

I. Perspectives in Science

Ignoring the Consequences of Climate Change

By John Abraham

John P. Abraham is an American engineering professor at the University of St. Thomas School of Engineering, Minnesota known for his interest in climate science. In this essay, Abraham analyzes the very different viewpoints that Democrats and Republicans have on climate change and his great concern over the lack of action taken in the US to eradicate climate change.

The science of climate change is clear. Scientists know that the Earth is warming and that humans are the reason. We also know that the Earth will continue to warm in the future; however, we can do something about it. We can dramatically change the trajectory.

If the science is so clear, why are there still so many people that don't accept it? Why are there so many people who try to deny the evidence? For various reasons, acceptance of climate science breaks down along ideological lines. First, a majority of people in every state in the US believes, for instance, that the Paris Accord is a good thing, that the USA should participate. It turns out, however, that there is higher acceptance of climate science and acceptance of the importance of action on the coasts (California, Oregon, Washington, New York, etc.).

There are exceptions to this rule but I am generalizing. It also turns out that the more liberal your politics are, the more likely you are to accept the science and the solutions. With respect to politics, the results are stunning. Vast majorities of Democratic and independent voters are supportive. Interestingly, small majorities of even conservative Republicans are supportive.

There are other correlations. For instance, the more religious, particularly conservatively religious someone is, the more likely they are to doubt or deny the science. But again, this is a generalization and it has exceptions. In fact, some religious leaders have become climate-action leaders. Perhaps the best example is Pope Francis. I am not saying that conservatives are not as intelligent as liberals, I am just pointing out that certain political and religious ideologies correspond to viewpoints on science.

The correlations don't end there. A hugely important work on the underlying motivations of people who deny the reality of climate change was performed by Dr. Naomi Oreskes in her book *Merchants of Doubt*. One of her central conclusions is that the denial of human-caused climate change is driven by peoples' distrust of the government and of government solutions to a problem, particularly when the solutions may impinge on personal freedoms.

While there is a clear relation between a scientist's knowledge of climate change and his understanding of the human influence, such a relation is not apparent in the general public. If you look far and wide to find a scientist who claims humans are not a major influence on climate, it is very likely that scientist is not very knowledgeable about the topic, does not work in the area very much, or has a history of faulty research.

Conversely, the scientists who accept the consensus view are more likely to publish more, do more research and just know more. However, if you talk to people on the street, this view breaks down. I see this in my own interactions with people. I often run across general audience members who have a pretty good grasp of the science but they discount the effects, or people who know very little about the science but fully accept it. What is most astonishing to me is where this all leaves us. Donald Trump has announced that America will withdraw from the Paris climate treaty. My view is, it is better for us to leave the agreement so we cannot sabotage it from the inside. But, only time will tell.

But back to where this leaves us. We have a situation in the USA and around the world where certain countries and certain political groups have inextricably aligned themselves with one or another side of this issue. For instance, in the USA, denial of human-caused climate change has become a litmus test for Republican candidates. The same is true in other countries. This is a real tragedy because Republicans don't want to pollute the planet. They don't want to screw things up for our future generations. But, their wholesale denial of the reality of climate change is doing just that.

From a political standpoint, if we think about the silly things President Trump is doing and how it will affect the world, the one thing he may be most remembered for is his climate inaction. Climate change will have very long-lasting consequences that we will be dealing with long after he is gone. Long after other issues like immigration, the economy, debt, jobs, terrorism, or new words like "covfefe" have passed from our minds, the implications of our climate effect will linger. Frankly, no challenge we are facing (except perhaps a potential nuclear war) presents the consequences that climate change does.

And this, sadly, will be the legacy of conservatives in my country. As we wake up to more severe weather, more droughts, heat waves, rising seas, severe storms, the world will remember that these issues could have been solved long ago but for an ideology and tribalism. It will be the job of scientists, historians, and the media to continually remind people of this. Climate change could have been solved. Those who will be blamed will certainly claim "But I didn't cause this climate change. You cannot blame this on me!" But we can and we have to. People need to be accountable for their actions. If you are someone who has stood in the path of climate action, you own the results.

And that is the sad part, because as I mentioned earlier, this means a significant part of the population will be tarred with the legacy of climate change. And that population does not, as a rule, want the climate to change. No one wants sea levels to rise or droughts to increase. But this observation does not change the fact that without the obstruction of climate action, we would be in a very different place. Another sad result is that my country has become a pariah – we have gone from leader to obstructionist on climate change. This saddens me.

What is ironic is that many of the people who deny human-caused climate change are the same people who live and breathe so-called "patriotism." But this patriotism has become a "my country right or wrong" parochial slogan that is anything but patriotic. To call your country what it is, to be honest about our strengths and our shortcomings, to work to make your country better, to never settle for the status quo – that is patriotic. And as a patriot, I am deeply saddened by my country's lack of leadership on this important issue. And as a patriot, I will hope for and work for change.

Discussion Starters

1. What are the reasons presented in the essay, along with your own ideas, about why Democrats in general believe in climate change and seek to eradicate it and Republicans don't believe in climate change?
2. In the essay, Abraham accepts man-made climate change as a given. Do you agree with him? Why?
3. What negative legacy does Abraham believe that Republicans and Donald Trump will be left with? Do you agree with him?
4. What is your own opinion on climate change, its consequences, and the danger it poses to our planet?

The Intelligence of Beasts

By Colin Woodard

Colin Woodard is an award-winning author and journalist who writes for The Washington Monthly, The Christian Science Monitor, and The Chronicle of Higher Education. In this essay, Woodard explores the intelligence of non-primates whose capabilities have often been both ignored and underestimated.

If you've ever doubted that elephants are contemplative, Joshua M. Plotnik has some video you should watch. Plotnik, a postdoctoral fellow in experimental psychology at the University of Cambridge, wanted to see if Asian elephants could pass a classic cooperation test designed for chimpanzees. The elephants already knew how to use a rope to pull a food-bearing table within reach. But what if the only way to move the table was two elephants pulling on separate ropes simultaneously?

On one video, one elephant ambles up to the rope and waits patiently, trunk and tail gently swinging, for its counterpart to arrive, half a minute later. Then, without hesitation, they grasp their respective ropes in synchronicity, pulling the food to themselves. In another segment, a young female simply stands on her rope, which—the way the mechanism is set up—forces her colleague to do all the work for the both of them. In 60 trials, all six pairs of elephants waited for their partners, with an average success rate of over 93 percent, suggesting that they easily understood cooperation.

“We were very excited by the results,” Plotnik says into his cellphone as he walks home, after midnight, through the streets of Chiang Mai, Thailand, not far from his research sites. “Their behavior was comparable to that of the chimpanzees. We’re getting further into understanding how intelligent they are.”

For much of the last century, research on animal cognition focused almost exclusively on primates, on account of their relatively close evolutionary kinship with humans. But in recent years, many researchers wishing to understand how higher intelligence evolved have taken a different approach, looking to apparently intelligent species that are only distantly related to ourselves, like elephants, dolphins, or ravens. In the process, many cognitive traits once thought to be exclusive to humans—including some that are considered definitive of human uniqueness—have been found in far-flung provinces of the animal kingdom.

“In understanding evolution, human cognition is like the elephant’s trunk: It’s a very unusual thing, and it really stands out,” says Evan L. MacLean, a doctoral student in evolutionary anthropology at Duke University, which is coordinating a collaborative project to compare 30 species, as varied as dogs and octopuses. “The best source of evidence we have are the closest relatives—chimps and bonobos—but we’ve been missing a ton of very interesting variation by just looking at primates.”

Nine-week-old puppies have been shown to be very good at recognizing human gestures and interpreting them for their own benefit, while adult dogs provide and request information, predict social events, and perhaps even speculate on what their masters are thinking—for example, finding

hidden food by picking up on subtle human cues. Dolphins recognize themselves in mirrors, while the New Caledonian crow fashions tools with which to capture grubs. The common raven has demonstrated the ability to test actions in its mind, solving complicated puzzles to obtain food on the first try.

“There used to be this chimpancentrism in the field, with research narrowly concentrated on primates,” says Ádám Miklósi, a professor of ethology at Budapest’s Eötvös Loránd University and an expert on canine cognition. “It’s really great to see research in other species expand exponentially, because we really need the breadth and depth of species to be able to say anything meaningful about animal cognition.”

While there are many reasons to study the thinking ability of animals—devising better conservation strategies, opening new pathways in artificial intelligence—the great evolutionary question driving many researchers is this: Under what evolutionary pressures do different types of cognitive abilities tend to develop? If several entirely unrelated species turn out to have a given intellectual ability—mirror recognition in humans, dolphins, and elephants, for instance—are there common denominators in the conditions they confront (membership in complex social groups, for example) that might explain the development? Can the study of such examples of convergent evolution help us understand how and why higher intelligence arises in nature? Researchers have taken only the first steps toward finding definitive answers to both of those questions.

Elephants are fascinating subjects in this regard. They have enormous brains, bigger than those of humans. Like many other animals thought to possess unusual intelligence, they live in complex societies in which individuals cooperate and interact to solve problems. They’re also unrelated to humans. Whereas we and chimpanzees had a common ancestor about five million years ago, with elephants (and their relations, the aardvark and manatee), it was 100 million years ago, a relationship even more distant than the ones we have with dolphins and whales.

“If you find an elephant and a human sharing an ability that most other primates don’t have, you can be pretty sure it’s an example of convergent evolution at work,” says Richard W. Byrne, a professor of psychology at the University of St. Andrews, in Scotland, who has studied cognition in both primates and elephants. “If you can see shared circumstances in which these animals use this ability, that can help show what its biological function is.”

Researchers like Byrne are finding that elephants have all sorts of intriguing cognitive abilities comparable to—and sometimes exceeding—our own. They recognize their reflections in mirrors. They act empathically toward fellow elephants in distress and offer them assistance. They mourn and even bury their dead. As Plotnik has shown, they’re not flummoxed by cooperative problem solving. And both Asian and African elephants make tools for a variety of purposes, from flyswatters to backscratchers.

Byrne’s fieldwork has taken place in Kenya’s Amboseli National Park, site of a long-term, multidisciplinary study of elephants, in its 39th year. (That research is described in an edited collection, *The Amboseli Elephants: A Long-Term Perspective on a Long-Lived Mammal*, published this spring by the University of Chicago Press.) In recent years, Byrne and his colleagues have conducted field experiments that show two additional mental abilities not seen in any other animal.

In one experiment, elephants were presented garments worn by two different human ethnic groups: the Masai (who sometimes spear elephants) and the Kamba (an agrarian people who rarely

interact with elephants). Whether given access to smells of previously worn clothing or to visual inspection of unworn clothing, the elephants responded with greater fear or aggression toward the Masai clothing. This led Byrne and his colleagues to conclude that elephants are able to categorize another species, humans, into subclasses. “We don’t know any other animals that categorize dangers in this way, but that may be because they haven’t been tested,” he says.

In the second experiment, the researchers wanted to test if elephants understand “person permanence” and “invisible displacement”—that is, if they are aware that absent individuals exist and if they contemplate the movements and activities of those individuals in absentia, an ability that human beings develop in infancy. Knowing that the members of the extended elephant family they were working with sniffed one another’s urine deposits, the researchers began moving the deposits around. “The nice thing was to see their surprised reaction when they encountered a sample from an individual who was actually a half-kilometer or more behind them, a much greater reaction than if the sample was from someone who was actually ahead of them,” Byrne explains.

The results suggested that each elephant was keeping track of the location and expected movements of everyone else in its foraging group—17 individuals, in this case—a remarkable display of working-memory capacity.

“They don’t use their eyes in the bright Amboseli sun, but they’re still able to keep track of 17 individuals in an environment that they cannot scan,” Byrne notes. “Think of a parent with 17 kids roaming around a department store; I think we would find it extremely challenging to keep track in our minds of where everyone is. This is an ability that appears to be rather more than humans can do.”

Miklósi, who is using cognition work with dogs to program robots that will, doglike, anticipate, serve, and respond to human needs, suspects that scientists will discover many more instances in which animals are found to have mental powers that humans lack. “So far, no matter how much you read in the literature, there is this notion that humans are always the best at everything,” he says. “If the tests were not so anthropocentric, we would probably lose a lot more often.”

Some other researchers agree that animal-cognition research will inevitably challenge human presumptuousness. “From ancient times, it’s always been us versus the rest of the animal world, and it wasn’t really considered that animals were thinking creatures,” says Diana Reiss, a professor of cognitive psychology at Hunter College of the City University of New York, who studies elephants and dolphins. “The big message is that we’re not the pinnacle of the tree, the only creatures who are thinking complexly. We share the upper branches of the tree with many species, each so beautifully evolved for their own environmental niche and social structures.”

But other scientists take a more skeptical view. They include David Premack, a professor emeritus of psychology at the University of Pennsylvania and the father of the influential “theory of mind,” which refers to the ability to infer the mental states of others. “I have a prejudice that’s not common among people who study animals, who tend to do so primarily to show similarities between the animal and the human,” he explains. “That’s a noble cause, but I feel it’s easily abused, as when they leap from similarity to equivalence.”

Humans and certain animals might similarly recognize that a large rock is more likely to break a branch than a small one, but Premack says there’s no evidence that this understanding of a

physical action is equivalent to causal reasoning. That is, if an animal comes across a large rock lying beside a crushed plant, it won't infer, as a human might, that the rock crushed the plant, he argues.

Microscopic study of the human brain, he notes, has revealed neural structures and forms of connectivity not found in any other animal. And cognitive research has not been able to keep pace with those developments. "Things that the naked eye can see—that the human is a very different entity than the nonhuman—is very much corroborated under the microscope," he says. "If you can't see we're special, you have to be permanently drunk."

Byrne agrees that it would be foolish to jump from similarity to equivalence, but he says comparative-cognition researchers are by no means trying to show that animals are "little humans in disguise." "None of the interpretations we make of our experiments require one to treat superficial resemblance as deep equivalence," he says.

As for his own research interests, Byrne would like to explore what creatures in other, unstudied corners of the animal kingdom might be thinking. Most species thought to be especially intelligent are social creatures, but what about large-brained nonsocial species? "I don't know anybody who's looking at bears. They have very large brains—I wonder why," he says. "If someone offered me a long-term study of grizzlies, I'd take it."

Discussion Starters

1. Why has the study of intelligence in animals other than primates been lacking historically? How do recent findings change our thinking about the intelligence of some non-primates?
2. How might the treatment of animals change given our understanding of their intelligence? What current practices regarding animal captivity should be examined?
3. What does the intelligence found in completely unrelated species – e.g. elephants, birds, dogs – infer about animal intelligence? What does it infer about evolution across the species?

The Amazing Teen Brain

By Nancy Shute

Nancy Shute is a senior writer at U.S. News and World Report. In this essay, Shute explores the effects of the still-developing brain on teen behavior and the potential risks and rewards that accompany it.

Behold the American teenager, a lump in a hoodie who's capable of little more than playing "Grand Theft Auto," raiding the liquor cabinet, and denting the minivan, thanks to a brain so unformed that it's more like a kindergartner's than a grown-up's. That's the message that seemed to emerge from the past decade's neuroscientific discoveries: that the brain, once thought to be virtually complete by age 6, is very much a work in progress during adolescence and *not* to be trusted. But experts now are realizing that the popular parental response—to coddle teens in an attempt to shield them from every harm—actually may be counterproductive.

Yes, teenagers make woefully errant decisions that factor big in the 13,000 adolescent deaths each year. And yes, their unfinished brains appear to be uniquely vulnerable to substance abuse and addiction. But they also are capable of feats of learning and daring marvelous enough to make a grown-up weep with jealousy. How they exercise these capabilities, it now appears, helps shape the brain wiring they'll have as adults. "You have this power you're given," says Wilkie Wilson, co-director of DukeLEARN, a new program at Duke University designed to teach teenagers how to best deploy their brains. Far from coddling the kids, he says, Mom and Dad need to figure out how to allow enough "good" risk-taking to promote growth and prevent wasted talent—while also avoiding disaster.

It can be a nerve-racking exercise. "These kids are such a crazy mix of impulsiveness and shrewdness," says Marcia Harrington, a survey researcher in Silver Spring, Md. She recalls the time she thought her then 16-year-old daughter, Alexandra Plante, had sleepover plans, but the girl instead ditched school and flew to Chicago to visit an acquaintance she'd met briefly during a family trip. The scheme was revealed only because bad weather delayed the flight home. Alex returned unharmed and has never conceded that the escapade was too risky. "She's going to be a great adult someday," says Harrington. "But, boy, there are moments that are terrifying." Further along the road to adulthood now, Alex has applied her daring spirit to becoming an emergency medical technician and volunteer for the local fire department, and to heading off to college 2,500 miles from home.

While society has known since forever that adolescents can be impulsive risk-takers, it wasn't until the 1990s, when MRI scans became a common research tool, that scientists could peek into the teenage cranium and begin to sort out why. What they found astonished them. The brain's gray matter, which forms the bulk of its structure and processing capacity, grows gradually throughout childhood, peaks around age 12, and then furiously "prunes" underused neurons.

By scanning hundreds of children as they've grown up, neuroscientists at the National Institute of Mental Health have been able to show that the pruning starts at the back of the brain and moves

forward during adolescence. Regions that control sensory and motor skills mature first, becoming more specialized and efficient. The prefrontal cortex, responsible for judgment and impulse control, matures last. Indeed, the prefrontal cortex isn't "done" until the early 20s—and sometimes even later in men. Meantime, the brain's white matter, which acts as the cabling connecting brain parts, becomes thicker and better able to transmit signals quickly. Recent research shows that this myelination process of white matter continues well past adolescence, perhaps even into middle age.

Now, dozens of researchers are studying how all these changes might affect adolescent behavior, and also shape adult skills and behavior, for good and for ill. The maturation lag between emotional and cognitive brain centers may help explain why teenagers get so easily upset when parents see no reason, for example; teens seem to process input differently than do adults.

In one experiment, young teenagers trying to read the emotions on people's faces used parts of the brain designed to quickly recognize fear and alarm; adults used the more rational prefrontal cortex. Deborah Yurgelun-Todd, the researcher at McLean Hospital in Belmont, Mass., who led this work, believes young teens are prone to read emotion into their interactions and miss content. Therefore, parents may have better luck communicating with middle-schoolers if they avoid raising their voice (easier said than done) and instead explain how they're feeling.

Other experiments shed light on why even book-smart teenagers come up short on judgment: Their brain parts aren't talking to each other. When Monique Ernst, a child psychiatrist and neurophysiologist at NIMH, uses functional MRI to watch teenage and adult brains engaged in playing a gambling game, she finds that the "reward" center lights up more in teens than in adults when players are winning, and the "avoidance" region is less activated in teens when they're losing. There's also less activity in teens' prefrontal cortex, which adults use to mediate the "yes!" and "no" impulses from other brain regions. "The hypothesis is that there is this triumvirate of brain regions that needs to be in balance" in order to produce wise judgments, says Ernst, whether that's to wear a seat belt or use contraception.

Does an unfinished brain make for bad behavior? There is as yet no proven link between bright blobs on an MRI and real-life behavior, but researchers are hard at work trying to make that connection. In a 2005 study by Laurence Steinberg, a developmental psychologist at Temple University, teenagers in a simulated driving test were twice as likely to drive dangerously if they had two friends with them—and brain scans showed that the reward centers lit up more if teens were told that friends were watching. A savvy parent might conclude that what's needed in the teen years is more guidance, not less.

In fact, study after study has shown that one of the most powerful factors in preventing teenage pregnancy, crime, drug and alcohol abuse, and other seriously bad outcomes is remarkably simple: time with responsible adults. "It doesn't have to be parents, necessarily," says Valerie Reyna, a professor of psychology at Cornell University. But it does mean that teenagers should be directly monitored by responsible adults so they have less time to get in trouble. Reyna thinks adults also need to teach what she calls "gist" thinking, or the ability to quickly grasp the bottom line. Instead, she says, teenagers often overthink but miss the mark. When Reyna asks adults if they'd play Russian roulette for \$1 million, they almost universally say no. Half of teenagers say yes. "They'll tell you with a straight face that there's a whole lot of money, and they're probably not going to die. It's very logical on one level, but on another level, it's completely insane."

If it's any comfort, the evidence suggests that teenagers' loopy behavior and combativeness is hard-wired to push them out of the nest. Adolescent primates, rodents, and birds also hang out with their peers and fight with their parents, notes B. J. Casey, a teen brain researcher who directs the Sackler Institute at Weill Medical College of Cornell University in New York City. "You need to take risks to leave your family and village and find a mate."

The revved-up adolescent brain is also built to learn, the new research shows—and those teen experiences are crucial. Neurons, like muscles, operate on a "use it or lose it" basis; a teenager who studies piano three hours a day will end up with different brain wiring than someone who spends that same time shooting hoops or playing video games. A 16-year-old who learns to treat his girlfriend with care and compassion may well develop different emotional brain triggers than one who's thinking just about the sex.

Only in early childhood, it turns out, are people as receptive to new information as they are in adolescence. The human brain is designed to pay attention to things that are new and different, a process called salience. Add in the fact that emotion and passion also heighten attention and tamp down fear, and teenagerhood turns out to be the perfect time to master new challenges. "You are the owners of a very special stage of your brain development," Frances Jensen, a neurologist at Children's Hospital Boston, tells teenagers in her "Teen Brain 101" lectures at local high schools. "You can do things now that will set you up later in life with an enhanced skill set. Don't waste this opportunity." (She was motivated to create the talks by her own befuddling experiences as a single mother of two teenage boys.)

Jordan Dickey is one teen who seized opportunity. As a 14-year-old high-school freshman, he asked his father for something unusual: a \$26,000 loan to start a business. The Dickey family, of Ramer, Tenn., raised a few cattle, and Jordan had noticed that people paid a lot more for hay in square bales than for the same amount in less-convenient round bales. After doing a feasibility study as an agriculture class project, Jordan convinced his dad to give him a three-year loan to buy a rebaling machine. He worked nights and weekends, mowing, raking, and rebaling; paid friends \$7 an hour to load the bales into a trailer; and hired drivers to deliver the hay to local feed marts, since he was too young to drive. "It taught me how to manage my own money," Jordan says.

That's an understatement. Not only did he pay off the loan in one year, he made an additional \$40,000. Now 17 and a senior, he has saved enough money to pay for a big chunk of college, much to his parents' delight. "He likes for the job to get done and get done right," says Perry Dickey, who owns an electroplating shop. "It was a big responsibility for him, and I'm glad he took the lines and produced."

Teens can apply the new findings to learn more without more study, notes Wilson, whose DukeLEARN program will be tested in ninth-grade health classes next year. Key points:

- Brains need plenty of sleep because they consolidate memory during slumber.
- The brain's an energy hog and needs a consistent diet of healthful food to function well.
- Drugs and alcohol harm short- and long-term memory.

Teens' predisposition to learn plays a critical role in the vexing issue of teenage drinking, smoking, and drug use. Neuroscientists have learned that addiction uses the same molecular

pathways that are used in learning, most notably those involving the neurotransmitter dopamine. Repeated substance use permanently reshapes those pathways, researchers say. In fact, they now look at addiction as a form of learning: Adolescent rats are far more likely to become hooked than adults.

And epidemiological studies in humans suggest that the earlier someone starts using, the more likely he or she is to end up with big problems. Last month, a study tracking more than 1,000 people in New Zealand from age 3 to age 32 found that those who started drinking or using drugs regularly before age 15 were far more likely to fail in school, be convicted of a crime, or have substance abuse problems as an adult. “You can really screw up your brain at this point,” says Jensen. “You’re more vulnerable than you think.”

When can the brain handle a beer? The new brain science has been used as a weapon by both sides of the drinking-age debate, though there is no definitive evidence for a “safe” age. “To say that 21 is based on the science of brain development is simply untrue,” says John McCardell, president of Choose Responsibility, which advocates lowering the drinking age to 18. But there’s also no scientific basis for choosing 18. The bottom line for now, most experts agree: Later is better.

Jay Giedd, an NIMH neuroscientist who pioneered the early MRI research on teen brains, is fond of saying that “what’s important is the journey.” Researchers caution that they can’t prove links between brain parts and behavior, or that tackling adult-size challenges will turn teenagers into better adults. But common sense suggests that Nature had a reason to give adolescents strong bodies, impulsive natures, and curious, flexible minds. “Our generation is ready for more,” insists Alex Harris, 20, of Gresham, Ore., who, with his twin brother, Brett, writes a blog and has published a book urging teens to push themselves. Its title: “Do Hard Things.”

Discussion Starters

1. How does the adolescent brain differ from the adult brain, and what, according to the essay, are the consequences?
2. What contradictory advice does the essay give parents on dealing with their teenagers? What kind of “balance” do you think makes the most sense between protecting adolescents from harm and allowing them to take risks?
3. What influence does teen behavior, according to the essay, have on adulthood? How do you view your own experiences and behavior, past or current, in the context of the essay?

How Can We Live on Mars?

by Matt Williams

Matt Williams is the Curator of Universe Today's Guide to Space and a free-lance writer. In this essay, Williams evaluates the pros and cons of creating a human colony on Mars and how we might overcome the significant obstacles in the way.

Why live on Earth when you can live on Mars? Well, strictly speaking, you can't. Mars is a completely hostile environment to human life, combining extreme cold with an unbreathable atmosphere and intense radiation. And while it is understood that the planet once had an atmosphere and lots of water, that was billions of years ago.

And yet, if we want to expand into the Solar System, we'll need to learn how to live on other planets. And Mars is prime real-estate compared to a lot of other bodies. So despite it being a challenge, given the right methods and technology, it is possible we could one day live on Mars. Here's how we'll do it.

Reasons to Go

Let's face it, humanity wants (and needs) to go Mars, and for several reasons. For one, there's the spirit of exploration, setting foot on a new world and exploring the next great frontier – like the Apollo astronauts did in the late 60s and early 70s. We also need to go there if we want to create a backup location for humanity in the event that life on Earth becomes untenable due to things like climate change. We could also go there to search for additional resources like water, precious metals, or additional croplands in case we can no longer feed ourselves.

In that respect, Mars is the next natural destination. There's also a little local support, as Mars does provide us some raw materials. The regolith, the material which covers the surface, could be used to make concrete, and there are cave systems which could be converted into underground habitats to protect citizens from the radiation.

Elon Musk has stated that the goal of SpaceX is to help humans get to Mars, and they're designing rockets, landers and equipment to support that. Musk would like to build a Mars colony with about 1 million people, which is a good choice, as it's probably the second most habitable place in our Solar System. Real estate should be pretty cheap, but the commute is a bit much.

And then there's the great vistas to think about. Mars is beautiful, after a fashion. It looks like a nice desert planet with winds, clouds, and ancient river beds. But maybe, just maybe, the best reason to go there is because it's hard! There's something to be said about setting a goal and achieving it, especially when it requires so much hard work and sacrifice.

Reasons NOT To Go

Yeah, Mars is pretty great... if you're not made of meat and don't need to breathe oxygen. Otherwise, it's incredibly hostile. It's not much more habitable than the cold vacuum of space. First,

there's no air on Mars, so if you were dropped on the surface, the view would be spectacular. Then you'd quickly pass out and expire a couple minutes later from a lack of oxygen.

There's also virtually no air pressure, and temperatures are incredibly cold. And of course, there's the constant radiation streaming from space. You also might want to note that the soil is toxic, so using it for planting would first require that it be put through a decontamination process.

Assuming we can deal with those issues, there's also the major problem of having limited access to spare parts and medical supplies. You can't just go down to the store when you're on Mars if your kidney gives out or if your sonic screwdriver breaks. There will need to be a constant stream of supplies coming from Earth until the Martian economy is built up enough to support itself. And shipping from Earth will be very expensive, which will mean long periods between supply drops.

One more big unknown is what the low gravity will do to the human body over months and years. At 40% of Earth normal, the long-term effects of lower gravity are not something we currently have any information on. Will it shorten our lifespan or lengthen it? We just don't know. There's a long list of these types of problems. If we intend to live on Mars, and stay there permanently, we'll be leaning pretty hard on our technology to keep us alive, never mind making us comfortable.

Possible Solutions

In order to survive the lack of air pressure and the cold, humans will need pressurized and heated habitats. Martians, the terrestrial kind, will also need a spacesuit whenever they go outside. Every hour they spend outside will add to their radiation exposure, not to mention all the complications that exposure to radiation brings.

For the long term, we'll need to figure out how to extract water from underground supplies and use that to generate breathable air and rocket fuel. And once we've reduced the risk of suffocation or dying of dehydration, we'll need to consider food sources, as we'll be outside the delivery area of everyone except Planet Express. Care packages could be shipped up from Earth, but that's going to come with a hefty price tag.

We'll need to produce our own food too since we can't possibly hope to ship it all in on a regular basis. Interestingly, although toxic, Martian soil can be used to grow plants once you supplement it and remove some of the harsher chemicals. NASA's extensive experience in hydroponics will help.

To thrive on Mars, the brave adventurers may want to change themselves or possibly their offspring. This could lead to genetic engineering to help future generations adapt to the low gravity, higher radiation and lower air pressure. And why stop at humans? Human colonists could also adapt their plants and animals to live there as well.

Finally, to take things to the next level, humanity could make a few planetary renovations. Basically, we could change Mars itself through the process of terraforming. To do this, we'll need to release megatons of greenhouse gasses to warm the planet, unleashing the frozen water reserves. Perhaps we'll crash a few hundred comets into the planet to deliver water and other chemicals too. This might take thousands or even millions of years, and the price tag will be, for lack of a better word, astronomical. Still, the technology required to do all this is within our current means, and the process could restore Mars to a place where we could live on it even without a spacesuit.

Even though we may not have all the particulars worked out just yet, there is something to be said about a challenge. As history has shown, there is little better than a seemingly insurmountable challenge to bring out the best in all of us, and to make what seems like an impossible dream a reality.

To quote the late, great John F. Kennedy, who addressed the people of the United States back when they was embarking on a similarly difficult mission:

We choose to go to the Moon!...We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard; because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one we intend to win.

Discussion Starters

1. Evaluate the pros and cons of creating a human colony on Mars presented in the essay and decide whether it is a worthwhile endeavor.
2. Evaluate the solutions presented in the essay for overcoming the considerable obstacles to humans living on Mars. How realistic is each solution?
3. What did you learn from the essay about the conditions on Mars that currently make it uninhabitable for any life forms?
4. Would you punch your one-way ticket to Mars to be one of the pioneers of Mars' colonization? Why or why not?

To Teach Evolution, Understand the Creationists

By Adam Laats

*Adam Laats is a Professor in the School of Education at Binghamton University and author of *Fundamentalism and Education: God, Darwin, and the Roots of America's Culture Wars*. In this essay, Laats argues that scientists are not helping to promote the understanding and acceptance of evolution by belittling the beliefs of creationists.*

If you follow the news about culture wars, evolution, and creationism, you've probably seen it by now. Earlier this fall, U.S. Rep. Paul C. Broun Jr., Republican of Georgia who ran unopposed for re-election, said in a widely distributed video that evolution, embryology, and the Big Bang theory were "lies straight from the pit of hell."

I don't agree. But the ferocious response to Broun's remarks tells us more about the widespread ignorance among evolution supporters than it does about ignorance among creationists. Broun, who serves on the House of Representatives' Science, Space, and Technology Committee, has long been one of the most staunchly conservative members of Congress. His comments have earned him widespread condemnation; Bill Nye, television's "The Science Guy," has called Broun "by any measure, unqualified to make decisions about science, space, and technology." In the blogosphere, comment has been even less restrained.

I disagree with Broun's views on evolution—and on a host of other topics, for that matter. But if we hope to understand creationism, we need to abandon the trope that only the ignorant can oppose mainstream evolutionary science. It is a comfortable delusion, a head-in-the-sand approach to improving evolution education in the United States. In the end, it stems from a shocking ignorance among evolutionists about the nature of creationist beliefs.

First of all, Broun is no ignoramus. He holds a bachelor's degree in chemistry and an M.D. He is the most recent in a long line of educated creationists. In the 1920s, William Jennings Bryan similarly defended his role as a man of science. In response to Clarence Darrow's accusation that only "bigots and ignoramuses" opposed evolution education, Bryan listed his many college degrees. As U.S. secretary of state, Bryan noted, he had met with "kings, emperors, and prominent public men." Throughout his career, Bryan complained he had never been called "an ignoramus...by anyone except an evolutionist."

Bryan's defense in 1925 could be revived by Broun today: "Christianity has nothing to fear from any *truth*; no *fact* disturbs the Christian religion or the Christian. It is the unsupported guess that is substituted for science to which opposition is made." Like Broun, Bryan insisted on his scientific credentials. Until his untimely death, in 1925, Bryan remained a member of the staunchly pro-evolution American Association for the Advancement of Science.

The notion that only the ignorant can oppose evolution does not hold water. As the political scientists Michael Berkman and Eric Plutzer demonstrate in *Evolution, Creationism, and the Battle to Control America's Classrooms* (Cambridge University Press, 2010), a slim majority of Americans are aware that mainstream scientific opinion supports evolution. Yet even among those 52 percent

of Americans who know that scientists support evolution, large majorities still want schools to teach creationism. And, among those teachers who teach young-earth creationism, a majority—like Broun—hold a bachelor’s degree or higher in science and almost half have completed 40 or more college credits in biology.

As it stands, scientists’ blundering hostility toward creationism actually encourages creationist belief. By offering a stark division between religious faith and scientific belief, evolutionary scientists have pushed creationists away from embracing evolutionary ideas. And, by assuming that only ignorance could explain creationist beliefs, scientists have unwittingly fostered bitter resentment among the creationists, the very people with whom they should be hoping to connect. Nor can we take solace in the delusion that these teachers are somehow rogue agents of a vast right-wing creationist conspiracy. As Berkman and Plutzer demonstrate, the creationist beliefs of teachers embody the creationist beliefs of Americans in general. The teachers are not ignorant of evolution, yet they choose to reject it.

More-focused studies support those findings. David Long, an anthropologist and science educator now at George Mason University, conducted an in-depth ethnographic study of creationists in college, reported in his *Evolution and Religion in American Education* (Springer, 2011). Among his batch of creationist biology majors, only one abandoned her creationist beliefs. Most striking, this woman was not convinced by the scientific evidence in her biology classes; rather, her home life in high school, including an out-of-wedlock pregnancy, had turned her away from her conservative Protestant upbringing. Of the biology majors Long studied, none was convinced of the truth of evolutionary science by scientific coursework alone.

This commitment to creationism by those who know the facts of evolutionary science makes no sense to mainstream scientists, many of whom have always been utterly flummoxed by the durability of creationism. And a snarky insistence that Broun does not have the qualifications to serve on the House science committee blunders into an uncomfortable truth: Broun’s views may fairly represent those of his constituents. Do we really want to demand that an elected official not fight for the ideas in which his constituents believe?

If we hope to spread the science of evolution, it does not help to charge forward in blissful ignorance about the nature and meanings of creationism. Broun may be wrong about evolution, embryology, and the Big Bang. But his scientific errors do not instantly disqualify him as a representative of the American people. Nor can they be explained away as a product of ignorance.

Rather, those of us who care about promoting evolution education must admit the hard truth. It is not simply that creationists such as Broun have not heard the facts about evolution. Broun—along with other informed, educated creationists—simply rejects those facts. Evolution educators do not simply need to spread the word about evolution. We need to convince and convert Americans who sincerely hold differing understandings about the nature and meaning of science.

Discussion Starters

1. Why does Laats believe that dismissing those who believe in creationism as “ignorant” does nothing to further widespread public acceptance of evolution? Do you agree with him?

2. Why do you think that the well-educated people Laats refers to embrace creationism over evolution? Why do you think that a majority of Americans want creationism taught in schools?
3. How does Laats feel that an understanding and acceptance of evolution can best be promulgated by the scientific community? Do you agree with him? What is your viewpoint on evolution and creationism?

Dr. Hans Holzer: Explaining the Unexplained

By Jeff Belanger

Jeff Belanger is one of the leading authors and experts on the paranormal. In this essay, Belanger interviews paranormal guru Dr. Hans Holzer, who makes the case that the study of the paranormal is a legitimate scientific endeavor.

This past January, Dr. Hans Holzer turned 85 years old. He laughs when you mention retirement. “I retire every day,” he says with the hint of an Austrian accent. “Every night at midnight.” After penning 138 books as well as several plays, musicals, films, and documentaries and hosting a television show, the only thing that slows him down today is a mishap from an operation on his leg three years ago. What does it slow him down from? “Swing dancing,” he said. I laughed. Then I realized he wasn’t kidding. “Not just swing dancing, *any* kind of dancing!”

Supernaturally speaking, Dr. Holzer has seen and heard it all. He’s worked with psychic legends like Sybil Leek, he’s investigated some of the most prominent haunted locations around the world, and he’s come as close as a living person can to touching the “other side of life” – a term he’s quick to point out that he invented. I spoke to Dr. Holzer about his life and work from his office in New York City. “I have no secrets,” he said. “I mean, I have secrets, but I don’t make them secret. If anybody wants to hear them, they can hear them.” I wanted to hear them.

Born January 26, 1920 in Vienna, Austria, Holzer embraced the supernatural from a young age. He had an uncle Henry who used to tell him about fairies. Uncle Henry had many interests in the field of the paranormal, and he certainly left an impression on young Hans. “I was in kindergarten,” Holzer said. “I was four years old – I see this as vividly today as when it happened – I see myself seated in a little yellow chair with all of the other kids around, and I was in the middle, pretending to read from an expired streetcar pass of my father’s. I couldn’t read at four, but I pretended. And I was ‘reading’ them ghost stories. Obviously fictional ghost stories, but the kids loved it. The only trouble was that they told their parents at home. The next thing that happened was the mothers came in and said, ‘What kind of a kindergarten are we running here?’ And so my mother was brought in, and the teacher said, ‘Look, either he goes or I go.’ At that point, I stopped telling ghost stories.”

In 1938, 18-year-old Holzer saw a very big war coming to his region. He figured being that close to Nazi Germany while a World War was brewing wasn’t healthy, so he and his brother came to New York. He’s lived in New York City ever since.

“What was your first paranormal experience?” I asked.

“It’s not a question of whether I had experiences,” he said. “My interest has nothing to do with personal experiences. In other words, you don’t have to be an investigator to experience things firsthand.”

For Holzer, each case must withstand journalistic integrity, and journalism is just one of the many subjects he studied during his academic career. “I took ancient history and archaeology at the University of Vienna,” he said. “Then I spent another three-and-a-half years at Columbia

University where I studied Japanese. In addition, I was a graduate of the Academy of Journalism in Vienna, which was a total waste of time. But I took it—it sounded nice. At the end, I studied at the London College of Applied Science which awarded me a master's in comparative religion, and then a year later a Ph.D. with a specialty in parapsychology.” By the time his schooling was finished, his reputation was sealed as an investigator of the paranormal.

“I’ve read you don’t like the term ‘supernatural,’” I said.

“I use the term because it is the one that people use,” Holzer said. “But nothing in my scientific view does not have an explanation. The question is, sooner we get it or later we get it, but there has to be an explanation. You can’t say nobody knows. I don’t accept that. And the paranormal is part of our experience – we just don’t always understand it as such.”

Eventually, we did get to speak about some of Holzer’s personal experiences. And while some people in this field of study have had personal experiences and believe that in itself makes them expert on knowing if a location is haunted, Holzer wants witnesses – several of them preferably, and the not-crazy kind. “That’s why I want to know my witness,” he said. “I ask them, ‘Who are you? What do you do for a living?’ I interview the witnesses. If there is a crazy in front of me, I’ll know it.”

“My first visual experience was when I lived in New York City with my father in a penthouse apartment on Riverside Drive. I was asleep in bed, and I woke up and there was my mother dressed in a white nightgown, pushing my head back onto the pillow. My head had slipped off the pillow. At that time I was subject to migraines. Had I not had my head back on the pillow, I probably would’ve had one, and there would’ve been dizziness and I would’ve been out of business for a day. I said, ‘Oh, hello, Mama.’ And she disappeared.”

We talked about the difference between a ghost or a spirit – how a ghost is a residual entity, like a psychic imprint left in an area that some people can pick up, whereas a spirit is intelligent and interactive. Holzer also mentioned a third category I hadn’t heard about before: the “stay behinds.”

“Stay behinds are relatively common,” he said. “Somebody dies, and then they’re really surprised that all of a sudden they’re not dead. They’re alive like they were. They don’t understand it because they weren’t prepared for it. So they go back to what they knew most – their chair, their room, and they just sit there. Next, they want to let people know that they’re still ‘alive.’ So they’ll do little things like moving things, appear to relatives, pushing objects, poltergeist phenomena, and so on.”

I asked him what we can expect to find waiting for us on the other side. His reply came without hesitation, and very matter-of-fact. “We all pass out of the physical body and we are now on the other side of life. It’s a world just like this one – it has only two differences: there’s no sense of time, and if you’re ill when you die you’re now no longer ill. But other than that, you’ll find houses, trees, gardens, and your relatives, friends, and so on. It looks like a very real world. Maybe a little nicer, but still a normal, real world. And you are just the way you were before. Maybe a little bit younger-looking if you wish, but you’re still in a very real world.”

“You’ll notice that the other side of life is a bureaucracy just like this one. You can’t just call Uncle Frank [who’s still living]. You have to get permission from a group of people who call themselves guides – spirit guides. They will say, ‘Why do you want to make contact? What’s your purpose?’ And if they approve of it, they’ll say, ‘Okay, find yourself a medium somewhere, speak

with them, and they will make contact for you.’ Or if you’re that strong, you can try to make contact yourself.”

“And if you don’t like where you are after a while—you may have a consciousness that you’ve been there a certain period and feel that you would rather be back on the other side with friends and loved ones. You’ll say, ‘I’d like to get reborn again.’ These are the words I got from them, they’re not my invention. They [the spirits] said you have to go to a line, and you have to register with the clerk. ‘Clerk’ is the word they used. So you get in line and register with the clerk that you want to go back. The clerk says, ‘Okay, I’ll let you know when I find an appropriate couple for you that will advance your development.’ They have no real sense of time, so they just stand there, and eventually the clerk will say, ‘I’ve got a couple for you.’”

“There is a well and they [the spirit about to go back] must walk through that well. They call it ‘The Well of Forgetfulness.’ They are sprayed with this water – not 100%, it never quite covers everything. That’s why people have memories, déjà vu experiences, and recurrent dreams. And then they are a baby again.”

“What I have learned in my investigations is that there are seven levels of consciousness on the other side of life that are concentric with our world. It’s not up or down, it’s just concentric. We can’t see it because it moves at a different rate of speed than we move.”

“The idea is reincarnation. This concept has been a part of many religions and belief systems for millennia.” Holzer continued with his ideas on how our physical and spirit bodies connect. “There’s three levels when you are born. You are born with a physical outer body, a duplicate inner body, and at the very moment of birth – that’s very important – the moment the child is supposed to see the light [during childbirth], that is when the soul or the spirit is inserted from the pool of available spirits from the other side. Therefore all this nonsense about abortion killing a child is pure lies, pure nonsense. The fetus, until the spirit of the child is inserted, is a physical part of the mother. It does not have any life – it’s not a separate entity.”

Holzer said he worked with several mediums to compile this information on how things work in the afterlife. Holzer believes a good medium is the most critical element to a good supernatural investigation. He believes the medium is the person who can speak for those on the other side and deliver clear messages.

“That’s putting a lot of faith in a person who is hopefully not a charlatan, but could be,” I said.

“That’s why you don’t ask questions of a psychic,” he said. “You just sit there and listen. I’ll give you an example. Philip Solomon, a British trance-medium, once called me out of the blue because I had written a rather harsh piece in a magazine. It was about psychics who didn’t deliver – not fakers – but incompetent psychics. So we talked on the phone and became friendly, and then he suddenly said, ‘Your uncle Henry is here.’ It became clear that he was talking about somebody who really is my uncle Henry. Weeks went on, and from time to time he would call me and give me messages from my parents and from Henry, which I found valid. Months went by, and he [Philip Solomon] said, ‘Yes, Uncle Henry is here again.’ So I said, ‘If it’s my uncle Henry, what does he want me to know?’ And Philip said, ‘Just a moment.’ And then he came back and said, ‘Your uncle Henry says the dog’s name was Rigo.’ Who the hell would know that? But it was Rigo.”

“That’s what I call evidence. There was no way that he could have known that my uncle’s dog’s name was Rigo. No way he could have known that—that was years and years ago. The only

explanation of that particular case was that this was my uncle Henry. That was his way of proving himself. That's the kind of evidence I demand. It cannot be explained away."

Paranormal investigative groups are popping up everywhere. More people are studying this field today than ever before, and Holzer has met many of them. "We are living in a technological age," he said, "and they [paranormal investigators] think, or at least some of them that I've met, in all sincerity, that running around with Geiger counters and cameras and instruments that can measure cold spots will be the way to investigate a haunting or a ghost. That's bullshit. Because if you really are an investigator of the paranormal, and you're dealing with ghosts or hauntings, you're dealing with a human being – nothing more, nothing less. Therefore you should have with you a good trancemedium who can lend her body or his body temporarily for that entity to speak through so you can find out what the trouble is. That's the way it works – not a Geiger counter."

"But certainly a Geiger counter is more accessible than a trancemedium for most people," I said.

"And it looks more professional to them," Holzer said. "But it really is bullshit."

The one piece of equipment Holzer doesn't completely dismiss is the camera. "I have worked with psychic photographers," he said. "That's a special form of mediumship. Psychic photography is a gift. Some have it. I've used these people in haunted places. When there was something there, they would photograph it."

"Have you ever been afraid during an investigation?" I asked.

"Fear is the absence of information," he said. "Fear is created by not understanding something. You bring on the fear. There is no object to fear. I've never been afraid during an investigation. I shouldn't be in this business if I was. There's nothing out there that isn't one way or the other human. Hollywood notwithstanding, there are no monsters out there. There is no other supernatural race, no devils, no fellows in red underwear. It doesn't exist."

"What have you learned about yourself during all of these years of investigations?" I asked.

"My purpose is that I have a job. First of all, the other side, being a bureaucracy and being a well-ordered world, invests in people's abilities. When the other side decides some individuals have very good minds and good hearts, then they are given talents with the proviso that they will use those talents for the betterment of the world and mankind. If you don't, they won't like it. So they make it very plain: you have a gift. Use it. I found out early enough that they had something in mind for me. I accepted that it's an assignment. I noticed that what happened to me was kind of programmed – I met some people who were important for my career, or for my enlightenment – it was all arranged. So I finally said, 'Friends, I noticed you're running my life. It's okay with me. I will do it.' And I hear this in my right ear: 'We will guide you, help you. Use your gifts. You have two separate paths, one has to do with science, parapsychology research, and the other has to be the entertainment business. But you combine them to let the world know what you find.' And that's what I do."

Holzer is fortunate to be doing what he loves to do. So there is certainly no need to retire. "People can be unhappy for two reasons," he said. "Because they have the wrong mate or because they have the wrong job. They can change both."

"How do you want to be remembered?" I asked.

"As a man who told the truth. I won't have a tombstone. Cemeteries are real estate wastes, and I don't believe in funerals of any kind. The sooner you burn the body the better. It's just a shell."

“What will you be doing on your 100th birthday?”

“Looking forward to my 101st,” he said. “I do what I’m meant to do. A man who takes himself too seriously, others won’t take seriously, so I’m very careful about that. I want to be factual and to be useful – and I try to help anybody who wants help.”

“And you want to keep swing dancing.” I said.

“Yes,” he said. “Not just swing, any form of dancing. When my daughter saw me at the wedding of my younger daughter, my older daughter saw all of us on the dance floor and said, ‘I didn’t know you had in you, Daddy.’ I said, ‘What do you think I do, the Govotte?’”

Thanks for dancing with me, Dr. Holzer.

Discussion Starters

1. Do you believe, like Dr. Holzer, that study of the paranormal is a science? Why?
2. Dr. Holzer claimed that a medium conversed with Holzer’s dead uncle and provided information that he could only have gotten from the uncle. Do you believe his claim? Why?
3. Dr. Holzer has very specific information about what the “afterlife” is like, information he gleaned from his investigations and various mediums. What do you think of his depiction of an afterlife? Do you agree that an afterlife exists?