Nature Podcast

Introduction

This is a transcript of the 8th February 2018 edition of the weekly *Nature Podcast*. Audio files for the current show and archive episodes can be accessed from the *Nature Podcast* index page (http://www.nature.com/nature/podcast), which also contains details on how to subscribe to the *Nature Podcast* for FREE, and has troubleshooting top-tips. Send us your feedback to podcast@nature.com.

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Interviewer: Benjamin Thompson
Welcome back to the *Nature Podcast*. This week in the show, the social smarts of magpies, and making tougher timber…

Interviewer: Shamini Bundell
Plus: cloned crayfish in Madagascar. This is the *Nature Podcast* for the 8th of February 2018. I'm Shamini Bundell.

Interviewer: Benjamin Thompson
And I'm Benjamin Thompson.

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Interviewer: Shamini Bundell
First up today, it's reporter Adam Levy, and this week he's marvelling at his own intellect.

Interviewer: Adam Levy
As far as animals go, I reckon I'm pretty smart. I mean, there probably aren't many non-human animals that can beat me at chess for example, or write a pithy podcast intro for that matter. But where does my intelligence come from? For that matter, where does intelligence itself come from? What drives it to evolve? Well, broadly, there are two schools of thought on the matter. One suggests that challenges in our environment drives the evolution of intelligence. For example, intelligence could have evolved in response to a need to catch or access hard to reach food. But there's another idea: the social intelligence hypothesis. This suggests that intelligence evolves so animals can better handle complex social situations, working out who are their friends, enemies and anything in between. To test this hypothesis, researchers previously compared the brain size of a species with the average size of their social groups. Species, who tend to live in bigger groups, should need more social intelligence. Sure enough, it seems like there may be a link. But there are plenty of confounding factors when comparing whole different species and brain size certainly isn't exactly the same as intelligence. Now though, a study has come out that's taken a very different approach. The team measured intelligence directly, and they didn't compare different species. I phoned up one of the authors, Alex Thornton, to find out more.

Interviewee: Alex Thornton
So what we wanted to do is to go within species and our logic was that, well if we expect social factors to have an influence on cognition, then we should expect to see them within species as well as between species. So, we studied Australian magpies. We were interested in asking, first of all a developmental question. So, does growing up in a bigger group, does that have an influence on your cognitive performance?

Interviewer: Adam Levy
I mean, what does it actually look like to test a magpie's intelligence?

Interviewee: Alex Thornton
So, I mean I guess you could think of them almost as like a little mini avian IQ test. One of them, for instance, is a colour association test. The idea is can birds learn that one colour is rewarded? So you've got these little wells with different coloured lids on them and if you look in wells with lids of one colour, you'll find a reward and so we can look to see how long it takes the birds to learn that association. These animals, they're very curious and they are also very motivated by food so we were giving them mozzarella cheese which they particularly like.

Interviewer: Adam Levy
So what did all these tests on magpies end up revealing about their intelligence?

Interviewee: Alex Thornton
Initially, all of the youngsters performed equally badly when they were very young but as they grew older, the ones that were in larger groups started to outperform the ones that were in smaller groups. We were also interested in understanding the consequences of these differences between individuals in their cognitive performance. So, actually does it pay to be smart, as it were? And so for that we could look at the breeding success of females who were doing well on our tests, or doing badly, and again we found a strong positive relationship where the females who were doing well on these tests tended to produce more offspring, to be more successful in reproduction and so this raises the possibility that actually natural selection might act on this variation in cognitive performance.

Interviewer: Adam Levy
So you've found that intelligence does indeed seem to go hand in hand with the size of these magpies' groups. You also found that this intelligence corresponded to how reproductively successful the females were. Together, what does this tell us?

Interviewee: Alex Thornton
Well, so it tells us that in this species at least, social factors have an influence within an individual's lifetime over their cognition, and because there's this reproductive benefit to being clever, it also raises the possibility that natural selection may act on these differences between individuals so it kind of unites this idea of developmental factors happening within an individual's lifetime with potentially evolutionary processes that would happen across the generations.

Interviewer: Adam Levy
Alex Thornton, there. So where does that leave us with the social intelligence hypothesis? Comparative psychologist, Andrew Whiten, has written a News and Views on this study and is impressed by this new research.

Interviewee: Andrew Whiten
I think it's an excellent contribution. So, what I think this study contributes is putting these three things together: that social group size predicts intellectual capacity and intellectual capacity then seems to predict reproductive success, as of course it would have to do for this evolutionary hypothesis to be correct. I think it's made an important contribution in linking all those three things together that perhaps haven't been successfully linked together in previous approaches to the problem.

Interviewer: Adam Levy
So it seems like studying these social birds answers some important questions about the evolution of intelligence. Does that mean the case is closed and the social intelligence hypothesis has been confirmed?

Interviewee: Andrew Whiten
No, no, no. I don't think so. I would say there are a couple of limitations to this study that is an important pioneering one in what it's done. But one thing one could say is well the actual tests you used are really just about learning. I mean, surely there should be more to intelligence that that? One might hope to look at creative intelligence and solving really novel problems.

Interviewer: Adam Levy
Andrew also points out that group size isn't necessarily the best way of working out how socially complex a species is. After all, cows like to hang out in pretty big groups, but aren't too tricky to outsmart. He hopes future work could help tackle these limitations. But for Alex Thornton, there's one particular question that he wants to answer first and foremost.

Interviewee: Alex Thornton
So the next stage, really, for our research is to try to understand why – why is it that growing up in a large social group seems to have this influence on the development of cognition? What is it? What are the informational challenges that animals face in larger groups that seem to have this impact on how their cognition develops?

Interviewer: Shamini Bundell
That was Alex Thornton, who's based at the University of Exeter, here in the UK. Andrew Whiten is also here in the UK; he's at the University of St Andrews. Find the paper and the News and Views online at nature.com/nature.

Interviewer: Benjamin Thompson
If you listened to the show last week, you'll have heard me talking to Shanti Pappu about the discovery of some ancient stone tools in India. This is how I started the piece: "Almost two million years ago our ancient ancestor *Homo erectus* is estimated to have first migrated out of Africa…" Well, we've had some feedback. Twitter user *danntag* reached out to us and

said: "Come on @NaturePodcast, less than a minute in and you claim *Homo erectus* is one of our ancestors." Well, I wondered what I should have said so I reached out to Ewen Callaway who's been reporting on archaeology stories for *Nature* for a very long time. This is what he told me…

Interviewee: Ewen Callaway
I tend to avoid the term 'ancestor' as your commenter pointed out and I typically describe something like *Homo erectus* which is a hominin, which is kind of a jargon-y word, I like to call them ancient human relatives, so it's not directly ancestral to us. That's something that we can never prove, but it's an ancient relative of ours and I think that's a pretty good way of describing *Australopithecus* or *Homo erectus* or even *Neanderthals*. So yeah, I'd go with that.

Interviewer: Benjamin Thompson
Ewen Callaway there, and thanks for your feedback *danntag.*

Interviewer: Shamini Bundell
If you want to get in touch with us, we'll tell you how at the end of the show. Now though, we can't keep him away. Adam Levy's back again with this week's Research Highlights…

[Jingle]

Interviewer: Adam Levy
Researchers have found an easy way to make some tricky polymers. Polymers are chains of molecules and gradient polymers gradually transition from one molecule to another as you move along the chain. They have unique mechanical and thermal properties but are a pain to put together so the team used an emulsion where droplets of one liquid are suspended in another. They dissolved one type of molecule in the droplets and the other in the surrounding liquid. Polymerization begins inside the droplets and then as that molecule gets used up, the other molecules start joining the chain, forming the gradient. Find out more about this chain reaction in *Angewandte Chemie International Edition*.

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Interviewer: Adam Levy
Wild fires are creating so much smoke they're having volcano sized effects on the sunlight. The smoke can dim sunlight around the world and the effect from North American fires was particularly bad in August last year. Researchers in France measured the layers of smoke in the atmosphere using both ground based and satellite observations. The data showed that the smoke blocked more sunlight than a 2009 volcanic eruption in Russia. Smoke blocking sunlight could have important effects on the global climate. Find that paper in *Geophysical Research Letters*.

[Jingle]

Interviewer: Benjamin Thompson

In Madagascar, an invasive army of rapidly multiplying clones is advancing through many of the country's freshwater habitats. These clones belong to a new species, only a few decades old, which appears to have come into existence in an aquatic tank in Germany. The species in question is known as *Procambarus virginalis,* also known as the marbled crayfish. Reaching only up to about ten centimetres in length, these crustaceans look like small lobsters and in fact they're from the same taxonomic order known as the decapoda, along with prawns, crabs and shrimp. The first recorded appearance of this new type of crayfish is believed to have been at a German aquatic trade fair in 1995 but these fresh water animals soon became popular pets and were distributed to other aquatic pet owners around the country. One of these owners spotted something puzzling, as Frank Lyko explains.

Interviewee: Frank Lyko
One of these guys approached a specialist in the field because he had noticed that he had only females in his aquarium and this is something that was unheard of in the aquarium communities. Normally you'd have males and females in a crayfish population if you keep them in an aquarium.

Interviewer: Benjamin Thompson
Frank, based at the German Cancer Research Centre in Heidelberg, has a paper out this week looking at the genomics of the marbled crayfish. Research showed that this species was able to accomplish something unseen in any other crayfish, or indeed, in any other decapod. It reproduced by parthenogenesis. This is a form of asexual reproduction which, in this instance, doesn't require an egg to be fertilised. Instead, females alone produce eggs with complete sets of chromosomes that develop into female progeny. And when it comes to sets of chromosomes, the marble crayfish is, again, a bit weird compared to other crayfish. The story here begins with two distantly related members of the Floridian crayfish species, *Procambarus fallax.* Let's call their two different genomes A and B. When this crayfish mated sexually, they would usually produce offspring with an AB genome, with one set of chromosomes from each parent. At some point though, something odd happened and one of these sets of chromosomes doubled, producing an offspring with two sets of A and one of B. This is known as polyploidy. Quite when and how this macro-mutation occurred is unknown but it does seem that stress may have been involved.

Interviewee: Frank Lyko
What has been observed also in other organisms and other invertebrates, for example, in oysters is that you can make a genome polyploid for example by cold shocking it or by stressing the animal. It is something that is often done in apiculture to increase the yield because these animals usually get bigger and produce more meat per animal. But what exactly has happened in this case, we don't know.

Interviewer: Benjamin Thompson
Whatever the reason, a new species was born, one that no longer requires males to reproduce. Frank and his colleagues have sequenced the genomes of several marbled crayfish to learn a bit more about their genetic identity.

Interviewee: Frank Lyko

We sequenced 11 animals from very distinct sources. Some of them, their lineages were from the pet trade, some of them were wild catches from Germany, some of them were wild catches from Madagascar.

Interviewer: Benjamin Thompson
The differences in the genomes of these 11 animals was tiny. In fact, when looking for individual differences in the protein coding regions of DNA, known as single nucleotide variants, the team only found four. This confirmed that these crayfish, regardless of where they were from, were clones of each other.

Interviewee: Frank Lyko
You know, a genome that is 3.5 giga bases big, meaning it's bigger than any human genome. This is an astonishingly small number. This number surprises many people. Why is it so small? And the reason is again because of the short time span that the marble crayfish has had to evolve so far. Of course, over time, they will accumulate more and more genetic variation so they will diversify but they haven't done this yet.

Interviewer: Benjamin Thompson
For such a young species that originated in Germany only a few decades ago, the marbled crayfish has already covered a lot of ground and populations can be found in the waterways of several European countries. The reason: humans releasing them into the wild, of course. While the cold winters found in much of Europe appear to be keeping these crayfish in check, the same can't be said for the island nation of Madagascar. Somehow the marble crayfish found itself there, thousands of miles away from Germany, and the population exploded. The team analysed several more genomes, this time from marbled crayfish taken from various parts of Madagascar, and confirmed that once again the animals come from a familiar source.

Interviewee: Frank Lyko
On the genetic level, the German animals and the Madagascar animals are indistinguishable. You can't separate them so this probably means that the Madagascar population originated from a German animal and that this formed the clone that is now spreading globally.

Interviewer: Benjamin Thompson
The marbled crayfish seems to represent a perfect storm for an invasive species. It's adaptable to different environments, it lays lots of eggs, and you only need a single animal to start a population. The team estimate that the range of this species on Madagascar has increased a hundred fold in just ten years, with a crayfish population that could number in the millions.

Interviewee: Frank Lyko
You can find marbled crayfish close to the sea but you can also find them in rice paddies, in streams, in lakes – very different environments but always the same genome, so how does this animal adapt? It can't be genetic because it only has one genome. So my opinion is that it has to be epigenetic and this will be a fascinating line of research for the future.

Interviewer: Benjamin Thompson

Frank is interested in how the clonal nature of the marbled crayfish might help us understand more about cancer, particularly its epigenetics which are the heritable changes in gene expression that don't require actual changes in DNA sequence. These genomes can also tell us something about tumour evolution.

Interviewee: Frank Lyko
One aspect would be that we use marble crayfish as a model to understand clonal genome evolution. This is a key feature of human tumours. But when a tumour is detected by a physician, it's usually so far evolved that it's hard to retrace the early steps. We have a genome here that is in its very early steps of evolution and we can follow the early steps by following it over time.

Interviewer: Benjamin Thompson
That was Frank Lyko. You can find his *Nature Ecology & Evolution* paper over at nature.com/N.E.E.

Interviewer: Shamini Bundell
Next up today, reporter Noah Baker has been investigating a new method for making super-strong wood.

Interviewer: Noah Baker
Wood is one of the oldest and best known construction materials on the planet, but that doesn't mean that its full potential has been reached.

Interviewee: Liangbing Hu
As I explore this mature oak we start to realise there is a lot of potential in this mature tree.

Interviewer: Noah Baker
That's Liangbing Hu from the University of Maryland in the States, but Hu hasn't always worked with wood.

Interviewee: Liangbing Hu
I've been working in a company on carbon Nano-chips.

Interviewer: Noah Baker
But after a colleague showed him an image of wood fibres taken with a scanning electron microscope, Hu was taken aback.

Interviewee: Liangbing Hu
I was actually confused. I thought this was carbon Nanotubes and he told me this was actually cellulose Nano-fibres.

Interviewer: Noah Baker
Cellulose Nano-fibres are the long aligned fibres which make up about 40% of wood's mass. We'll tweet a pic so you can see what he's talking about, @NaturePodcast.

Interviewee: Liangbing Hu

Once I noticed the similarity in carbon Nano-tubes and cellulose Nano-fibres, I realised this is a material I want to work on and that has a lot of potential to be explored.

Interviewer: Noah Baker
Hu wanted to try to maximise wood's mechanical strength by engineering it at the Nano-scale. But first he needed to understand the Nano-structure of wood.

Interviewee: Liangbing Hu
As trees grow, you know, you have these wonderful Nano-fibres along the cross direction and this lignin is embedded in the wood.

Interviewer: Noah Baker
This lignin is an important player.

Interviewee: Liangbing Hu
Lignin is like a binder that glues everything together in a tree.

Interviewer: Noah Baker
So, we have fibres glued together by lignin, and then there's one final structural component.

Interviewee: Liangbing Hu
The fibres are arranged in a way that they have these micro-sized channels that help to pump the water or pump the nutrition up to the top of the tree. But if you look at this as a mechanical structure material, these big channels are defects so our process is basically; remove these big channels by compressing them.

Interviewer: Noah Baker
The idea is that by squishing out these channels, Hu can remove the mechanical defects, but before he can press the wood, he has to remove that glue-like lignin. However, crucially, not all of it.

Interviewee: Liangbing Hu
To be able to hold this structure together we have to keep part of the lignin inside of the wood and by doing so you can realise the potential of this material.

Interviewer: Noah Baker
The process Hu uses is quite simple; in fact, it's very similar to the process used to make paper. Hu removes some of the linin from the wood in a high temperature chemical bath, and then compresses it.

Interviewee: Liangbing Hu
In our process, we carefully keep the integrity of the wood, and then you press it into this strong, tough material.

Interviewer: Noah Baker
After testing, the densified wood's strength and toughness were significantly increased.

Interviewee: Liangbing Hu
In the end, it's still a piece of wood but the strength is about 10 to 20 times higher and the toughness, at the same time, is also 10 to 20 times higher. And the weight is about four to five times better than the best steel.

Interviewer: Noah Baker
Hu compared the densified wood to another well-known material.

Interviewee: Liangbing Hu
Its strength and toughness is very similar to carbon fibre but it is about 10 times cheaper than carbon fibre.

Interviewer: Noah Baker
Hu's densified wood isn't quite as strong or tough as carbon fibre just yet, but it isn't far off. So, what could super strong wood be useful for? Well, Hu suggested the construction industry. He even mentioned skyscrapers, but he has plenty of other ideas too.

Interviewee: Liangbing Hu
So, this mature oak can be used in many applications when you need the strength and toughness, and even better if you need a lighter weight. You know, for light weight vehicles, for wind turbines, for aeroplanes.

Interviewer: Noah Baker
Hu isn't claiming this material can do everything. It can be brittle and although there is an improvement over natural wood, there remains a possible problem with moisture resistance, but no one material can ever suit all applications. Now, Hu isn't alone in this research area. Other researchers have already achieved somewhat comparable results and some actually consider this paper to be a fairly underwhelming advance. Fred Kamke, chair of wood-based composite science at Oregon State University also noted that, quote, 'these other methods are probably much less expensive than a seven hour boil in a caustic solution,' end quote. He was referring to Hu's delignification process. Hu, however, believes that his process is still economically viable.

Interviewee: Liangbing Hu
To be honest, we haven't done a careful comparison but I think it's going to be fairly cost effective compared to many of the composites people made using biomass, or even using carbon fibre or glass fibre.

Interviewer: Noah Baker
Either way, Hu has patented certain steps of his process, specifically the bits related to the partial lignin removal. He's also in talks with the automotive industry and the construction industry and aims to commercialise his product. So who knows, maybe in twenty years' time you'll re-listen to this episode while you drive to work in your wooden car.

Interviewer: Benjamin Thompson

That was Liangbing Hu from the University of Maryland. Quick straw poll then everyone… Which do you think is more likely: 'a' that people will be driving wooden cars in the future or 'b' that they'll be listening to 20 year old *Nature Podcasts*? Answers on a post card.

Interviewer: Shamini Bundell
Or on Twitter @Naturepodcast: whichever you prefer.

Interviewer: Benjamin Thompson
Last up this week it's the News Chat, and joining me again here is Ewen Callaway, a Senior Reporter here at *Nature*. Ewen, thanks for coming back.

Interviewee: Ewen Callaway
Yeah, any time.

Interviewer: Benjamin Thompson
Okay, so first up today we're going to be talking again about ancient hominins and this time we're going to revisit a story from last year about a rather controversial paper suggesting that humans might have settled in North America an awful lot earlier than previously thought. Ewen, in the first instance then, maybe you could refresh our listeners' memories with what happened before.

Interviewee: Ewen Callaway
Yeah, I can't remember if we covered this one on the podcast but listeners probably will have heard of it. Basically, about a year ago – April or so, 2017 – *Nature* published a paper from some researchers claiming that this mastodon found in suburban San Diego was butchered by humans 130, 000 years ago which is a crazily old date for humans to be in North America. The best evidence suggests that humans from Asia crossed the Bering land bridge 20 or so thousand years ago, 25,000 years ago and made their way down to the Americas. I think the oldest archaeological site that most people, that universities agree is a site is about 15,500 year old or something like that. So, this find from San Diego pushed human occupation of the Americas back 115,000 year, let's put it, and not everyone believed it. Let's just put it that way.

Interviewer: Benjamin Thompson
So this then had the potential to rewrite a lot of previously held dogma about human movements and the rest of it. But as you say there, it's not without its naysayers. So what's happened this week then?

Interviewee: Ewen Callaway
First it's important to say that as soon as this paper was published, there was criticism. I reported it as a reporter and very few of my outside sources believed it. They just said, you know, extraordinary claims require extraordinary evidence. What's new though is that *Nature* is publishing a response from a team of archaeologists basically saying this looks more like the sort of damage they saw in the mastodon bones in San Diego. This looks like damage that was caused by a digger or backhoe, you know, construction equipment or just natural processes. And to kind of back up that claim, they looked out of their back yards to a site with a couple of dozen ancient mammoths and found damage patterns in the mammoth

bones that they say are very similar to the ones in the mastodon bones which the authors of that paper use as evidence to say this looks like it was hit by a stone tool, by a hominin. What the authors are saying in this new paper, is basically, hominins may have been here 130,000 years ago but this isn't evidence for it.

Interviewer: Benjamin Thompson
Yes, so in the brief communication that you can read in *Nature* this week, they do seem to systematically go through some of the claims in the previous paper and are unflinching in their thoughts.

Interviewee: Ewen Callaway
Yeah, I spoke with them and their thoughts were pretty instant when the paper was published and it's just taken quite a few months to get this thing out as it often does in science publishing. But yeah, I mean they go step by step and say that none of this reaches their criteria for proving that humans did this. They say there are other explanations in every single case and the authors in the original paper, they're allowed their one page rebuttal. They stand by their argument and they told me the other day when I spoke with them on the phone. They just said look, we know this is an extraordinary hypothesis, but just come and look at these bones and see what you think. But nobody is convinced so far, that I've spoken with.

Interviewer: Benjamin Thompson
Well I guess that the Latin root of the word 'science' is 'knowledge' and if one group are saying 'x', the other group are saying 'y' and then our first group is saying, no it really is 'x' again, where does that lead us? Where do we take it next?

Interviewee: Ewen Callaway
Yeah, that's a good question because we're doing science and you should present a hypothesis that is falsifiable. You know, what will prove you wrong? If you're not doing that, you're not doing science and I don't really know what the answer is here. I asked this question to the authors of the original paper, making this claim that humans were in California 130,000 years ago and they said if somebody can come up with a better explanation than humans did this. And obviously the authors of this response think they've come up with quite a few explanations so what do you do? You just shrug your shoulders and the community will decide.

Interviewer: Benjamin Thompson
Well, let's change tack completely in this instance and let's go to South Korea and a government investigation into manuscript authors. What have we got going on there then?

Interviewee: Ewen Callaway
Yeah, I mean, the big news in South Korea obviously is the Winter Olympics coming up really soon but the other big news, it's been all over Korean newspapers, is that the government has launched an investigation into scientists who put their children as co-authors on research papers in order to boost their children's chances of getting into university. As I said, the government has looked into accusations that this has happened. So far they found 39 instances in which kids that were on papers but they actually did something. Summer

science project, summer job, that sort of thing but they found that 43 instances where it seems like the kids didn't really earn their authorship.

Interviewer: Benjamin Thompson
Okay so they found this many papers then – is that all of them?

Interviewee: Ewen Callaway
I would seriously doubt it. It sounds like they're going to be doing a much more thorough investigation, going through lots of papers and identifying those that have children as authors. I guess they'll be looking for instances where there was no contribution to the paper and in the instances where they find those I think they'll be referred to the universities but as our story indicates, some of these could result in the dismissal of the researcher involved because this is misconduct. Putting somebody's name on a paper who didn't do any work, whether it's your children, your mother, your grandmother or your barber, that's misconduct.

Interviewer: Benjamin Thompson
But I guess people putting names of friends, colleagues, higher-ups on papers is something that's gone on for a very, very long time.

Interviewee: Ewen Callaway
Yeah, it has. It's got a term; it's called ghost-authorship and it's something that, as you say, has gone on all the time. You could imagine that you put your advisor on, or some senior person in your department on a paper and they haven't done any work to earn it. So, yeah this goes on all the time. And it's important to note that journals and others are trying to crack down on this. If you look at the back of a lot of papers and I think including papers in *Nature*, you'll see an explanation of what each author did to earn their authorship in this case. So I think funders, journals, universities realise that ghost-authorship is a problem and are taking steps to deal with it but with so many journals out there it's hard to police them all so I think this problem will continue of ghost authorship, whether it's children or Nobel laureates.

Interviewer: Benjamin Thompson
Thank you very much then Ewen. For more on these stories, and the latest science news, head over to Nature.com/news.

Interviewer: Shamini Bundell
And, some science news from a few weeks ago: you may remember Adam finding out about a tiny magnetic robot.

Interviewer: Benjamin Thompson
Ah, that robot is adorable.

Interviewer: Shamini Bundell
Well if you want to see it in action, you can check out a short film all about it online at youtube.com/NatureVideoChannel.

Interviewer: Benjamin Thompson
Well, that's it for this week then. Don't forget to tweet us @Naturepodcast or email us on podcast@nature.com. I'm Benjamin Thompson.

Interviewer: Shamini Bundell
And I'm Shamini Bundell. Thanks for listening.

[Jingle]