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HD **Addicted to the screen?**

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Telescope celebrates 40 years

Robots - not about to take over, but certainly getting smarter

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Exotic ants tip the balance on Christmas **Island**

How to help the paedophile who seeks help

Compulsive gaming - something to be worried about?

Robyn Williams: We're on Siding Spring Mountain in western New South Wales, and this is the Orbital Swing Band of Coonabarabran:

[Music]

The band helping to celebrate two magnificent anniversaries, 50 years of astronomy on top of the mountain, and 40 years of the Anglo-Australian Telescope. It was opened on 16 October in 1974. This is The Science Show on RN, and let's climb the great light bucket to see what's changed.

I'm standing outside very, very high up on one of the most ancient mountain ranges in the world, the Warrumbungles, on Siding Spring Mountain, and I'm on top of the great telescope, the Anglo-Australian, that I came to visit when it was being built in 1972 - '73. And Doug, what are we looking down at here?

Doug Gray: We're looking down into the National **Park**. This is where the fire started in 2013. As we are looking out into the Valley there is a little hill over there are called Split Rock, that's where the fire started on the Friday or the Saturday, I can't remember exactly now, and by Sunday it had blown right over the observatory.

Robyn Williams: And how close did it get to the telescope, and the other telescope, the buildings?

Doug Gray: The fire front came right over here. It came over in three fronts. The fire front came over there, over to where you can see Sky Mapper. The telescope was standing on…it's about 50 metres off the ground, and the fire front was 50 metres above that. One of the RFS fire captains was a helicopter pilot and he was actually hovering over here when the fire front came over and he had to actually get out of the way.

Robyn Williams: So how much damage was that to the instrumentation and so on?

Doug Gray: To the telescopes on the mountain, no damage sustained at all. The fire authorities were quite aware of the value of the **property** here, so they protected the telescopes, but unfortunately we lost what's called the Lodge accommodation for the astronomers, and we also lost the house up here. But apart from that we lost nothing else.

Robyn Williams: And that Lodge I stayed in in '72, it was just being finished.

Doug Gray: Well, there's plans afoot to replace it.

Robyn Williams: And tell me, at the top of this telescope as we look down, I can't quite see it, you've got a red ribbon right around it. What for?

Doug Gray: Well, this is the 40th anniversary of the telescope here. We are celebrating a number of anniversaries. It's the 50th anniversary of the mountain at Siding Spring when the first telescope arrived. It is also the 40th anniversary of the AAT, it's the 30th anniversary of the ANU's 2.3 telescope, and so on. There's a number of anniversaries all being celebrated today.

Robyn Williams: Why was Siding Spring chosen in the first place 50 years ago, can you remember?

Doug Gray: I wasn't around at the time, but a lot of effort went into **site** testing, and also Australia was trying to find a collaborator to build a telescope with. Originally they were trying to collaborate with the Americans but they went solo. So they collaborated with the British, and they wanted a telescope in the southern hemisphere, so there was extensive research done to try and find the best location, and Siding Spring was chosen.

Robyn Williams: Of course it's wonderfully peaceful here, the viewing is good, the weather is not bad either.

Doug Gray: No, we are in a very dark region of New South Wales, and that's one of the reasons it was chosen. We are on top of a hill, about 1,100 metres, and we have very clear skies. The weather is not too dissimilar to the British weather, but we put up with that, there's not much we can do.

Robyn Williams: It's as clear as anything at the moment, wonderful blue skies, and the viewing is pretty good, isn't it.

Doug Gray: It's spectacular. The view from the top of the dome here is absolutely wonderful.

Robyn Williams: Going back to the fire, I remember the last time I drive up and drove back actually at night, the animals were everywhere. They tell me that since the fire the animal population has been somewhat depleted. Is that right?

Doug Gray: It was to a point, it's now coming back. We've had koalas on the mountain again, the kangaroos have come back in leaps and bounds, as they say.

Robyn Williams: And what's the plan for today, for the open day to show the public?

Doug Gray: Well, all the telescopes are going to be open. The AAT is open, the 2.3, and there's a number of other telescopes. An organisation called iTelescopes, they are going to be open. That's an organisation where people can actually subscribe to the **company** and do observing. It can be anybody from the public.

Robyn Williams: And there's the Schmidt telescope, which has been here many, many decades, and that is a mapping telescope, is it not, where you actually do charts of the sky itself.

Doug Gray: That's correct. Unfortunately that telescope won't be open. It is being renovated getting ready for a new project coming up called Taipan, and we're in the process of refurbishing the telescope, the dome, the drive systems, and getting a new instrument ready for Taipan which will work in collaboration with the SKA in Western Australia.

Robyn Williams: The Square Kilometre Array. What is Taipan exactly?

Doug Gray: I've no idea I'm afraid!

Robyn Williams: I shall ask an astronomer! Thanks very much Doug.

Doug Gray: Not at all, you're welcome.

Robyn Williams: Well, I have to confess I have been to the very top of the telescope, the observatory, and I never dreamt that I could do it, it's very, very high up. I'm standing with Amanda Bauer, actually inside now, where the great dish is. Amanda Bauer, you do research here astronomically, do you?

Amanda Bauer: Absolutely.

Robyn Williams: What aspect?

Amanda Bauer: I work on how galaxies form, how they form new stars and particularly how they stop forming new stars.

Robyn Williams: What stops them?

Amanda Bauer: Well, they run out of gas, they run out of fuel. If you run out of wood to throw on your fire you're not going to burn a fire anymore. But how do they run out of the gas? Where does it go, or is it there and for some reason it just can't get onto the fire? Those are the interesting questions.

Robyn Williams: So we are under the dome and we've got the great big mechanism which is presumably controlling the huge mirror, is that right?

Amanda Bauer: Yes, this is the mount on which the big mirror sits, and that turns around inside the dome, and the dome opens a little hole so you can see right out there and it follows where the telescope goes throughout the night.

Robyn Williams: And as I remember it's computer-controlled, so you do your settings and gradually it obeys.

Amanda Bauer: Absolutely. It's a good thing those computers do that for us. I don't really want to do that calculation in the middle of the night.

Robyn Williams: No, but when the computers were put in, it was such a big deal 40 years ago, and we are celebrating the 40th birthday now. It's presumably not the same computers as way back then?

Amanda Bauer: No, we've definitely improved the computer technology, although the interface, the buttons you push to actually move the telescope around are the original 1974 control panels, so you feel like you are jumping back in time.

Robyn Williams: How charming! And the same mirror, which is a precision instrument. Of course now they are doing mirrors in parts up to 30 metres across, it's incredible, isn't it.

Amanda Bauer: The weight of gravity makes it such that you can't make a mirror quite that big because it just pulls on different sides, so we make a mirror in sections. So some of the mirrors will have eight-metre mirrors put together to form a 30-metre mirror. Or we have little tiny ones that are made up of maybe 90 hexagonal mirrors that you all put together. But then you need the computer technology to focus them all into the same spot. You don't want one accidentally pointing a bit off to the side.

Robyn Williams: Exactly. Out there, way high up, I was talking to Doug about Taipan. Do you know what Taipan is?

Amanda Bauer: It's a very bad snake that I don't want to meet out in the bush! We have a new project that's on the other telescope, the old UK Schmidt telescope, and this one is using what we call Starbug technology, individual little robots that zoom around on a glass plate. And each one of them lands on a galaxy. So maybe we will have 400 of these little Starbugs zooming around. They can position themselves in just a few minutes, and then we are off observing 400 galaxies at a time.

Robyn Williams: 400! Why don't you just concentrate on one galaxy? And our galaxy is so huge that the light travelling across would not leave in our lifetime.

Amanda Bauer: That's absolutely true. Imagine if you were trying to figure out human life and all you had was a photo album and it had some baby pictures and some pictures of the teenage years with your horrible hair and pictures of people at different ages and you were just thrown those and asked how does a human go through its life. You can't figure that out just by looking at one human, one snapshot at one point. You have no idea that at one point it was this two-foot-long tiny baby. So what I try to do is statistically look at as many galaxies as I can and see what their typical stages are, try to put together their lifetime through as many photos as I can throughout their life. So that's why I want to look at 400 at a time, ultimately hundreds of thousands of galaxies.

Robyn Williams: This used to be called the Anglo-Australian telescope. What is it now?

Amanda Bauer: The telescope name is the same but the observatory itself is now the Australian Astronomical Observatory, which is a bit of a mouthful, I have to say.

Robyn Williams: With the headquarters in Sydney.

Amanda Bauer: Yes. So the headquarters were in Epping. We just recently got a new building after we moved into the Department of Industry, and so we are based in North Ryde, that's where we do a lot of the instrumentation and technology development and the science operations. So I come up here and I use the telescope for about a week, I'll stay up all night, but then I take my data back to Sydney and I have my computer there and I sit there and I analyse things and figure out how the universe works.

Robyn Williams: And the other telescopes stretched around the mountain, they are still in use, are they?

Amanda Bauer: There's many of them up here. Some of the original ones have shut down, so you just have the guts of the domes. But there are about 12 operating telescopes, some of them are remote from other places in the world. And then the iTelescope shed has 18 telescopes inside and those are amateur

telescopes that are all used remotely through a computer from somewhere, wherever people are in the world.

Robyn Williams: And you are getting ready today to show the public around. What interest does the public have? Obviously they love astronomy and they love science, but is there any pattern? Is it fairly random, or what?

Amanda Bauer: You come in here and it is just a massively impressive bit of technology. I think telescopes now, they can build tiny little domes, but because of the way this telescope has its equatorial mount, it needs this huge dome, and it just feels like you are in a monster museum or something. And then we've got our 2DF robot, so you can see this robot placing little optical fibres, and it's just such impressive work that we've all done in-house in Australia. I think you forget how cool it is just to look at it.

Robyn Williams: 2DF, that's two degrees of field, and that's looking at a part of the universe in a very concentrated way and getting one light, if you like, coming from each star, or something like it. Is that roughly it?

Amanda Bauer: Yes, one snapshot of what a galaxy looked like, however far away it was, so whatever it looked like at that distance that time ago.

Robyn Williams: So it's really a concentrated look at one patch.

Amanda Bauer: Exactly. So the two degrees, that's about four full Moons next to each other and a big circle around that. And so that's actually a very big field. That's why the 2DF also allows us to look at 400 galaxies at once because there will be many, many, many in that two-degree field, but we can look at all of those, get all of those snapshots, make a whole photo album just from one hour of exposure.

Robyn Williams: Thank you very much.

Amanda Bauer: Thank you for having me.

Robyn Williams: That was Amanda Bauer, a research astronomer with the Australian Observatory. And before her I was with Doug Gray, the operations manager.

And now I'm outside again on the mountain, where a fireman is just getting out of his big red truck. His badge says Tony Waldron. Tony, were you here at the time of the big fire?

Tony Waldron: January 13, 2013. Yes, it was a bit like a scene from one of those Apocalypse Now movies I suppose. Yeah, the worst hand that could be dealt at us was dealt at us; dry hot conditions leading up to weeks before and the wind and the amount of fuel that was on the ground.

Robyn Williams: Were you here yourself, Tony?

Tony Waldron: I was on the northern end of the **park** here, just actually when Siding Springs was being impacted on I was helping set up the airbase, keep it running, to get the planes up here. And then I responded out to my brigade area where we were impacted on and lost several homes.

Robyn Williams: Incredible. Well, the thing that amazed me, looking as we are now at the foot of the great telescope with its red ribbon around it, up the top there…I was standing at the top there, I couldn't believe I could actually do it, they told me that the fire went twice as high.

Tony Waldron: Yes, it would have done on the day. I mean, there's enough vision around, you'd see on Facebook and local media and ABC, most of the flames that day were probably triple the size of what they would be on any other day. It was catastrophic conditions to the west of us. Yeah, it dealt its worst hand at us.

Robyn Williams: How did it compare with the great terrible fire around Canberra?

Tony Waldron: I was down in Canberra back in 2003, it looked twice as bad as that, and the noise it made, and again, it was uncontrollable, it was catastrophic conditions. Again, it just comes down to people being prepared, like the observatory here being prepared. I mean, they lost one building but that was due to just one bit of mesh being missing and embers getting involved, that's what takes them out. It was ferocious, but again we all coped on the day, no lives were lost, that was the main thing.

Robyn Williams: That's great. But how do you cope in a situation like that where it's so big? How do you fight it?

Tony Waldron: When it's that big we fall back into **property** protection, and lives of course, lives is the number one responsibility to us. But it just comes down to our training.

Robyn Williams: You know, there was a special program done on ABC television, Catalyst, called 'Don't Panic', and what it showed is that families who are bright, they are sensible but they haven't practised, and when the fire comes the brain does something different, it kind of melts, and you actually can't cope with it. So the whole point is to be prepared and have practise.

Tony Waldron: That's what we say to them and that's part of my job, as I say, I'm a firefighter. But after being in Canberra in 2003, the preparation before the fire impacted, after the event but by the other areas that were going to be impacted on, and it worked. I mean, I came home here and I've been pushing it ever since. And again, the houses that have survived here were ones that were well prepared, people had a plan. I mean, admittedly we didn't get much chance to activate it and get going, but if you are…planning to have a plan is not a plan. You've got to have a plan and run through it a couple of times. Even now, now is the time to be practising at home because we are running into another severe fire season, and again, we are not going to have a red truck at every house, so people have to be prepared. It comes down to having a pump or evacuating, leaving early. Don't leave it to the last minute because unfortunately that's when people lose their lives.

Robyn Williams: What are the signs of a bad summer?

Tony Waldron: No rain, dry conditions, long grass around your house and in the bush. Again, this El Niño thing that's coming. But yeah, now is the time to start preparing your **property**. Actually the RFS have got a weekend happening…I think it's Prepare Your Home Weekend, next weekend I think, don't quote me on that, about the 18th or 19th, and they are asking everyone in the state to actually do the spring cleaning, prepare your **property** because of the fire season that's coming.

Robyn Williams: Thank you very much.

Tony Waldron: Thank you, have a great day.

Robyn Williams: Tony Waldron, captain of the Rural Fire Service on Siding Spring Mountain.

And this is The Science Show on RN where we just heard Amanda Bauer talk about all those robots running the giant instruments. Here's one of them.

Amanda Bauer: This is the robot. The robot reaches down and clamps onto one of these little metal pieces and moves the optical fibre to a place on the metal plate and drops it, and its little magnet allows it to stick very precisely. Each one of these fibres has a little light that comes out of it, so the robot can detect that light and know exactly how accurately it's pointing and pick it up and adjust it and then move it a little bit.

Robyn Williams: I suppose if you did it by hand it would take about four years.

Amanda Bauer: Well, have you heard of the Sloan Digital Sky Survey? This is a big survey that is based in New Mexico, and they were developing their technology about the same time this was, and they decided to have big metal plates that they drilled holes in, and they have humans plugging these optical fibres into those plates, and that's what they've been doing for 20 years. So you never quite improve your efficiency that way, whereas we decided to go with the robotic technology. And robots are a bit finicky. They have little attitudes, but we have robot whisperers, as you see around here, who know how to talk to it.

Robyn Williams: A chain is being moved…

Amanda Bauer: Technical things are happening! So with the robotic technology we can still improve the software and improve aspects of it over the years. So it's a bit better now than it was when we first developed it, but it's a funky little robot.

Robyn Williams: Amanda Bauer with the robot running the telescope. But many other robots don't seem quite so funky. Over in Birmingham for instance is one that is trying to pick up objects you'll find in your kitchen. You and I pick them up and put them down without thinking, but this robot…well…

So you are about to give me an object to put on the table in front of the robot. Any particular one? The funnel, the pan?

Jeremy Wyatt: Pick which you like.

Robyn Williams: I rather like the funnel, it's a red funnel. So I put it over there…

Jeremy Wyatt: We're going to put it on here first, and now you put the final on top.

Robyn Williams: There we are…

Jeremy Wyatt: Oh, see, you've broken it already…

Robyn Williams: I've broken the…aw! Let me just to describe, while you're trying to work out what needs to be fixed, it's huge, each arm has got two arms and they are something like twice the size of a normal human arm, lots of joints, and a kind of head up the top with seeing eyes perhaps. Anyway, tell me who you are first and where we are.

Jeremy Wyatt: So I'm Jeremy Wyatt, we are at the University of Birmingham in the robot lab.

Robyn Williams: Right, and you've got a whole number of robots. Which is this one?

Jeremy Wyatt: This is Boris.

Robyn Williams: Boris…but he doesn't have a blond mop.

Jeremy Wyatt: He doesn't have a blond mop, no, I'm not going to draw comparisons with the Mayor of London. They look like quite different characters to me.

Robyn Williams: Right, okay. And what you are trying to do here is pick up an object, and this is an object that is unexpected. In other words, it's not the kind of routine picking up and movement that we can see in places where robots build motorcars, this is de novo, this is something that it's got to learn and home in on afresh. So you are teaching it to learn in many ways, are you?

Jeremy Wyatt: Yes, exactly. So what we're doing is we showed it one object and we showed it exactly how to grasp that one object, and then what we are doing here, as you say, de novo, we are showing it a new object which it hasn't seen before, and you cunningly put the funnel upside down, and so that's going to break it in this case, but if we turn the funnel the other side up it will figure out how to grasp it, because this particular grasp, it knows how to grasp a rim.

Robyn Williams: Can I dare do it without breaking it again? Is that okay?

Jeremy Wyatt: That's looking pretty good.

Robyn Williams: And it will decide at some point…

Jeremy Wyatt: Up on the screen over there you can see its little hands appearing, and those hands are where it thinks it might be able to grasp it.

Robyn Williams: So we are looking at its brain, are we, in other words?

Jeremy Wyatt: You are looking at a visualisation of what it's thinking about.

Robyn Williams: Okay. The tension is killing…beginning to…no, no, it's just still thinking…

Jeremy Wyatt: You'll know when it wants to do something because by looking at this screen over here it will tell you it wants to go and grasp it.

Robyn Williams: Is it a real challenge, teaching it to do something new every time?

Jeremy Wyatt: Yes, I think is the one-word answer to that! The interesting thing is building it so that it's robust even to a relatively small range of variation. So it's a real challenge to build a robot that is robust even to variations that to a human are trivial. So, for example, if you pick up a glass, it's all shiny. That foxes current robots. Metal, shiny, that's also really hard. Things that are too brittle, things that are too soft. So to bring robots out into the real world, into our world, to get them to work with us, you've got to cope with all of this variation…

Robyn Williams: It's doing it now, it's doing it now! It has picked up the funnel, it's grasping it, a big hand, lifting it up, and the task is to bring it across to a tray full of polystyrene where presumably it will be placed securely. Moving towards the tray, and up and down it comes…drops. And that's good, is it?

Jeremy Wyatt: That's good, I'm happy with that.

Robyn Williams: What is the task that it might do when you've got full computerisation of the actions and so on? What can it do in the household, for example?

Jeremy Wyatt: So the task of this project, the objective is to get the robot to load a dishwasher tray. So you going to have a bunch of objects on the table, scattered as you might have them on a regular kitchen surface, then the robot is going to look through the set of objects, find the one it wants to pick up, figure out where to put it into the dishwasher, and load it. And that is not because we think that dishwashing-loading robots are a critical social need…

Robyn Williams: You could have a Polish au pair to do that for you more easily.

Jeremy Wyatt: I couldn't possibly comment. But the thing is that it's a typical task that humans engage in that requires all of your manipulative faculties that evolution spent hundreds of millions of years developing. And so by being able to put that into a robot we hope to make the robots more flexible in the future. So immediately it's going to do the dishwasher loading task.

Robyn Williams: Now, a naive question; we already have driverless cars which can adapt to presumably the unexpected in a busy highway. How does that compare with what I've got in front of me in terms of robotics?

Jeremy Wyatt: In terms of the machine learning…so machine learning has really been the revolution in all kinds of computing, so you can see a lot of data mining, you can see self-driving cars, robots like this, they are all doing machine learning in one form or another, so in that way they are the same. What's a little bit different here is that you are coming into contact with the world to change it, whereas in the car you are moving along the road and you are trying not to change the world, you're trying not to touch things other than the road surface with the wheels.

And so what we are doing here is we are really trying to alter the world, and that's what humans do because we are tool-using animals, that's how we made our world. And so it is thinking about almost a kind of a third generation of robots, because the first generation was industrial robots and they manipulate the world when it is very precisely controlled. And now what we are getting is drones and we are getting self-driving cars and mobile robots that can move around in our world and share it with us safely, even though that world is very uncertain and novel to them. But the moment you want to contact the world and change it, manipulate things in your fingers, use tools, make stuff, assemble things, work with people, then you've got to be able to contact it and that then makes it much, much harder again if you are going to do it under uncertainty.

Robyn Williams: Well, that's Boris. What sort of other robots do you have in this laboratory?

Jeremy Wyatt: So if we walk over here we've got Baxter. So Baxter has come from America. So Boris we built here, but Baxter is an American robot. And whereas Boris cost about $350,000, the Americans have made Baxter for about $20,000. So this is a really good example of trying to get some of the tech that actually in future we are developing in Boris could go into a robot like this because this is meant to reshore small-scale manufacturing. So that was the idea of Rod Brooks, its inventor.

And it's a big red robot with two arms, and these arms are very floppy and flexible. So what you can do is you can teach the robot by moving the arms around and showing it how to do tasks. And it can pick things up. It also has little cameras underneath its wrists. So that one is, again, not so much for assembly but for picking and placing things in production lines.

Robyn Williams: Again he is just about the same size as a fairly hefty human. And Rodney Brooks is in fact an Australian at MIT, is he not?

Jeremy Wyatt: He is, yes. And over here we have an educational robot which is based on a French platform called a Nao, made by a **company** called Aldebaran, and that robot, what it's doing is some children when they are learning they get a lot from interacting with a robot. So some children prefer to interact with a robot to a human, and so what happens the robot is used to give feedback to the children on what they are doing.

And then outside we've got our mobile robot, Bob. And Bob is a robot who we've been…well, he's been on work placement as a security guard at G4S, the security **company**. And he's developing technology for running over very long periods of time. So a very long period of time for a research robot is anything more than a day, because trying to make these systems reliable, particularly when they are encountering humans, because humans always do something that you don't expect. Bob has got to cope with that. And so Bob tries to build up a picture over time by learning how the humans behave, so then he can adapt to the way that the humans work.

Robyn Williams: How far off are you from doing something that's almost like a human in its adaptability and flexibility?

Jeremy Wyatt: I think we are possibly still a really long way. But the message here is that even a little bit of adaptability and flexibility goes a really long way. So we are going to have robots coming with just a little bit of intelligence and they are going to solve little tasks for us. So, for example, James Dyson has just announced that he is going to release his new robot vacuum cleaner. That's going to be the first robot vacuum cleaner in the world that can see and can recognise where it is in the room. So it's just a little bit of intelligence but it's really, really useful for the task of doing the robot vacuum cleaning and going back and cleaning up the bits of the house that you know people tend to leave really dirty.

Robyn Williams: Okay, you're in Birmingham, you're in the computer department here. How would you compare Britain with robotics to, say, Germany, you mentioned America, in the league table?

Jeremy Wyatt: In terms of research the UK actually does really well. We have lots of really interesting ideas coming out of the labs. The Germans are really, really good at industrial robotics and they are the powerhouse in the world. I mean, other than the Japanese, Germany makes all the world's industrial robots, so they are brilliant at that.

In America they do a lot of work in military robots and they also have some wonderful labs. Australia is actually the hotbed for field robotics. So down in Australia, particularly for the mining industry, there's a huge amount of work going on in field robotics there, and they are amazing at that.

Robyn Williams: Thank you.

Jeremy Wyatt: Thank you.

Robyn Williams: Jeremy Wyatt and the robot lab at the University of Birmingham, with Boris and Baxter, Rodney Brooks' great big red brute from MIT. And you can see Baxter in the new edition of Cosmos magazine, just out, with a special on robotics.

Our PhD this week is from La Trobe University in Melbourne, though he spends most of his time on Christmas **Island**. Luke O'Loughlin, on invasive species:

Luke O'Loughlin: Human activities are significantly transforming natural environments. One key consequence of human success has been the movement of many species beyond the limits of their native ranges into areas they do not naturally occur. Now there is essentially no ecosystem that is free of exotic species. Yet not all species become invasive and cause impact. Some are unsuccessful and never establish.

It has been increasingly recognised that the properties of the recipient community play a key role in either allowing or inhibiting the entry and spread of an invader. However, what is also evident is that successful invaders can, through their impacts, alter key properties of ecosystems that they invade, thereby creating altered communities. And it's in these altered communities that previously unsuccessful exotic species may now have an opportunity to enter and become invasive themselves. In a time where the eradication of many invasive species is simply not practical, understanding the kinds of interactions that conform is vital to the conservation effort of these now novel ecosystems.

For my PhD research I'm thinking about these kinds of issues in the context of exotic species interactions on Christmas **Island**. Due to its isolation and position within the Indian Ocean, Christmas **Island** has evolved a unique tropical ecosystem with high species endemism. Essentially all ecosystem processes in the rainforest there are driven by the highly abundant native red land crab. This species is found in natural densities of almost one crab per square metre. They are responsible for consuming almost all leaf litter and new seedling germinates, so that rainforest on Christmas **Island** looks quite interesting and unique in that it is structurally simple and open and the ground free of leaf litter for much of the year.

Unfortunately, in recent decades areas of the **island** have become overrun by the exotic yellow crazy ant. These ants establish a mutualistic relationship with exotic honeydew producing scale insects and form multi-queen super-colonies that overwhelm and kill all red land crabs within an area. This local extinction of a real keystone species causes significant changes to the properties of the ecosystem. Leaf litter builds up and is able to persist throughout the year, seedlings recruit en masse, which increases habitat complexity, and as the red crab is an omnivorous species, there is also the creation of enemy-free space through the removal of a potential predator.

So the main question of my project: do successful invaders (in this case the yellow crazy ant and scale insects) facilitate the invasion success of other previously unsuccessful invaders as a result of altering properties of the recipient community? To address this I looked at the exotic land snails on Christmas **Island**, a community that comprises of around 22 species in which the smallest are one-millimetre-long litter dwellers, and the largest are the giant African land snails which can be as big as the palm of your hand.

From sampling across the **island**, I found that although many of these snails were present in intact forest where crabs were common, in areas where crabs had been removed by the crazy ants, these exotic snails were orders of magnitude more abundant, the difference of only a few individuals versus hundreds. This suggests that the majority of these exotic snails was small enough to escape predation by the land crab but were limited by the lack of habitat and resources that intact rainforest on Christmas **Island** offered. The changes in properties of the recipient community as a result of yellow crazy ant invasion created conditions whereby populations of these exotic snails were released, and therefore able to increase in abundance, spread and become invasive.

It's my aim that by untangling these complex species interactions I can contribute to the kinds of important data needed to better understand the impacts of successful invaders and their potential indirect role in facilitating the invasion success of others, a process called secondary invasion. As I mentioned at the start, in a time where humans are constantly moving species all over the globe, understanding novel species interactions in altered ecosystems is highly important to our conservation efforts and the maintenance of healthy ecosystems.

Robyn Williams: Luke, that's amazing, the fact that the land crabs are so important is kind of well known, but their absence causing such disruption…now, if you are at La Trobe, and Christmas **Island** is, what, the other side of the continent, better known for asylum seekers, how often do you manage to get there?

Luke O'Loughlin: I've actually spent the best part of the last three years there. I've been mostly based on Christmas **Island**. It's a great spot.

Robyn Williams: It's an amazing **island**, isn't it, people forget that it's part of Australia.

Luke O'Loughlin: Yes, it's quite unique, it's like a place unto itself.

Robyn Williams: Far closer to Indonesia in some respects.

Luke O'Loughlin: Yes, only 300 kilometres south of Java.

Robyn Williams: Indeed. Thanks Luke. Luke O'Loughlin finishing his PhD at La Trobe.

And so to the internet, its unwanted effects on our minds. Last week I spoke to Dr Amy Lykins from the University of New England in Armidale, New South Wales, about paedophilia. This time, what about those who recognise their tendencies, how they're attracted to children sexually, but don't want to act on them? What can be done? Amy Lykins:

Amy Lykins: I've seen some people who come in and said, 'Look, I can't control this, I don't want to get in trouble, I don't want to hurt anybody, please let me take these medications.' And other people who it was very strongly recommended that they needed to take them, and those, when we are looking at recidivism, that tends to be the treatment that has the best outcome. I'm not saying that I recommend it for everyone, but if you are just looking at what does predict recidivism and lack of recidivism, if we are looking at reducing sex drive, sex drive reducing medications, that seems to have the best outcome for a number of people. You just take that edge off. There's really no good data at this point to suggest that we can change sexual preference in any respect, but if we can take the edge off the sexual desire and be able to give them tools to be able to manage their interests and their behaviour, then I think we are probably heading in a better direction.

Robyn Williams: You seem to be fairly sympathetic to some of them.

Amy Lykins: I'm sympathetic for the experience of it, I'm not sympathetic to the behaviour. I don't think that adults should be having sexual interaction with children. I think a lot of people would agree with me about that.

Robyn Williams: Everybody I should imagine!

Amy Lykins: Well, no, you'd get a number of people who are attracted to kids who say it's fine. But taking them aside, yes, most people are going to agree with that statement. The empathy that I have is for…imagining growing up, when everybody starts to realise what their sexual attraction is, if it's adult females, adult males, for anyone, gay, straight, whatever, we all start to realise that right around adolescence, we start to recognise sexual attraction. Imagine from that age and the rest of your life that your sexual attraction is to something you can't have, that society would put you in prison, that you may do more harm than anything else by engaging in this activity. This is how people are living their lives forever, 60, 80 years of having a drive to something that they know they can't have.

And that's where my empathy comes in, is that I feel that that is quite sad, and I think that to help with the kinds of things that may come along with that—depression, anxiety disorders, things like that—will help them live more productive lives and will also help them not offend, help them stay out of situations that would make them more likely to offend. So, looking at substance abuse issues, depression where people feel, 'well, forget it, who cares, I've got nothing to lose'. That's where we get into trouble I think. But that's a sad life.

Robyn Williams: Now, the other example of what seemed to be, as I read it in the paper only the other day in the Sunday Times of London, a married man in his 40s, happily married apparently, kids, a grown-up daughter in fact, and decides to go on the internet to look for sexy things, and gradually he is linked more and more down the road to paedo stuff. And the next thing he knows he's addicted. And the article referred

to 50,000 or more of people like that who had been normal, adjusted adults, and the internet comes along, unlimited choice comes along, and suddenly their brain is overwhelmed by this stuff. Does that make sense to you?

Amy Lykins: You know, we are in the really early stages of trying to understand why that might happen, because in human history…the internet has been around for 20 or 30 years. So looking at what effects that is having on us, our behaviour, possibly our brains and neuroplasticity, is still very early stage. Thinking about what might be an explanation for that, the 'normal person' who suddenly finds himself looking at child pornography, my first question would be, well, are we entirely sure that the person didn't have that interest before? My second response would be is it possibly curiosity?

One client I worked with, he wasn't an offender, but he came in because he was worried about his increasingly what he considered out-there behaviours. He happened to be a gay adult and was interested in obviously adult men, but he found himself engaging in more types of activities that he felt didn't represent his true interests, so he was filming himself, he was having sex without condoms, things that were putting him in risky situations. His explanation for that and a lot of people's explanation for that is I find that this doesn't get me off any more so I'm looking for the next thing, what is just that much more exciting.

And it's a common story that you hear in people who…maybe these 50,000, who say 'this is what I like but somehow I ended up looking at this'. There are different theories for that. The main theory that is being proposed now…I will say that they are not researchers, although they are very engaged in this area, aside from the fact that they are lawyers and…is looking at the idea of what we would call dopamine pruning. So similarly to we would see with a chemical addiction and tolerances that people experience. They take, say, one level of a drug that works for them for a certain amount of time but then it starts to not work for them because the brain adapts to it, so they have to take higher levels of the drug and increasing amounts. It's kind of a similar pattern where you are seeing at least self-reported for people who are saying that they are experiencing porn addiction, that 'I used to be fine with this but then that wasn't really interesting and so then I started looking at a little bit of S&M, and now I'm looking at really crazy S&M, and I don't know why, I don't feel like I'm attracted to this, but the other stuff isn't…'

Robyn Williams: And next kids.

Amy Lykins: And potentially next kids. It's really hard looking at activity preferences versus partner preference and how that all intersects.

Robyn Williams: Well, the guy that they are quoting in the paper says he'd never act on it in 1,000 years. In other words, his addiction is to the screen, not to personal behaviour.

Amy Lykins: And I hope that's true. But we as humans are notoriously unreliable in reporting our motivations. So it's one of the things that we ask in psychology if we are dealing with a client, you know, why do you think you did this or why do you think you feel this way. But as far as how accurate that might be, there's really no telling.

Robyn Williams: One could look at it in two ways, one could either say that yes, there is a slippery slope and you end up with marginal stuff because that's the only experience that gives you a hit with your addiction, or you could say there's something in lots of men's brains that is being exposed by this new technology, and hidden down there in the limbic system is all this nasty squirmy potential for being antisocial and being turned on by kids. If you had the choice, given the limited amount of research there is available, which would you go for?

Amy Lykins: It's hard to say. I would hope that the slippery slope is probably the better explanation, because it's not nice to think that everyone is a potential sex offender, and I don't believe that. As far as deep down in the 'reptilian brain', that's where you get the argument that sexual attraction to pubescents shouldn't be considered a problem, that they are, at least in some people's argument, becoming sexually mature, and that when people were only living up until their 30s and that was old age, that they needed to reproduce quite young so that they could actually reproduce before they died. You know, our longevity now is a new thing in our history. So I don't think that that would explain attraction to a one-year-old, put it that way.

Robyn Williams: Amy Lykins at the University of New England in Armidale, New South Wales, a clinical psychologist doing research on paedophilia.

And so to another disturbing effect of the new technology.

Computer game voice-over: Sid Meier's Civilization: Beyond Earth is your chance to create the future of humanity. After emerging from the global dark age known as the Great Mistake, the human race struggles to survive on Earth. The redeveloped nations focus on finding a new home on a new planet. Now your

leadership is needed to colonise these alien worlds, amass mighty armies and make contact with new life forms.

Robyn Williams: Computer games. What are they doing to us, to our adolescents? Is there a pattern, even an addiction? Andy Przybylski studies these games at the Internet Institute in Oxford.

Andrew Przybylski: I used to play videogames, but now I study them. And so I've nearly driven all of my love for the medium out myself. But no, I study what makes videogames fun, what makes them engaging, why people play them in the face of not being paid, sometimes facing social ridicule or other kinds of challenges, nagging spouses. Why would we invest so much of ourselves in a place that strictly speaking doesn't exist?

Robyn Williams: One of the strangest examples of that, parents who are both academics had a teenage son, and you sometimes wouldn't see him for three days, and he'd be up playing games all night and he'd be on the phone texting his friends who would be doing it as well, and this was like living in another world. Does that strike you as an uncommon phenomenon, or is it the sort of thing you come across all the time?

Andrew Przybylski: That's a really interesting question. Psychologists definitely think a lot about what makes something addictive or what makes something not. So if we have things like heroin or caffeine or cigarettes, it's very easy to identify what is the agent that is addictive that people are drawn to. We are at a stage with a lot of different behaviours, having a hobby like playing boardgames, where we don't really know what the secret ingredient is in the activity that draws people to it normally, to say nothing of what could be driving people in a way that might be pathological.

Robyn Williams: Well, there is some research that suggests that the areas of the brain that get lit up when you are addicted to a drug, for example, match those which some people experience when they are playing games.

Andrew Przybylski: Exactly right, and a lot of that same research would show that that part of the brain lights up when you receive pay for completing a task, when you see a photo of a loved one, when you pat your dog. And so the question really becomes one of are we really measuring from a neurological perspective the things that we find enjoyable, the things that we find attractive, or are we measuring something that might just be correlated to very serious pathology.

Robyn Williams: Well, they are some of the uncertainties. What have you found?

Andrew Przybylski: On the topic of addiction I found a good deal. The first thing that's very important to remember is that there might be a difference between those who are playing out of a sense of compulsion, for instance playing because they feel like they have to play a video game, compared to those who are playing out of a sense of choice, wanting to play a game. And so in this way the motivational quality, why someone is playing a video game, might actually be a lot more important than how much someone is playing a video game.

Robyn Williams: If the videogames are such that they disturb your normal life, then we have a different kind of problem. Have you isolated that as a phenomenon to worry about?

Andrew Przybylski: No. If you talk to research psychologists who are very focused on studying addiction and games, they will provide you estimates. They will say 2%, 5%, 8% of the population who play videogames are addicted. And just to check in with you and your listeners, 5% of an addiction rate is massively high.

In the United States right now for instance the main prescription pain medication, OxyContin, is probably one of the most physically addictive opioids that has ever been given in humankind. It is destroying communities, Staten **Island** and on Long **Island** and in the New York City area for instance. They can't build clinics fast enough. The abuse rate for OxyContin is roughly 5%.

So if we are to be talking about something like being very immersed in videogames and we think that the addiction rate is something like 5%, something that is on par with the most addictive prescription medication ever given to a populous, we would expect to see a massive level of societal disruption. And we are just not seeing that, we are seeing a few clinics in South Korea, a handful in **China**, some in the United States that are attended largely by people of means, but we are not seeing a massive wave of human suffering.

Robyn Williams: How do you explain that disparity then?

Andrew Przybylski: There are two ways to explain the disparity. The first is in how something like addiction is conceptualised, and the second is thinking about how addiction is operationalised. In terms of the conceptualisation, videogame addiction and internet addiction are typically equated synonymously with the

way we look at gambling addiction or other kinds of problematic behaviours. And so there is a very heavy level of borrowing of the basic logic and ideology that underlies this mode, and these assumptions haven't actually been in any way thoroughly vetted or tested, and this fits a lot into the second part of this which is the operationalisation of gaining addiction.

And what psychologists will do who are worried about videogame addiction is they will take the symptoms that are described for something like gambling addiction, they will remove the word 'gambling' and then they will put the word 'World of Warcraft', whatever videogame you are afraid your child might be addicted to today, they will insert that videogame into the scale. Then they will give this scale to a sample of gamers out in the world and they will use the cut-off scores that would be used for gambling. So if you score above 42% on this pathological gambling scale that is typically used by therapists or health practitioners, if you score that same score on the World of Warcraft scale, then you might be addicted.

But the thing is, that's how you get something like a 5% incidence rate. But that doesn't necessarily mean that those 5% of people who are scoring above a threshold, that what's going on with them is fundamentally different. For example, if you score above this threshold for gambling, six months later there's a very high probability that if you take the test again you will also score above that threshold. The same can't be said for any of the scales of videogame addiction.

So roughly right now there are between 16 and 18 published assessments of videogame addiction. Only six of those scales have been used in more than one study, and in only one of those studies have they followed the same people over time. And if you are to carefully look at the results of the study, specifically there was a study of 5,000 German videogame players, it found that only three out of the 5,000 who were 'addicted' at time one were still addicted at time two, and you would not expect that for other kinds of pathology. Other kinds of pathology don't burn out, they tend to metastasise.

Robyn Williams: So it's early days in assessing what's going on, but here we've got the people who make these games, they are getting more and more clever at pressing our buttons. Do you see a trend there, that the problem is going to increase because of the sheer sophistication of the way games are organised and **sold**?

Andrew Przybylski: I think there are two trends in videogame design that probably merit some attention and some additional focus. The first is called a free to play videogame. So these are games that you download on your iPad, but these games are absolutely free to play at first. But in order to advance in the game or an order to save yourself time you need to start spending real money, real money **transactions**. And actually what you find is that the features that go along with the real money **transactions** actually introduce some very manipulative contingencies where it's less you playing the videogame and more the videogame playing you in order to empty your pockets. So that's the first trend I'd like to highlight, and I'm not sure actually that these videogames are going to remain popular.

But on the second point in terms of a trend that probably merits some serious inquiry that hasn't found any to date are things that are called videogames, they look like they are videogames but they are essentially a gamified version of traditional gambling. So in a videogame when you play a videogame there is always some role of chance. So when the creators of Nintendo created Mario they actually put code into their game so that Mario didn't always jump exactly the same way every single time. And so when people have gone back to copy Super Mario, they think they are copying all the physics from the original engine but between the cartridge and the game system and the controller it introduced a little bit of almost quantum interference. And so it made your version of Mario a little bit different than the rest.

So while games have always featured an element of chance built into them, what some companies are doing is taking advantage of some of the mechanics that have been built into games and they are combining them with mechanics from electronic gambling, such that the role of player skill is not as important for the final outcome, and money is introduced into the system, your bank account or your online credit account of some type, PayPal or whatever, is linked to the outcome of play. And so this introduces an extrinsic orientation to the game and potentially the chance for losses. And so you have a very glossy exterior to the experience; oh, this is just a videogame, this is just something that 97% of young people do that's not like scary gambling, it's just a videogame. But within that veneer is actually a very old system of reinforcement.

Robyn Williams: Some people have suggested recently that these games, some of the better ones perhaps, whatever that may mean, have a good educational result. Would you agree?

Andrew Przybylski: You know, that's a really interesting point. In the same way that we have always hoped that there will be brain training games like crossword puzzles or the like, or that getting out in nature will set us straight and reboot our cognitive clocks, just like there have been a lot of fears placed on videogames, there have also been a lot of hopes heaped on their shoulders. And so when you think about videogames that a great, they are typically not the ones that you think of as educational. Educational videogames, those

that are designed to teach people things with a pedagogical angle, they typically aren't very fun to play. And there is a graveyard of failed government grant funded attempts along this road.

The videogames that actually wind up serving the most productive role in the classroom are the ones that aren't necessarily designed to be educational. These are what videogame developers and researchers in this area call sandbox games. These are games that don't actually have a clear goal of saving the princess, defeating the terrorist, or winning the sports league. Videogames like Minecraft, and one called Kerbal Space Program are these relatively open-ended games. Minecraft allows you to develop and create a world in which you harness resources and anneal alloys and all these different kinds of strange survival challenges that are procedurally generated in the environment. And there have been multiple mods, modifications of Minecraft, that teachers have done. So everyone actually in the classroom plays Minecraft together and they, say, have a lesson on cooking or basic chemistry, because it's a very abstract videogame, essentially it's digital alchemy. But you can teach a lot of physics lessons in the game. So while the game wasn't necessarily designed with a pedagogical aim, it is flexible enough that inventive and creative teachers or inventive parents can use the game to teach something to the young person.

Robyn Williams: Andrew, obviously to generalise would be foolhardy. I could say, you know, in the old days would telephones or books have a good influence or a bad in the long term. But how do you see this field generally growing? How do you see it moving in the best of all possible worlds and the reverse?

Andrew Przybylski: I'll start with the worst because I'm a realist. In the worst and probably most likely case, what's going to happen are videogames will be replaced with something else that people will be very afraid of. If you look at recent technological growth you see Facebook acquiring the **company** Oculus Rift, it's a **company** that creates virtual reality headsets that track your motion in the environment. We have a few here in the department, they are actually great. And I can imagine a world 15 years from now or 20 years from now where people who are 30 now think to themselves wasn't it great when we all sat on a couch together and looked at the same screen and played a videogame together. Now look at my kids, my kids are sitting alone with a headset and they are completely immersed in a virtual environment, and those were the days when we had two-dimensional video games. So that's where it is in 15 years, if I'm cynical.

But the optimistic self that I have is that psychology and its allied fields are currently undergoing what's called the replication crisis, so we are finding out that a lot of the things that we think or we're afraid of might actually not replicate if scientists independently try to find these things out. Only the people who invent an effect can find it, and this is leading to a real improvement in research methods.

So I believe, for instance, that people who are engaged in these debates around violent video games or videogame addiction, they're definitely entitled to their own opinions, but they are not entitled to their own facts. And I think that if granting agencies and governments are very interested in knowing what happens with video games, and what they will do is they will require researchers to share their data, the actual videogames that they use on participants. So we can get some idea about whether or not the studies are actually done well or carefully.

Right now there are two large camps that are really beating each other up right now, one that is very afraid of videogames and their effect on society, and another that really does just believe that videogames are the latest bogeyman. And these two camps don't get along personally, they certainly don't get along scientifically, and no progress gets made because people really are just fighting about whether or not they are ruining children.

Robyn Williams: Andy Przybylski at the Internet Institute in Oxford.

Next week a history of copulation. And on Catalyst, the physiology of crying.

Production by David Fisher and Joe Wallace, I'm Robyn Williams. In tears.

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