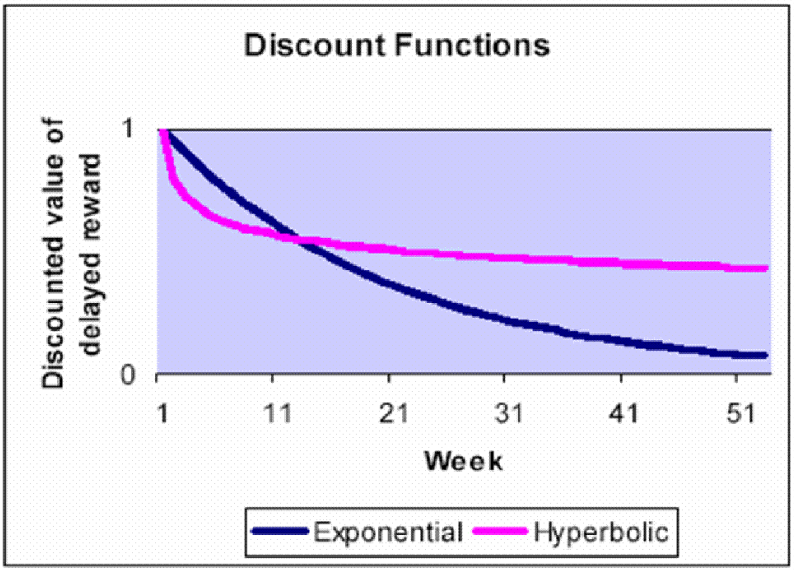
Our culture presents a smorgasbord of options that allow us to 'feel' like our ancestors did when they were successful. Neuroscientist Robert Sapolsky likens the physiology of two grand master chess players to a marathon runner - the body is experiencing the same neurotransmitters (presumably, they did not have chess back on the Pleistoscene). Many of the options available to us that engage our neurotransmitters are maladaptive. Pornography, fast food, arcade games, lottery tickets, etc. all give us feelings identical to those our ancestors were good at pursuing. But now they often trick our brains into thinking they too will lead to evolutionary success.



Cultural Options - Maladaptation?

SO WHAT IS A DISCOUNT RATE?

Everyone is familiar with the 'discount rate' in the financial markets. It's the rate that the Federal Reserve charges its member banks. Its also the rate that a stock analyst might use to discount a companies future earnings stream back to the present. Imagine a company whose entire business plan is to sell a product in 10 years – say at the Olympics – they make no money until then but a lot of money in that one year, say $100 million. How much would investors pay for this company? Certainly something less than $100 mil, as that money wont come for 10 years. They would determine what the risk was of actually getting that $100 mil 10 years hence, then determine what an appropriate rate of return would be, say 15% per year. Discounted at 15% per year, $100 mil is $24.75 mil- that is what they should be willing to pay. So in this example, the discount RATE is 15% and the discount FACTOR is 24.75%, or how much something in the future is worth today. The higher a discount rate the lower the discount factor will be. A discount rate approaching 1, means things in the future have no value at all in the present moment. A discount rate of zero means that $1 dollar in 2050 is worth $1 today.



The Human Hyperbolic Discount Rate

The original neoclassical assumption was that the discount rate curve was exponential, meaning that we discounted the same from period to period. Actual economic experiments however show that the shape of the discount curve is hyperbolic, or as Harvard economist David Laibson prefers *quasi-hyperbolic*. This means that the early periods have much steeper discount rates than later periods. Laibsons research indicates that peoples discount rates are 12% during days 0-5 but drop to 4% in days 20-25. We REALLY prefer the present.

Animals (and humans) have their own internal discount rates exogenous from the market on how they choose between the short term and longer term options offered them in life. Since many animals have short lifespans, they have been shaped through evolution to gather resources and reproduce quickly before they die (this is not a conscious motive – they innately pursue behaviours that were historically successful). Different species have different discount rates, though all are steep, much steeper than our financial systems rates. If you leave for the weekend and give your goldfish 3 days of food at once, you will probably return to a dead bloated goldfish - they have discount *factors* close to zero and discount *rates* close to one. One reason humans discount rates arent quite as steep is probably due to our sunk costs. If we didn't have mortgage payments and college funds for our kids, our discount rates might even be steeper. Its quite logical – animals that deferred opportunities to eat, might come back and their food was stolen, or they might have been eaten themselves in the interim – the long arm of selection would have favored organisms that valued immediacy over those who preferred to wait.

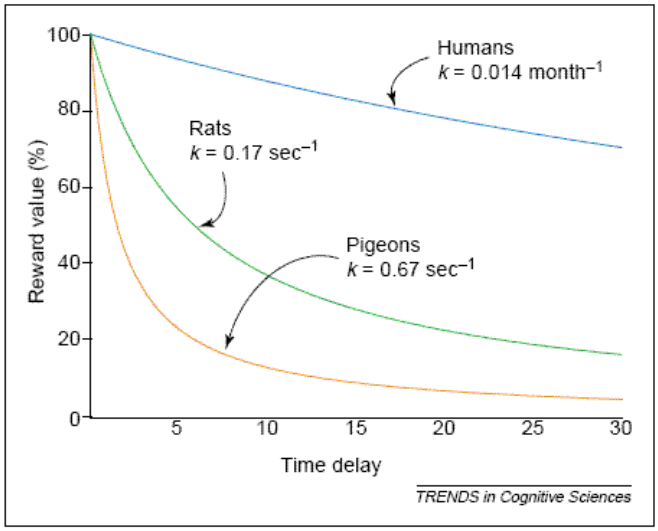


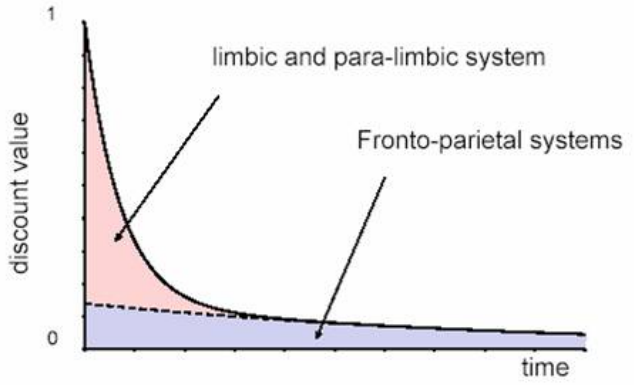
Figure 3. The discounting rate describes the steepness of the discounting function – that is, how quickly the reward is devalued over time. The hyperbolic model of discounting is described by $V = A/(1 + kD)$, where V is the subjective value of the reward, A is the amount of the reward, D is the delay to reward, and k is a free parameter describing the discounting rate. This discounting rate k has been estimated for pigeons and rats, suggesting that both species rapidly devalue food delayed in a matter of seconds [27,28]. Similar experiments on humans suggest that we devalue money at a much lower rate, on the order of months rather than seconds [29]. (Note that the Time delay axis has dual units. Discounting functions plotted from k values reported in Mazur [27], Richards *et al.* [28], and Rachlin *et al.* [29]).

Humans care more about Peak Oil than rats or pigeons

Researchers on animals and humans measure discount rates using the following technique. They offer a small short term reward (SS) as well as a larger long term reward (LL) with differing time delays depending on the experiment. To calculate the discount rate they repeat the experiment until the subject is indifferent between the 2 choices – based on how large the future reward must be, they can compute a discount rate and discount factor, similar to the business example above. With animals, the discount rate tests are almost always food, while with humans they are often money or drugs (e.g cocaine addicts). A recent study on two different monkey species suggests an ecological basis for differing discount rates. Two monkey species, similar genetically and in habitat but differing in diet were studied using food rewards. One species was a gummivore - it scratched on trees and waited for the sap to ooze out which was its main food source. The other species was an opportunistic insectivore, grabbing whatever insect it would see and could catch. As hypothesized, the monkey whose feeding behaviour had evolved to require patience had lower discount rates than the other species in laboratory tests. How cool is that?

NEURO-ECONOMICS

Neuro-economics is a rapidly expanding field that combines traditional economics experiments with fMRI or PET scans. Economist David Laibson has made an amazing observation. During economic games, subjects who choose the LL (larger long term reward) had their prefrontal cortex activated. Those who chose the smaller short term rewards showed neural activity in the limbic system, or emotional mammalian brain.



The relentless progress of brain and behaviour

This graph shows that humans in effect have 2 discount rates. The blue line shows our 'thinking' discount rate whereas the steeper red line shows our emotional discount rate. This is clearly suggestive that we make decisions in different parts of our brain. It also proves (not that we needed proof) that emotions have the ability to trump reason.

DISCOUNT RATE STUDIES

Some people balk at evolutionary psychology because they feel it is deterministic and doesn't apply in all situations. I agree. However it does give an accurate general template for how people interact with eachother and the world. If I say that 'men are taller than women', that doesnt mean that ALL men are taller than ALL women, just that on average this is the case. (Not the case on TOD staff, fyi). I have shown that our evolutionary origins tilt us towards valuing the present more than the future. Not as much as lower animals, but much more than purely 'rational' beings. The table below shows some research results suggesting certain members of society have even steeper discount rates than others. Specifically, those who smoke, do heroine or cocaine, gamble, are mentally ill, consume alcohol, or are young. Of import is studies on cocaine addicts show that not only do they discount cocaine steeply versus the future - but they discount other things as well. In other words, if you have are addicted to something, you tend to value the present more than the future in other areas of life too.

Not on the table is a study by anthropologists Wilson and Daly showing that when shown a pretty female face versus an average one (activating the limbic system) men's discount rates increase and they subsequently make irrational monetary decisions. Women, by contrast, made equally rational decisions whether they had been shown pictures of handsome men or those of average attractiveness. (7) Somehow I believe this study.

Table 2. Representative empirical studies linking estimated discount rates for monetary rewards to various individual behaviors and traits. Studies marked with an asterisk (*) used hypothetical rewards; others used real rewards. *N* = total # of participants in study.

Variable	Study	*N*	Discount Rate Findings
Nicotine	Bickel, Odum, & Madden (1999)*	66	Current smokers > never-smokers and ex-smokers
Alcohol	Bjork, Hommer, Grant, & Danube (2004)	160	Abstinent alcohol-dependent subjects > controls
Cocaine	Coffey, Gudleski, Saladin, & Brady (2003)*	25	Crack-dependent subjects > matched controls[a]
Heroin	Kirby, Petry, & Bickel (1999)	116	Heroin addicts > age-matched controls
Gambling	Petry (2001b)*	86	Pathological gamblers[b] > controls
Risky Behavior	Odum, Madden, Badger, & Bickel (2000)*	32	Heroin addicts agreeing to share needle in a hypothetical scenario > non-agreeing addicts
Age	Green, Fry, & Myerson (1994)*	36	Children > young adults > older adults
Psychiatric Disorders	Crean, de Wit, & Richards (2000)	24	"High risk" patients[c] > "low risk" patients
Cognitive Ability	Benjamin, Brown, & Shapiro (2006)	92	Low scorers on standardized mathematics test > high scorers

DISCOUNT RATE STUDIES (2)

Increasing research in the side fields of economics is painting a clearer picture of our tendency to value the present. The above graph is suggestive of different sub-groups of society that exhibit higher discount rates than average. Anecdotally, I originally promised Professor Goose I'd write this piece a month ago, but perhaps since I'm single, male, drink wine and coffee, play poker on the internet, and have been called 'crazy' by some of my friends, I wrote the entire post in the last 24 hours. Its a good thing I don't smoke or do cocaine or it would never have gotten written. However, since I am aware of my own steep discount rates (also called procrastination in favor of other more fun and intersting things), I devised a solution. I decided to *consciously* email the entire TOD staff and alert them this post was in the queue this week. In effect I made a social contract and would have suffered embarrassment that I let the team down if I blew it off. More research in this area is necessary - social contracts may provide solutions for a society driving towards a cliff but addicted to driving.

THE FUTURE EATERS

Australian biologist Tim Flannery has called the human species "The Future Eaters". Indeed, paleo-anthropology suggests many historical societies collapsed due to resource depletion even though they must have been aware of it. The example made famous by Jared Diamond is 'what was that Easter Islander thinking that chopped down the last tree'? The best documented recent mass extinctions of flightless birds and other large mammals from New Zealand and Madagascar show that humans were to blame. Though Neandertals and early Homo Sapiens did hunt game without hunting it out, upper Paleolithic hunters were more numerous and better equipped for mass slaughter - 100,000 horses killed at one site, a thousand mammoths at another. Given the millions of years of shaping of our neural circuitry, it is hard to imagine that our mental structure has changed that much in the last few thousand years. Indeed, for those who are not high on the oil subsidy banquet and need food stamps to survive, scientists have shown a 10-15% decline in caloric intake during the month, implying a steep discount rate exists when food is the primary concern.(1)

WHAT THE HECK DOES THIS HAVE TO DO WITH CLIMATE

CHANGE AND PEAK OIL?

If you're still with me, Im impressed, as the above diagrams and verbage are quite disparate. Yet so is our situation. Environmental icon Gus Speth, in "Red Sky at Morning" laments that the single biggest failing of his generation of environmentalists was that they just 'talked'. We have tens of thousands of well intentioned environmentally minded scientists and activists in this country and others. I pose no answers in this post, because I don't have them. But I am certain that a fusion of the brain sciences and evolutionary biology into the environmental and energy discussions will be a large step forward.

Ultimately we are after impact. If we spend 99% of our efforts on educating people on the facts of peak oil, yet nothing happens, it would be better to spend 50% of our efforts on education and 50% by example. For example, researchers attempted to persuade young students not to litter either by teaching them about ecology and pollution or by telling them they were neat and tidy compared to other students -only the latter had a positive effect.(4) E.O Wilson suggests *"A stiffer dose of biological realism is in order..The only way to make a conservation ethic work is to ground it in ultimately selfish reasoning. An essential component of this formula is the principle that people will conserve land and species fiercely if they forsee a material gain for themselves their kin or their tribe."* All of our past environmental successes (DDT, Ozone depletion, unleaded gasoline, etc.) had some sort of smoking gun - an emotional trigger. The problem with climate change/peak oil, is when we do get the emotional trigger, it may be a gatling gun on full bore.

After preparing this (what I thought was novel) post, tonight I found that Larry Karp at Cal-Berkeley has written a paper on the same topic, titled "Global Warming and Hyperbolic Discounting" Here is the abstract:

> ABSTRACT: The use of a constant discount rate to study long-lived environmental problems such as global warming has two disadvantages: the prescribed policy is sensitive to the discount rate, and with moderate discount rates, large future damages have almost no effect on current decisions. Time-consistent quasi-hyperbolic discounting alleviates both of these modeling problems, and is a plausible description of how people think about the future. We analyze the time-consistent Markov Perfect equilibrium in a general model with a stock pollutant. The solution to the linear-quadratic specialization illustrates the role of hyperbolic discounting in a model of global warming.

THE BOTTOM LINE

1. Education about oil depletion and climate change is not enough. We need to incorporate how people react to information. If companies like Daimler Chrysler are using neuromarketing to sell more cars, an equal effort needs to be made on the environmental and energy front.

2. Two of the planets largest problems, climate change and peak oil, are in the future. As such, our evolutionary derived penchant to focus on the present lacks the discipline to think and act ahead. Either accelerating the expected 'bad news' or making the expected bad news 'worse' are both ways to increase the weight we place on these events.

3. We can't easily reduce our discount rates. But having a team of middle aged female monks running the climate change team may not be a bad idea (I'm only half kidding).

4. There are so many scientific disciplines running parallel courses. Somehow we need to integrate them into a logical framework that makes sense and is practical. I don't expect President Bush

will soon appoint a Secretary of Darwinian Ecology but the time is now to combine the sciences.

5. Though it's difficult, we can learn from our mistakes. Those on Easter Island, Rome and the Mayas and Aztecs were neurally not dissimilar from us. To recognize they valued the present even when they could forsee the future (cutting down the last tree) means we have to acknowledge ahead of time that our intelligence will be trumped by our emotion, and plan accordingly.

5b. In writing this post, it dawned on me that much of the work we do in raising peak oil awareness is received by readers as kind of an interesting horror movie. Yes - tell me more scary facts and I will sit at my computer and read them. But its the *rational* brain that is receiving this information. And its not budging behavior much.

5c. Understanding that stress increases peoples discount rates suggests to me that the events surrounding peak oil (and perhaps climate change) will reach an inflection point. We need to hit the emotional triggers well ahead of peak oil. Once people are stressed and things become difficult, accessing peoples rational minds will be all the harder. Plus, greater awareness of resource depletion might trigger *increased* consumption, as people try to get their share.

6. I think steep discount rate is another term for addiction. Humans are addicted to what modern life offers. Some more than others.

P.S. Lets do lunch!...;)

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