Science Magazine Podcast
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Music

Host – Kerry Klein
Welcome to the *Science* Podcast for May 10th, 2013. I'm Kerry Klein.

Host – Sarah Crespi
And I'm Sarah Crespi. This week we take a look at markets and morality [00:49], origins for cirrus clouds [16:14], capturing an asteroid [26:27], and more.

Host – Kerry Klein
Plus, a few stories from our online daily news site [34:44].

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[00:49]
Host – Sarah Crespi
In a democracy, the people and the government decide what goes on the market. For example, in the U.S., markets are O.K. for t-shirts but not organs. Not everything is for sale. It's thought that using a market-based approach for the distribution of organs may lead to immoral behavior, but is that the case with all markets? In a Research Article this week, Armin Falk and Nora Szech provide some evidence that markets tend to disconnect people and their morals. I spoke with Falk about the findings.

Interviewee – Armin Falk
So what we do in the experiment is we show that markets have a tendency to erode moral values. The way we find this out is we contrast decisions taken in what we call a non-market condition, if you like, with decisions taken in markets. In the market and the non-market condition, subjects could trade off money and life, in our case the life of mice, so these are moral consequences. And what we show is that in markets, many more mice die for a given monetary amount compared to a non-market conditions. And we show that in a causal way, markets actually lead to the erosion of moral values.

Interviewer – Sarah Crespi
So let's start with the big question, for me anyway. Were any mice killed as a consequence of this study?

Interviewee – Armin Falk
It is absolutely important to stress that the mice used in the experiment were so-called surplus mice. The mice would all have been killed without the experiment. Because of the experiment, if a subject decided to save the life of a mouse, we purchase this specific mouse. And therefore, as a consequence of the experiment, many mice were actually saved that would have otherwise been killed. And the mice that we purchased – the mice that were saved – are now kept in perfect conditions. They are perfectly healthy.

Interviewer – Sarah Crespi
So why did you decide to set up your study this way? Why include the life of a mouse as a part of the study?

Interviewee – Armin Falk
One of the key challenges in studying the morality of market interactions or the moral outcomes or the moral consequences of market interactions is to have a choice paradigm that involves a morally relevant decision. And morality is an elusive term if you like. Its content is culture-specific. It varies across varies across space and time. But there is a basic consensus that harming others in an intentional and unjustified way is typically considered as immoral activity, and this is probably universally true. And this is why we decided to use the so-called mouse paradigm. It introduces the tradeoff between money, or self-interest, and harming others, in our case the killing of animals. And we would therefore argue that the choice paradigm is well suited to study moral consequences of decision-making and of markets in particular. It's a drastic and irreversible decision.

Interviewer – Sarah Crespi
Can you talk a little bit about how you demonstrated to your participants that this was actually going to happen?

Interviewee – Armin Falk
Yes, so everything was explained in great detail. We guaranteed credibility in showing subjects the picture of a mouse and also a demonstration video of the killing process. It's standard to gas these mice, and we used the demonstration video. On top, subjects were answering control questions to check understanding, and the experiment did not start before everybody had completed the questionnaire and showed us that they had perfectly understood what was going on.

Interviewer – Sarah Crespi
So let's get back to the actual study design. So what did the word "market" mean in your study?

Interviewee – Armin Falk
Markets are typically understood as institutions where sellers and buyers meet, interact, and trade items. And in our experiment we studied two classic versions of markets that have been studied and explored a lot in experimental economics. One is a very simple and basic form of markets where there is just one buyer and one seller interacting, bargaining over the life of a mouse. And we also study a so-called multilateral market

with many buyers and many sellers. In both markets, buyers and sellers were continuously making price offers. In fact we did not tell them that they had to make price offers, so this is also important for understanding the experiment. No one was ever forced to either kill a mouse or do anything that he or she would morally object to. So they were free not to make any price offers, but in case they wanted trade and kill a mouse for money, they could continuously make price offers. And if a buyer accepted the offer of a seller, or a seller accepted the offer of a buyer, a trade occurred, and in this case, if trade occurred, as a consequence, a mouse was killed.

Interviewer – Sarah Crespi
So let's talk about the three main conditions that you looked at. Can you talk about those and then how these various different treatment groups showed the difference between market and not market conditions?

Interviewee – Armin Falk
So the first condition is what we call a non-market condition, or the individual treatment. This is a condition which serves as a benchmark, really, for the prevalence of the moral values in the population of interest – the population of interest being basically students at the University of Bonn. And in this condition, subjects were facing a very simple binary choice labeled either option A or B. In case they chose option A, it implied that they would not receive money and the mouse would be saved, and if they chose option B, they would receive 10 euros, and at the same time a mouse would be killed. And this treatment informs us therefore about the fraction of subjects who are willing to kill a mouse for 10 euros, and it's really setting the stage for our analysis of what happens in markets. We contrast this individual condition to the two markets I explained: the bilateral market and the multilateral market. And our main finding is that the fraction of subjects who are willing to kill a mouse for a given amount of money is substantially – and also in a statistical sense – significantly higher in markets than in the individual condition, which means that market interaction really lowers moral values relative to the individual condition. We show a causal effect of market institutions. They lead to the erosion of moral values in the sense that more mice are killed compared to the individual condition.

Interviewer – Sarah Crespi
And you also found that if the mice were taken out of the equation, if this was less of a moral quandary that the people were faced with – a coupon was used instead of a mouse – subjects actually behaved differently.

Interviewee – Armin Falk
The intuition we had was that if non-moral values, or let's say morally neutral values, are involved, markets would not display a tendency to erode these values or, put differently, that they would somehow respect these individual values, private consumption values. And that's exactly what we find. So we basically replicated the exact same procedure as we discussed above, and here, when morally neutral values are at stake, we don't find a significant difference between the values attached to this private consumption value in the individual condition in comparison to the values attached in the market condition.

Interviewer – Sarah Crespi
So what is at work here? How might markets in this experimental setting act to erode morality?

Interviewee – Armin Falk
Yes, this is a very important question, and to be frank here, the paper really shows the effect. It's somewhat weaker in terms of finding out why it happens, but I have a strong intuition, and if I may, I would like to point out say three or four mechanisms that I think are at work here. And they are complementary in a sense, right. They all add up to the effect that we see. So the first is in markets it takes at least two people to agree on a trade. In the individual condition, it's just me who takes a decision. In markets, there's a buyer and a seller, and trade occurs only if the two agree on trading and killing the mouse, and it's therefore that an immoral outcome is caused by these two people, which makes it possible to share feelings of guilt. The second important mechanism, I think, is social learning. Markets allow for a particular type of social learning. What you do in markets is you see prices. You see all the price dynamics. You see prices going down, and observing others trading and ignoring moral standards makes the pursuit of self-interest ethically more permissible, potentially leading other individuals to engage in trade as well, and that is reinforcing if you see even more people trading. A third potential mechanism is that markets itself – or markets interaction – actually provides very strong framing and focus on what you may want to call mutualistic aspects such as negotiation, bargaining, prices, competition, *et cetera*, which may divert attention from possible effects and consequences or moral implications of trading. Again, that is absent in individual trading where it's just you who decides to either take the money or pay for the mouse. Here, it's really people are involved in this negotiation process, and exposed to a very strong focus and framing. And in a sense, this strong focus creates some remoteness between people active in markets and possible victims. And I think this remoteness makes moral transgressions much easier. And then there's a final argument, which I think is particularly relevant in markets generally, and this is true only for the multilateral market, not in the bilateral market. But in the multilateral market with its presence of competing sellers and buyers, what happens here is that the notion of being pivotal may be diffused. If you don't care about your specific mouse, what you could come up with as an argument is, "If I don't save my mouse, another person may." So there's some replacement logic. If I don't do it someone else will. And I think this is a very important justification or a mechanism to diffuse responsibility operating in many markets. People have that impression that if they don't do it themselves, another one may, and then from the outcome of it, it doesn't really matter who does it, but if everybody believes "If I don't do it another one may," the outcome will materialize anyway.

Interviewer – Sarah Crespi
Okay. So you also mentioned that there were a number of people in the different conditions that were not tempted to engage in trading at all. Can you talk about them and how they compared to these other condition called the priceless condition?

Interviewee – Armin Falk
Yeah, I'm doing experimental economics for years now, and it's one of the most probably important and at the same time most obvious findings. People are very different. And that is also true in our study. In fact, there is a fraction of roughly 15 to 25%, depending on conditions, of subjects who completely refuse to trade off life for money. In a condition that is not reported or part of the paper we talk about, we offered subjects as much as 100 euro, and yet a fraction of 10, 15% completely refused to take that money saying, "We would rather forego a hundred euros than kill a mouse." People who are not willing to trade off money for life could be classified, if you like, following some rule-based or Kantian type of ethics, meaning that there are things you just don't do. It's almost like a taboo, and you don't break it no matter how much money you will offer me. And on a personal level, I'm actually happy to see these subjects. When we started this project we had no clue about the amounts necessary to induce people to actually kill a mouse. And my personal intuition, and also the intuition of many of my colleagues, is that you would have to offer subjects much more money, so I'm actually happy to find that at least for some people, 10 euros or 20 euros is not enough to kill an animal.

Interviewer – Sarah Crespi
So in your conclusion, you don't say, "Let's throw away all markets." You say we need to be more selective about what ends up in a market. Can you talk about how your findings fit in with that?

Interviewee – Armin Falk
The hypothesis that market interaction may erode moral values is, of course, not a new idea. It's a long-standing, controversial hypothesis in philosophy, ethics, social science, *et cetera*. It's also one of the most discussed controversial topics in current public debate, but to the best of my knowledge, no study has so far provided actually causal evidence on this issue, and this is what the paper does. But I'm also happy for what you said before, and I would like to add this, and make the point that the paper is not saying that markets are all bad or that we have to abandon market economies in general. Markets do have their virtues, and they are capable of generating information, allocating resources efficiently, *et cetera*, and other organizational forms, and this has been shown in history, of allocation and price determination have not generically placed higher values on moral outcomes. Think about totalitarian systems or command societies; they are not perfectly known to be supportive of moral values, in fact quite the opposite. So I think the general conclusion of the paper is this: even if markets are, you know, having all these virtues and have their positive aspects, we really have to think about where they are appropriate and where they are not appropriate. And I think we have to take this very seriously. The real message of the paper really is that while we – people from the U.S., Germany, Europe, whatnot – express objections against, you know, things like child labor or exploitation of work force, detrimental conditions for animals in meat production or environmental damage. While we do that, at the same time, we seem to completely violate or ignore these standards when acting as market participants searching and buying cheapest items like electronics, fashion, food, *et cetera*. And that causes outcomes that are in a more general way undesired given our moral standards. One policy implication

that could derive perhaps from what we do is if people hold these standards – and I'm not telling people, "Look, you're immoral" – the paper shows that for a given moral standard, the same people – meaning the random assignment, the same type of people, right – the same people do violate their own moral standards. So in a sense, you could make these people better off, but also make the victims better off if you would enforce that the conditions of production that we would consider as appropriate for our own people, in our own city, our own neighborhood, at least to some extent that they also hold in facilities and companies in other countries.

Interviewer – Sarah Crespi
I mean you're really arguing that the market is not going to correct these things. Other things need to take place.

Interviewee – Armin Falk
Absolutely. And that calls for political action.

Interviewer – Sarah Crespi
All right, well Armin Falk, thank you so much.

Interviewee – Armin Falk
Thank you very much.

Host – Sarah Crespi
Armin Falk and Nora Szech write about morals and markets in this week's *Science*.

Music

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Host – Kerry Klein
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Host – Sarah Crespi
And, if you're having difficulty choosing, I recommend Mary Roach's new book *Gulp: Adventures on the Alimentary Canal*. She always does a good job walking that line between disgusting and intriguing.

Host – Kerry Klein
Okay. Well I hope you get a chance to check out that book and more from Audible, and don't forget—you can get a free download just for signing up. Just go to audiblepodcast.com/sciencemag.

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[16:14]
Host – Kerry Klein
There's a substantial research base examining aerosols and their effect on the atmosphere and climate. What's less known is their effect on cloud formation. Clouds that contain ice require tiny particles to nucleate, and it has been thought that organic carbon and other biological particles make up the lion's share of cloud seeds. Now, using an innovative sampling methodology, Dan Cziczo and colleagues have examined some cloud seeds—and they found something quite unexpected. Cziczo spoke with me about the formation of cirrus clouds.

Interviewee – Daniel Cziczo
Cirrus clouds are the clouds that you often see on a clear day. They're very high altitude. They look very wispy. And what you're actually seeing is snow taking place high in the atmosphere. These are ice crystals forming. They become so big that they start to sediment out. They fall, and then upper level winds are moving those ice crystals off to the side. And one reason that they're important, one reason that we're interested in investigating them, is that they cover a lot of the Earth's surface. About 30% of the globe is covered by cirrus clouds, and we don't often see them because there's lower level clouds that are in the way. They're so high in altitude that we just simply don't see them, for example, when it's raining out or when it's cloudy. Those clouds are lower in the atmosphere, and they obscure the cirrus clouds.

Interviewer – Kerry Klein
So you were interested in figuring out how these cirrus clouds form. I mean, I think for most of us clouds are either there or they're not. We don't stop to really think about why or how they form. Why was this important to you?

Interviewee – Daniel Cziczo
Yeah, that's a great question. So we were very interested in how these clouds formed, and one of the things that's maybe not obvious if you don't start looking at these clouds in depth is that clouds are forming on pre-existing particles in the atmosphere. So there's always some amount of particles in the atmosphere – and these are things like dust particles that are getting kicked up; they're the smoke that's coming out of the back of cars or out of smokestacks. So those particles are always there. And the cirrus clouds are forming on some of those particles that are present in the upper atmosphere. So they're acting as condensation sites or something that we call ice nuclei onto which that ice forms the cloud. So what we were really trying to do in this study was figure out what those seeds were – what those nuclei were that were forming the ice crystals.

Interviewer – Kerry Klein
So how on Earth does one measure the seeds of clouds?

Interviewee – Daniel Cziczo
That's a great question, too. Well first off, as I mentioned at the very beginning, you have to get to these very high altitude ice clouds, and to do that we needed to use high altitude research aircraft from NASA. And we also used one from the National Science

Foundation. So these are specialized aircraft that are able to take measurements in the upper part of this atmosphere. So that's the first step is to find a platform to get to them. The second thing that you have to do is that you have to separate out the ice crystals, and this is maybe a little harder than it sounds like. Very often what we're talking about are a few ice crystals per liter, whereas there might be hundreds, thousands, or tens of thousands of particles per liter. So they're very tenuous clouds. There's only a few ice crystals there. So we have to very efficiently separate out the ice crystals from the particles. And to do that, we've made some special inlets to bring that material in. And the analogy that I like to use is it's a bit like flying around with a hair dryer. And what I mean by that is that you can imagine that if you have a hair dryer, and you sort of point it up, and you drop something like a ping pong ball on it, the flow from that hair dryer sort of stops the ping pong ball, and it shuffles it off the side. And so we built an inlet to do that, and we force a flow of gas out of the front of the aircraft. And what that does is it stops all of the small particles that we don't want to sample, and it sort of shuffles them off to the side. If you think about that same hair dryer analogy, and you drop a bowling ball on the hair dryer, it's not going to care that the hair dryer is on, it's just going to come crashing down. And that's the same idea behind these ice crystals that are in the cirrus. So we allow those particles to make it into the inlet. And you can imagine that the flow of that gas, just like a hair dryer, is it's going to be warm, and it's going to be dry. We melt off that ice, and what happens is we release the original aerosol particle that that ice crystal formed on. And that's what we're interested in investigating. So we look at those particles both on the aircraft – we fly instruments, mass spectrometers, on the aircraft – to look at the composition. We collect some of that material to bring back to the laboratory where we can use techniques like electron microscopy. And we also compare it to other things. So we compare it to, for example, relative humidity measurements made on the aircraft to understand formation conditions. And we also compare it to models afterwards. We try to understand these formation mechanisms and sort of back up the data that we collect in the atmosphere by understanding it from sort of a theoretical sense.

Interviewer – Kerry Klein
Wow, that is awesome! So how big are these particles?

Interviewee – Daniel Cziczo
So it depends on what we're talking about. The ice crystals can be quite large. They can be some hundreds of microns in diameter. The seed particle that we start with is actually quite small in comparison. It's usually only about a micron in diameter, so you've got many orders of magnitude difference between the size of the ice crystal and the little particle that seeded it.

Interviewer – Kerry Klein
And so what sorts of cloud-forming seeds did you find?

Interviewee – Daniel Cziczo
Well, the results were pretty interesting. One of the things that we were very interested in from the outset was if the particles that these cirrus clouds formed on were just the

background aerosol, were they just the background particles that we very often find in the atmosphere? And they weren't, so the first result was that these ice nuclei were very special particles in the atmosphere not representative of the whole. We found a lot of mineral dust in these clouds, so the sort of seed particle, the ice nucleus, was very often a small bit of mineral. Very often it was also a metal, so something that came from human activities. One of the reasons that this is interesting is that if it was just sort of the background aerosol, the background particles, there isn't sort of a lever to change cirrus cloud properties. It would way that you would have to change all of the aerosol in the atmosphere very radically to get a big effect on the clouds. But because mineral dust and metallic particles are such a small amount of the particulate matter – just a percent or two – it means that you only have change something about a percent or two of the particles to get a big effect on these clouds. We also had an interesting sort of negative result, which is what the clouds don't form on. So it had been theorized for a good bit of time that maybe they form on something from human activities like black carbon, and this is the sort of sooty material that comes out of the back of a dirty truck or out of a smokestack. And we actually didn't find this material in the ice crystals. So it sort of implied that we don't have to worry about this as a source of cirrus cloud formation. We also didn't find a lot of biological material, so we know that very close the Earth's surface, there's some bacteria that are very good at nucleating ice. It doesn't appear that these make it in sufficient number into the upper atmosphere to have an effect on cirrus clouds. So that was sort of another interesting negative effect, something that we also don't have to worry about.

Interviewer – Kerry Klein
So you could rule out black soot, but many of the other particles forming clouds are still man-made, right?

Interviewee – Daniel Cziczo
That's absolutely right. In fact, it's an interesting point that you make about minerals because we sort of think of mineral dust, or we want to think if it, as a natural particle – you know, something that comes from a dust storm, which is just naturally occurring. But it turns out that human activities actually have a big effect on the amount of mineral dust in the atmosphere, and this maybe isn't surprising when you think of land usage, you know, farmland being created out of forested land, or maybe plowing under fields instead of leaving the root systems intact, so when the wind comes by, it can blow mineral dust into the atmosphere. And there's some estimates that there's as much maybe 50% more mineral dust in the present atmosphere than there was before human activity took place, so this isn't really a natural material anymore, it's now sort of a man-made material. And then, as you mentioned, the other thing that we found was this metallic aerosol, so these are little bits of metals from things like smelting activities, from industrial activities, that type of industry puts metal particles into the atmosphere. And we're seeing that these maybe are a quarter of the particles that are in the cirrus clouds.

Interviewer – Kerry Klein
And which metals and minerals in particular did you find?

Interviewee – Daniel Cziczo
The mineral dust is actually going to take more work. So we haven't sort of specifically found one source region for this, and probably that implies that it comes from a number of different areas. It seems to be aluminous silicate material, which is quite common at the Earth's surface. The metallic particles are also very variable. The big one that we've found is lead. There's still a bit of lead in the environment. It comes from things like tetraethtyl lead in fuels; most of that has been eliminated from cars, you know, for about 25 years now, but it's still used in some light aviation. Metals like lead are also emitted by things like fossil fuel burning. Coal burning puts a bit lead into the atmosphere. So that's probably the biggest metal that we find, or the most frequent metal that we find. But we find a whole host of different metals, actually.

Interviewer – Kerry Klein
So if human activity is influencing the amount of these particles in the air, does this mean that the amount of cirrus clouds being formed is changing as the globe industrializes and develops?

Interviewee – Daniel Cziczo
That's what we're trying to understand, and I think that this is the first attempt to do this – the first cut that we've taken at it – is this type of research. So, you know, what we're finding is that a significant amount of the material that seeds these clouds is from human activities, and it does imply that there could a human effect. It's something that's going to take follow-on studies – things like modeling studies, better understanding of the emission of, for example, mineral dust and metal aerosols to the atmosphere – to really be able to pin down sort of a global effect of what these clouds could be doing to the Earth's climate. It's very uncertain right now. So if you look at things like the recent Intergovernmental Panel on Climate Change report, cirrus clouds and clouds in general are one of the things that lead to a high error bar in our understanding of climate. They're sort of the most uncertain thing in the climate system right now, and what we're hoping is that this work can really help us to shrink that error bar, that it's going to give us an increased ability to understand cloud formation, and specifically these high altitude clouds.

Interviewer – Kerry Klein
Great! Well, Dan Cziczo, thank you so much.

Interviewee – Daniel Cziczo
Thank you!

Host – Kerry Klein
Dan Cziczo and colleagues talk about clouds and anthropogenic particles in a Report this week.

Music

[26:27]

Host – Sarah Crespi
NASA has plans to capture a passing asteroid and tow it into a reasonably accessible orbit near the moon. I spoke with Richard Kerr about what's driving the plan and what we might gain from this type of study.

Interviewee – Richard Kerr
President Obama has told NASA that it should send astronauts to an asteroid by the year 2025. Well, NASA is finding that it doesn't have the money to do that right away. And so it's proposing to bring the asteroid to the astronauts; go out, grab hold of an asteroid with robotic spacecraft, haul it back to the Earth/Moon system, and then send the astronauts out on a short survey of the asteroid a few weeks. The problem is, as seen by some planetary scientists, as finding the right asteroid fast enough.

Interviewer – Sarah Crespi
So is this on the same timeline as that "go visit an asteroid by 2025" deadline that Obama gave?

Interviewee – Richard Kerr
If things work out the way NASA would have them they could have astronauts to an asteroid as early as the 2020s.

Interviewer – Sarah Crespi
So you're saying they would go out and get an asteroid and bring it back. What's the technology behind capturing it and bringing it back?

Interviewee – Richard Kerr
Well, the technology is not too crazy, as a JPL engineer told me. The cost-savings would be in sending robotic spacecraft. Sending astronauts on a long trip – we're talking up to six months – the technology isn't there, and it would be very expensive to develop it. But to send the robot you'd have to improve the performance of so-called solar-electric propulsion, ion drive – you see it in some sci-fi movies, but there's a spacecraft operating on ion drive as we speak. The Dawn Mission just visited a huge asteroid, Vesta, and it's now on its way to the asteroid Ceres.

Interviewer – Sarah Crespi
How does an ion drive work?

Interviewee – Richard Kerr
Well, NASA is going to have to build bigger and better solar panels, and they collect solar energy, convert it to electricity, then the electricity ionizes onboard fuel – maybe xenon gas – and accelerates it out the back of the spacecraft – a nice glowing rocket tail. So the technology is there. They have to scale up. The other thing they need to do is design, construct, and launch some sort of apparatus that as presently conceived would open up what looks like a long umbrella. And the spacecraft would move on to the asteroid, which is going to run 7 to 10 meters in size, you know, 30 feet, 500 tons, and basically engulf the asteroid, pull the drawstrings at the end, and enclose it and then tug

away on it and bring it back to either an orbit high around the Moon, or this special gravitational spot between the Earth and the Moon where it can just sit with very little effort.

Interviewer – Sarah Crespi
Wow! You also mentioned that this timeline is doable in the 2020s. How close would the asteroid have to be to meet that timeline?

Interviewee – Richard Kerr
These are asteroids that are passing by Earth, probably beyond the Moon's distance, but not too far beyond. These are 10-meter asteroids. Scientists do believe that you can see them coming, and then you'd have to be in a great and very organized hurry to figure out whether the asteroid you've just discovered is the one that would work. It can't be too large or too massive or too oblong or spinning too quickly. And you have to do all this in a matter of days, maybe a week, before that one keeps on going and goes out of sight basically. But one of the things you have to determine in that week or less is when is it going to come back? It will come back, but depending on its orbit relative to Earth's orbit, NASA's looking for it to come back in the early 2020s.

Interviewer – Sarah Crespi
Okay, so you're not going to scramble a rocket in a week. You're just going to make your measurements.

Interviewee – Richard Kerr
No, you're going to scramble a lot of telescopes, maybe a planetary radar like the one in Puerto Rico, Arecibo, and size it up as quickly as you can.

Interviewer – Sarah Crespi
You mentioned in your article that asteroid specialists aren't convinced this timeline and tactic will work. Can you talk about that a bit?

Interviewee – Richard Kerr
Well, planetary scientists – the ones who specialize in asteroids, finding them and studying them – see this as a very difficult task. Not that you can't see a 10-meter object when it's coming at you, but it all has to go, with each candidate shows up, things have to go very smoothly and very quickly, as I said. And then you have to do it again and again and again. There are millions of these objects out there, but very few are going to come by in the next few years that would be suitable. And so scientists' concern is can NASA do this on the schedule that the President has given them?

Interviewer – Sarah Crespi
And there are some other objections about what useful information can actually be gleaned from this type hunt. Can you talk about that?

Interviewee – Richard Kerr

Well, NASA is doing this in response to the President's goal setting. It's supposed to be a step on the way to Mars, sending astronauts to Mars. So NASA will get experience in sending astronauts out beyond low Earth orbit operating in slightly deep space, but NASA's also pitching it as an opportunity to understand how to someday use the minerals and maybe the water that's in these asteroids to support space exploration. You might take the water and pour it around a spacecraft and protect the astronauts inside from radiation, but nobody out there thinks there's much of a chance that you will find one of these rare types of asteroids that are rich in the minerals and water that NASA would need. And so that side benefit has faded already. The other one is the claim that this mission will benefit efforts to defend the planet against asteroid impacts. It probably will find some threatening asteroids in the course of this beefed-up search, but the one they're going to go after, the one they're going to get a close look at, is so small that if it were to approach Earth on a collision course, it would break up and burn up in the atmosphere. Ten-meter asteroids do not pose a threat to Earth. So what have you learned by getting your hands on an asteroid, a whole asteroid? While being scientifically interesting, it will not help you defend the planet.

Interviewer – Sarah Crespi
Well, let's talk about some of the scientific information that we might gain from this. What might be learned from pulling an asteroid in close and taking a long look at it?

Interviewee – Richard Kerr
Well, planetary scientists are very interested in the whole asteroid. They've got the close-up look at a number of them. They've touched down on asteroid Eros. Japanese scientists and engineers have returned a bit of dust from asteroid Itokawa. But having an astronaut come up to the asteroid, inspect the surface –the surface is probably different from the interior – scientists are interested in how the asteroid is put together. Some of them – some of the bigger ones, anyway – are just piles of rubble, boulders that barely hold themselves together with their own gravity. Of course, astronauts will be able to return samples. As I said, we have a little dust from one. There's a NASA mission going to return kilograms of material from an asteroid, but it's not until 2022, -23. The astronauts are going to an asteroid in parking orbit like that, I don't know, tens of kilograms, just as the astronauts did on the Moon, they'll be able to select exactly what the scientists want to look at up close.

Interviewer – Sarah Crespi
Great! All right! Well Richard Kerr, thanks for talking with me.

Interviewee – Richard Kerr
Thank you, good to be here.

Host – Sarah Crespi
Richard Kerr is a staff writer for *Science*. You can read his story on lassoing an asteroid in this week's issue.

Music

[34:44]
Interviewer – Kerry Klein
Finally today, I'm Kerry Klein, and I'm here with online news editor David Grimm, who's going to give a rundown of some of the recent stories from our online daily news site. So Dave, in our first story, we're looking at nice guys versus bullies.

Interviewee – David Grimm
Right and this is in spiders. It turns out that nice guys do indeed finish last, at least if you're a spider. There's a social spider known as *Anelosimus studiosis*. This is a spider that's native to North and South American forests. And it turns out this spider has a bit of a personality. Some of the spiders can be pretty docile, and some can be pretty aggressive.

Interviewer – Kerry Klein
So what were scientists interested in? Why do we want to know the personalities of spiders?

Interviewee – David Grimm
Well, what scientists wanted to know is is one personality better from an evolutionary standpoint? In other words, are aggressive spiders more likely to survive in the wild than docile spiders or vice versa? And what the researchers did in this study was they basically separated this population into aggressive and docile spiders, and they returned them to the wild. It was actually just one researcher here, and he actually monitored the spider nests for six years, and he wanted to see how the aggressive spiders did versus the docile spiders.

Interviewer – Kerry Klein
Well backing up a second, how do we even determine the temperaments of spiders in the first place?

Interviewee – David Grimm
That's a good point. When the researchers actually had the spiders in the lab, what they did was they put two spiders together, and what will happen is if both spiders are docile they'll just sort of hang out together overnight. If they're both aggressive they start fighting each other, and then they move to opposite ends of their enclosure, and if you have an aggressive one and a docile one, the aggressive one sort of fights off the docile one. So it turns out that these personalities actually made a big difference. When they returned these spiders to the wild, what happened was that the researchers let some of the colonies just sort of exist on their own. And with other colonies, they actually prevented invading spiders from coming in. Now, when they did that they didn't notice any difference in the success between the docile spiders and the aggressive spiders, but when these spiders were left to fend for themselves, at first the docile spiders seemed to be doing better, but a few years into the study the docile spiders were really starting to decline. A lot of the colonies had disappeared, and by the end of the study all of the

docile spider colonies had disappeared. Meanwhile with the aggressive spiders, three-quarters of the original nests were still standing.

Interviewer – Kerry Klein
So what happened here was nice spiders did better in the short term; mean spiders did much better in the long term.

Interviewee – David Grimm
Right and it seems to be because nice spiders, although they get along well with each other, they're not very good at defending their colonies. And while this mutual sort of cooperation will be good in the short term, in the long term, it's really bad because you're not going to be able to defend yourself against enemies. Where the aggressive spiders, even though there's a lot of in-fighting, and they're probably killing each other a bit, that personality really protects the colony as a whole. And in the long term that's really good for the population.

Interviewer – Kerry Klein
So does this mean that meaner is better?

Interviewee – David Grimm
It kind of does. It does mean that from an evolutionary standpoint, it's better to be a jerk than to be a nice guy, but the researcher says that actually a mix is probably good because if you have these aggressive spiders that defend the nest, the docile spiders probably do important things. They probably gather food. They probably take care of the young – also very critical functions for the colony although apparently not as critical as being able to fight off an enemy.

Interviewer – Kerry Klein
Right, well interesting implications for international diplomacy.

Interviewee – David Grimm
Right.

Interviewer – Kerry Klein
All right, moving on, a new look at the origins of language.

Interviewee – David Grimm
Well Kerry, this story suggests rather controversially that some of the words you and I are speaking right now may date back more than 15,000 years to a time when people may have been sitting around campfires and watching the glaciers recede at the end of the last ice age.

Interviewer – Kerry Klein
Why is that a controversial view? How old are most languages and words today considered to be?

Interviewee – David Grimm
Well, it's a very tricky field to figure out how old some languages are, but researchers in the past few years have focused on something called cognates, which are basically words that are shared between two different languages. For example, the word for "mother" in French is *mère*; not exactly the same word, but it's clear that there are some similarities there. Researchers actually can look at them the same way scientists look at genes. For example, we share 99% of our genes with chimpanzees. That means we're really highly related; we diverged fairly recently. We don't share that many genes with turtles, which means, from an evolutionary perspective, we're much more distant relations. Researchers can do something similar with cognates and language. Using these methods, researchers have dated many common words back as far as 9,000 years ago. They've suggested there's this ancestral language known as Proto-Indo-European, which gave rise to languages including Hindi, Russian, French, English, and Gaelic. But this new study stretches things back even further. It suggests that maybe there's an ancestral language that existed not 9,000 years ago, but as far back as 15,000 years ago.

Interviewer – Kerry Klein
Okay, so researchers had previously used this method similar to genetics that languages that share more words diverged more recently from a common ancestor. What was new about this particular study that got this much older common ancestor?

Interviewee – David Grimm
Well, this new study focused a little less on cognates and focused more on the frequency of the word's use, the part of speech it was – a noun, verb, *et cetera*. They kind of ignored the sound; they were trying to find more basic ways that words can be related to each other. And then they looked at seven major language families. These included Indo-European, Eskimo, the group of non-Russian languages around Siberia. And they sort of combined all this together. They used some statistical methods again, and they found that there was core group of about 23 very common words that were used about once per 1,000 words in everyday speech. That not only persists in each of these language groups, but also sounds similar to the corresponding words in other families. For example, the word "thou" has a sound and meaning among all seven language families they studied. And they looked at the rate of change of these words over time, and the statistical model they used suggested that some of these words have retained a similar form since about 14,500 years ago. And this suggests the existence of an ancient Eurasiatic language that gave rise to many of the languages that are spoken today. And not only that, but some of the words may actually be similar to the words we speak today, even in English.

Interviewer – Kerry Klein
Okay. And our last story is about a very bizarre find in South America.

Interviewee – David Grimm
Kerry, I would say this is probably one of the strangest stories we've ever run *Science*NOW, and that's saying a lot. This story deals with a very unusual skeleton found in the Chilean desert about 10 years ago.

Interviewer – Kerry Klein
So why is this skeleton making the news?

Interviewee – David Grimm
Well, it's a very strange skeleton. We've actually got some pictures of it on the site. First of all, it's very tiny; it's only six inches tall. It looks like a human, but the head is very misshapen. It actually looks a bit like some alien heads if you're a fan of science fiction. It was found, apparently, in pouch in a ghost town in the Atacama Desert of Chile. There's been recent documentary where a filmmaker has proposed that this is evidence of alien life. So there's a lot of controversy. There's a lot of strangeness swirling around this skeleton.

Interviewer – Kerry Klein
Right. And this picture just looks unreal. I mean it looks like something straight out of a fictional movie, a scifi movie. So my first question is is this for real?

Interviewee – David Grimm
And that was really the first question of the scientist that actually got involved in this study about a year ago. He had heard about the film. He had heard about the skeleton. He had heard it was sort of being hyped as alien life. He is an immunologist, and he said, let me lend some of my scientific expertise here. What he found right away was some other unusual things about the skeleton. First of all this specimen, which has been referred to as Ata, sports 10 ribs instead of the usual 12. He took some pictures to some doctors in the neonatal care unit at the hospital he worked at, and they said they'd never seen anything like it before. One of the going hypotheses was that this skeleton was potentially tens of thousands of years old. But when this researcher started doing some DNA analysis on it, he found it was only a few decades old. More importantly the DNA suggested this was indeed a human being. It was not an alien. And actually some specific analysis suggested that the specimen's mother came from Chile, so it probably died in the same region that it was found in.

Interviewer – Kerry Klein
Wow, what a disappointment. It's really human.

Interviewee – David Grimm
It's really human. Probably one of the most bizarre things that came out of the analysis was that the bone development suggests that this was actually a 6- to 8-year old child.

Interviewer – Kerry Klein
And it's six inches long.

Interviewee – David Grimm
Which is six inches high, which makes almost no sense. There is a couple going hypotheses. One is that Ata had a very severe form of dwarfism; was actually born as a very tiny human, lived until about 6- to 8-years old, and died. The other theory is that

this was actually a fetus that suffered from some sort of severe form of rapid aging disease, which would have given it the bone structure of a 6- to 8-year old child, but that it died in the womb or died right after being born. There are ways to determine which of these is true or if potentially something else is true by some further analysis, which is ongoing.

Interviewer – Kerry Klein
So even though some mysteries remain, this scientist, Gary Nolan, actually debunked an alien theory with science.

Interviewee – David Grimm
He did. So that's a disappointment for those of us out there that were sort of hoping for evidence of alien life, but there's still a lot of really cool things going on here that remain to be teased out.

Interviewer – Kerry Klein
Great! Well, what else have we had on the site this week?

Interviewee – David Grimm
Well Kerry, for *Science*NOW, we've got a story about a story about a rejuvenating hormone that's been found to reverse symptoms of heart failure. Also a story about using mosquitos to fight malaria. For *Science*Insider, our policy blog, we've got a story about what the U.S. Senate is doing to address a shortage of helium in the United States – didn't even know that was happening. And also a story about how the retirement of a prominent proponent of teaching evolution in American schools will affect the future of U.S. science education. Finally for *Science*Live, our weekly chat on the hottest topics in science, this week's *Science*Live is about the search for exoplanets and alien life, not alien life in Chile's desert, but alien life out there in space. Next week's *Science*Live is about the fate of the world's bees – why so many of them keep on dying. So be sure to check out all of these stories on the site.

Interviewer – Kerry Klein
Thanks, Dave.

Interviewee – David Grimm
Thanks, Kerry.

Interviewer – Kerry Klein
David Grimm is the online news editor of *Science*. You can check out all of our news at news.sciencemag.org, including daily stories from *Science*NOW, science policy from *Science*Insider, and *Science*Live, live chats on the hottest science topics every Thursday at 3 p.m. U.S. Eastern time.

Music

Host – Sarah Crespi

And that concludes the May 10th, 2013 edition of the *Science* Podcast.

Host – Kerry Klein
If you have any comments or suggestions for the show, please write us at sciencepodcast@aaas.org.

Host – Sarah Crespi
The show is a production of *Science* Magazine. Jeffrey Cook composed the music. I'm Sarah Crespi.

Host – Kerry Klein
And I'm Kerry Klein. On behalf of *Science* Magazine and its publisher, AAAS, thanks for joining us.

Music ends