AMY EDMONDSON / ANDREW HUBERMAN / BRAD DELONG / DEVON ZUEGEL / DOYNE FARMER / ED YONG / KATHERINE RUNDELL / SIMON SEBAG MONTEFIORE / STEVEN PINKER

THE PODCAST READER

WISDOM AND INSIGHTS FROM OUTSTANDING LONGFORM PODCASTS

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THE PODCAST READER

Welcome to Issue Ten of *The Podcast Reader*, a more permanent platform for outstanding longform podcasts. Whilst audio podcasts can be great, we feel it is too easy to be distracted when listening to them. Our curated transcripts make it easier to follow important ideas and highlight key points. In a world of digital distraction and ever-shorter attention spans, we are proud to provide a more reflective platform for important ideas.

In this issue we present full transcripts from six longform podcast interviews, and edited highlights, or 'Podcast Bites', from a further three episodes. We cover three broad categories of content:

How to improve society:
Brad DeLong on economic history and his most recent book, *Slouching Towards Utopia*
Amy Edmondson on improving organisations via an understanding of psychological safety
Doyne Farmer on learning curves in renewable energy technology

Just fascinating:
Katherine Rundell on writing, history and religion, and her most recent book *Super-Infinite: The Transformations of John Donne*
Simon Sebag Montefiore on his most recent book, *The World: A Family History*
Ed Yong on how animals sense the world
Devon Zuegel on applications of crypto currency and blockchain to work around problems of hyperinflation

How to improve yourself:
Andrew Huberman on the science of self-improvement: sleep, caffeine, impulse control and breathing

Each issue of *The Podcast Reader* aims to present content from the arts, entrepreneurship, history, public policy and science. In short, a cross-section of ideas that shape our world. Reader feedback is essential to help us learn and improve, so please don't hesitate to share your thoughts about the magazine at hello@podread.org.

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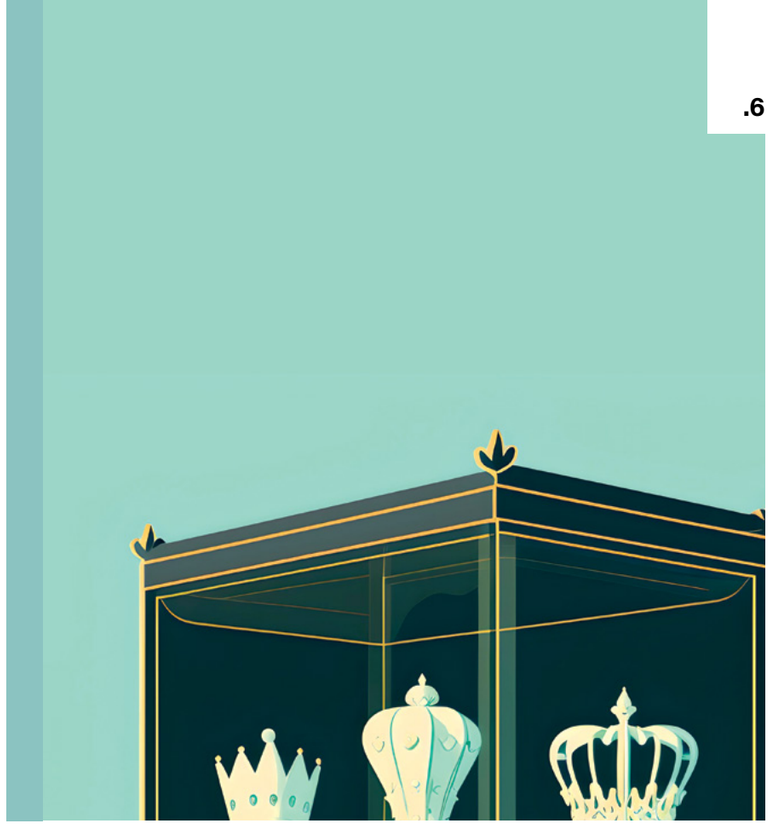

> “… once you recognise that vulnerability is a fact, not a choice, then you realise that your only choice is whether or not you admit it. And I think it’s a sign of strength to admit it.”
>
> **AMY EDMONDSON**

FEATURED GUESTS

Amy Edmondson is the Novartis Professor of Leadership and Management at the Harvard Business School. Her research examines psychological safety in organisations. Her most recent book is *The Fearless Organization*.

Brad DeLong is an economic historian and Professor of Economics at the University of California Berkeley. From 1993 to 1995 he was Deputy Assistant Secretary of the US Treasury for economic policy. His most recent book is *Slouching Towards Utopia*.

Devon Zuegel is a programmer and writer, who is currently researching start-up cities and land use policy. She is host of the Tools & Craft podcast, and author of the paper 'Inside the Crypto Black Markets of Argentina', published at Freethink.com.

Doyne Farmer is the Baillie Gifford Professor of Mathematics, and Director of Complexity Economics at the Oxford Institute of New Economic Thinking. He is a co-author of the 2022 paper 'Empirically Grounded Technology Forecasts and the Energy Transition.'

Andrew Huberman is a neuroscientist and professor in the department of neurobiology at Stanford School of Medicine. His most recent work focuses on the influence of vision and respiration on human performance. He is host of the Huberman Lab podcast.

Steven Pinker is the Johnstone Professor of Psychology at Harvard University. He is a two-time Pulitzer Prize finalist, and was elected to the National Academy of Sciences in 2016. His most recent book is *Rationality: What It Is, Why It Seems Scarce, Why It Matters*.

Ed Yong studied zoology at Cambridge University and biochemistry at University College London. He is currently a staff writer and science journalist at The Atlantic. His new book is *An Immense World: How Animal Senses Reveal the Hidden Realms Around Us*.

Katherine Rundell is an English author and academic. She is a Fellow of All Souls College, Oxford. Her latest book is *Super-Infinite: The Transformations of John Donne*, which won the Baillie Gifford Prize for Non-Fiction.

Simon Sebag Montefiore is an author and historian. He has won prizes for both history and fiction, and is the author of international bestsellers *Stalin: The Court of the Red Tsar* and *Jerusalem: The Biography*. His most recent book is *The World: A Family History*.

FEATURED PODCASTS

MONEY MAZE
SIMON SEBAG MONTEFIORE
P. 6

ECONTALK
DEVON ZUEGEL
P. 18

IN GOOD COMPANY
AMY EDMONDSON
P. 28

THE KNOWLEDGE PROJECT
DR ANDREW HUBERMAN
P. 36

VOLTS
DOYNE FARMER
P. 50

CONVERSATIONS WITH TYLER
KATHERINE RUNDELL
P. 62

MINDSCAPE
ED YONG
P. 77

ECONOMICS EXPLORED
BRAD DELONG
P. 79

THE JOLLY SWAGMAN
STEVEN PINKER
P. 85

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World History is Family History

The resurgence of family power

SIMON SEBAG MONTEFIORE
MONEY MAZE

Interview by Simon Brewer
Illustration by Vaughan Mossop

Simon Brewer: Simon Sebag Montefiore, welcome to the Money Maze podcast.

Simon Sebag Montefiore: Great to be on. Thank you for having me.

SB: It's a pleasure. We've known each other for a decade now and I've been looking forward to this interview enormously. You've become one of the world's celebrated historians. But let's begin with a glimpse of your own history. Were you a family of books and stories?

SSM: I was brought up in a very literary family. Books were our religion almost – the house was full of them. We talked about books all the time. I remember when my father took me aside when I was about eight and said to me, 'Here's a history of the world, maybe you'll write one of these one day.' But also, my mother was an actress. She studied at RADA and then she wrote novels. Her first novel was published when she was fourteen, so she was a bit of a character also.

SB: And how would you describe a young Sebag?

SSM: A terrible nerd, of course. A strange child who knew every Soviet defence minister and general secretary and Israeli prime minister off by heart when everyone else was studying football scores.

SB: You go to Cambridge to study history, and then you flirt with finance. Tell me about that.

SSM: I come from a banking family. So, I was very interested in finance and entrepreneurialism, and I felt I should experiment with that. I also felt that for a writer, it's very important to know how actual offices and people work, rather than just being someone who spent their whole life in the media. I was very keen to do a sort of proper job, if finance can be called a proper job. I was at Credit Suisse First Boston in London and then I was at Ansbacher Media, which was a tiny but very successful media M&A boutique in America. I flew all around America. It was an amazing

job. I would fly into some small town in Pennsylvania or Indiana and just go and see the people that own the local newspaper or the television station or radio station and get them to sell. It was something of an adventure. But it was really a relief when I left finance. I didn't inherit any of the financial talent of my ancestors.

SB: Let's jump to your new book, *The World: A Family History*. I heard you speak the other night at a Rothschild dinner. And you said that Putin had taken Potemkin's body from Kherson in Ukraine, but that was only one part of his fascination with Potemkin and Ukraine. So just put this jigsaw together.

SSM: Well, my first history book was *Catherine the Great & Potemkin.* And one of the strange things about the Soviet Union was that they curated history according to what suited them. So, Stalin decreed that they would study Ivan the Terrible and Peter the Great and Nicholas the First: tsars who reformed and led Russia from the top. But they eschewed and didn't study at all Catherine the Great and Potemkin because they were decadent, aristocratic, cosmopolitan and rather debauched. They ignored them. And so, no one had really studied this subject for 70 years. When I looked in the sheets that they have in their archives that show who's taken out documents, very few people had really looked at these documents at all for 70 years, because these files were created in the 1920s. When I wrote the book, I actually got quite a lot of interest in Russia. It was published, I think, in 2000. And, of course, there was then a new Russian president, a new leader, who was hailed for his liberalism and reforming instincts, his decency, by George W. Bush and Tony Blair, Vladimir Putin. I was approached by his office, the presidential administration, and they said, could they meet me? I met them. And they said, 'Can you talk to us about how Potemkin took South Ukraine and Crimea?' Because Potemkin was just a fascinating character, a visionary who annexed South Ukraine, annexed Crimea and founded cities like Sevastopol, Odesa, Kherson. They asked me if I could write a one-pager for a certain personage, which I did, about this subject. And then of course, it was translated into Russian. And when George W. Bush visited Petersburg, he and Putin discussed Potemkin, instead of discussing Peter the Great. So that was 20 years ago, and as a reward for that, I never met Putin, but I was approached by his office again, and they said, 'Would you like a reward for writing this book about Catherine the Great and Potemkin?' And I said, 'Yeah.' And they said, 'Would you like to be the first person to work on the archives of Joseph Stalin?' So that became my book, *Stalin: The Court of the Red Tsar*. And when I published the book, Putin hated it. So, then I lost all my privileges in the archives and they wouldn't help me at all. So, I've experienced both the radiant glow of the favour of the Kremlin for a very short period, and then experienced the cold wind of the tundra of being out of favour.

SB: But you've also found your way into one of those Central Asian republics, at turbulent times?

SSM: Yes. At a very exciting time. When the Soviet Union started to break up, I applied to stay via a bed and breakfast system with families all over the Soviet Union. I stayed in St Petersburg, I stayed in Moscow. But in Central Asia and the Caucasus, I stayed in Samarkand, I stayed in Bukhara, I stayed in Tbilisi and Baku. Those were very exciting places. The Soviet Empire was disintegrating. Wherever I arrived, civil war broke out, and I got to know the warlords and the presidents. So that was an amazing experience. I think for a historian, to see empires falling, is an extraordinary experience. And of course, in *The World: A Family History*, I often put that moment, that experience, to good use, as well as telling the stories about what happened to me in Tbilisi in the Karabakh War. In Chechnya, I was in Grozny in 1994 so I saw some pretty awful things, and I also saw things that fascinated me. I became friendly with Shevardnadze at that time and also the first president of Georgia, Gamsakhurdia, who was later killed. So, politics was a pretty dangerous pursuit there.

SB: But there was one incident which you need to share with our audience, where you managed to talk to your mother who was extremely concerned about your welfare.

SSM: Well, in late '91, the new president of Georgia was Zviad Gamsakhurdia. He was rather interesting because he was a Shakespearean scholar. He thought of himself as a sort of heroic Henry V character, but he turned out to be more King Lear or even Julius Caesar, because a civil war very quickly broke out against him, a rebellion. When I went to see him, he liked to sit there and talk to me for hours about Shakespeare while there was a revolution going on in the streets and the palace was being surrounded. But I realised that my parents would be very worried about me, and there was no way to get a message out. This was before mobile phones. But when I spoke to him, I noticed the single satellite phone in the whole of Tbilisi was on his desk. So, when he went to the balcony to address his followers outside who were all yelping and shouting and firing guns, I said Mr President, 'Any chance I could use your phone and phone my mum?' He said, 'Please, sit in my throne.' He called it a throne, I remember. So, I sat in his throne and I rang my mother. She said, 'Where the hell are you?' I said, 'I'm in Tbilisi.' She said, 'But there's a civil war going on there.' I said, 'Yes, I'm right in the middle of it. I'm at the President's desk.' She said, 'Well, get out of there fast!' Then she listened and she said, 'What's that noise in the background? It sounds like Hitler talking from the balcony.' I said, 'Well, some would say it was a bit like that.' Anyway, so that was my first experience as a war correspondent. I was very lucky that I experienced some amazing things. The Karabakh War was pretty fascinating, between Armenia and Azerbaijan, which has now flared up again. All of this seems very recent. A deeper thought is that we presume that the fall of the Soviet Union was rather a surprisingly peaceful process, that everything went smoothly. But there were these very vicious ethnic wars in the Caucasus.

> "I wanted to get the span of world history, which is about great movements, migrations, technology, finance, pandemics, and then on the other hand, the intimacy of biography."

SB: So, let's talk about *The World*. Somebody once said, 'The scariest moment about a book is always just before you start.' I wondered how long you'd cradled this idea?

SSM: That's a really good question. I really struggled to write this book. It was the most daunting, most stressful, but also most joyful and satisfactory book I've ever done. I struggled about how to write a history of the world. When you're a writer, you write a very short proposal for publishers, and they sell it all over the world. Then the terrible moment comes when you have to actually write the damn thing. I wanted to get the span of world history, which is about great movements, migrations, technology, finance, pandemics, and then on the other hand, the intimacy of biography. So, I came up with this idea of following families through world history. I think that this way, you do get a feeling of the world through these families, but also the grit, the juice of intimate human life. That's the idea of the book.

SB: I have to say it builds momentum and becomes increasingly gripping as it goes along. We have the Medicis, the Incas, the Rothschilds, the Krupps, Kennedys, Nehrus, Pahlavis, Kims and Assads. What surprised you as you researched and wrote the book?

SSM: I didn't know a lot of what's in the book, of course. I knew the same stuff that most people know about the great dynasties from the Habsburgs onwards, the Romanovs of course, the Saxe-Coburgs, the Stuarts. But what I wanted to do something different. First of all, the great thing about family in the new world is its diversity. This is a brilliant way to look at the world. I wanted to treat the royal families of the Zulus, the Incas, the Dahomeans, the Benin Kingdom, exactly as I would the Habsburgs or the Rothschilds or the Medici, and that's what I've done. So, in that sense, it's a new approach. Of course, women have been neglected in traditional history. Obviously, with families, it works extremely well. And then I didn't want it to be a victor's history either. So, it's not just about the great empires, the Portuguese Empire handing over to the Spanish Empire to the British Empire to the Dutch Empire to the French Empire. No. It's also about places that you should know about but you probably don't, like Albania, which is very relevant today in Britain because of migration. There's a lot of Albanian history, Cambodian history, Haitian history, Hawaiian history, Congolese history. I wanted to have a completely fresh feel and everything about this surprised me. I think one of the most interesting things is that we presume, sitting here in West London, that dynastic history is a thing of the past. It is in places like Britain and France. But in much of the world, it's not only thriving, it's reverting, it's resurging, and you only have to look at Asia to see that actually family power is returning because states have failed somehow to provide the security and justice and comfort perhaps that people need and they've reverted to clans and to family power. You can see that both in democracies from the United States to India to Singapore, but also in dictatorships and regimes that are really monarchies to all intents and purposes. The Assads, the Aliyevs of Azerbaijan, the Kims of North Korea. But then look across Asia and you see that Marcos has just been elected, Kenyatta has just left power in Kenya. These are all big dynasties, but they're elected. We're in a very interesting place in the world at the moment in terms of family power. But I don't make too many claims for this family approach. It's a very useful way to tell the world history so that you follow these families, you know them. When you meet Genghis Khan, for example, you kind of know his family history already, and that's the fun thing. When you meet Adolf Hitler, you've actually met his father, Alois Hitler, as an official in the Austro-Hungarian Empire, a typical Habsburg

official. When you meet Donald Trump when he was elected president very recently, you actually have met his grandfather, Drumpf, who leaves Bavaria in the 1890s. This is the way I've approached history, and I hope it works. It's certainly been great fun to write.

SB: I think it absolutely does. This opus shows war, destruction, recreation of the norms jostling for a position as a constant, and mischievous behaviour to Machiavellian and murderers. But one of them, of course, is the financial intrigue that repeats itself. Talk about the Suez Canal, because in conventional terms, this wasn't a normal takeover battle, was it? What happened?

SSM: No. In 1876, Benjamin Disraeli, Prime Minister who had been elected in a landslide in 1874, managed to clinch the Suez Canal for Britain, which was a key moment in the expansion of British power into the eastern Mediterranean. And also safeguarding, of course, India, then regarded as an essential part of British power. One of the fascinating families that's told in this, which is now kind of forgotten, is the family of the Albanian dynasty that ruled Egypt from 1806 to 1952 when they were overthrown by Nasser in Egypt. So, it really takes Egypt into the modern era. It was founded by Muhammad Ali. He was really the sort of Napoleon of the Middle East, one of the greatest statesmen of world history, but probably the greatest Arab leader of modern times and the most successful by far, and he wasn't actually Arab at all. He was actually Turkish-Albanian, born in Greece. He set up this dynasty that modernised Egypt, which was the first non-European country to industrialise in its cotton production. So really an extraordinary character. His descendants modernised and borrowed a lot and really prospered, especially in the period of the 1860s, the American Civil War, because when cotton production was subverted by the war, Egypt stepped in and became vastly rich. But, of course, they overborrowed. So, Ismail the Magnificent was then the Khedive of Egypt. He vastly overborrowed. He also tried to expand an Egyptian empire into Sudan, all the way down into Uganda. It was really him who started the Scramble for Africa, not the Europeans at all. Very important figure, but he went bankrupt and the banks had to step in. And this was Benjamin Disraeli's great opportunity. So, he wanted to borrow the money and he needed to borrow £4 million immediately. When the cabinet agreed to it, he sent his private secretary Montagu Corry off in a carriage to St Swithin's Lane, where the Rothschild family bank was. One's got to remember that Disraeli was great friends with Lionel de Rothschild, who was then head of the bank. He received Montagu Corry and he was eating grapes, famously. Montagu Corry wrote his own account of that meeting, and he was eating grapes and spitting out the pits as he listened. And of course, he'd been geed up already by Disraeli. But he went in there and he said, 'Mr. Rothschild, the government needs to borrow £4 million.' And he spat out a couple of grapes and finally said, 'Fine, you've got it.' So Corry ran back to Downing Street where Disraeli sent the telegrams and we bought the controlling share of the Suez Canal, which of course we then had until 1956 to the Suez Crisis, which was the end of the British Empire in that region.

> "... when you look at many world leaders, they were given their confidence by brilliant mothers, not always to the benefit of humanity. Hitler and Stalin were classic examples of that."

SB: You alluded to the female dynasties, and there are some fascinating stories of powerful women in your book. What did you discover that held your attention most?

SSM: The interesting thing is, of course, dynasties make women very important. Women are very important in families. We're all part of families. Partly this book is a chronicle of the family. Power families are a little different and, of course, because often the woman who was the mother of the heir to the throne had immense power. So that was how many women came to power, either as widows or as mothers. The dominating, inspiring influence of the mother who loves her son is a theme of the book, of course. And when you look at many world leaders, they were given their confidence by brilliant mothers, not always to the benefit of humanity. Hitler and Stalin were classic examples of that. But in many of the dynasties, especially of the East, were places like the Ottoman Empire, the Mughal Empire, the Mongol Empire. There are incredible women who were clearly great statespeople and clearly great politicians as well as devoted mothers and they came to rule whole empires.

One gets a feeling of how the East was so much more powerful. For example, in British history, we're just obsessed with the Battle of Agincourt. In school, all we do is study these little English victories but, in fact, the armies at the Battle of Agincourt in 1415 were about 6000 each, which is like a skirmish compared with just a few years earlier, Tamerlane defeated Bayezid, the Sultan of the Ottoman Empire. They each had an army of over 150,000 people. So you can see why in this book, I don't pay much attention to Agincourt, but I'm much more interested in the Ottoman Empire. It's in the Ottoman Empire that really fascinating women become very powerful. One of the most interesting is Roxelana, who was known by the Turks as Hurrem Sultan. That was the name given to her by Suleiman the Magnificent, and she's really the most powerful Ukrainian woman, the most powerful Ukrainian, full stop, in world history. She became the sole wife of Suleiman the Magnificent, but she was stolen, kidnapped, enslaved from a Ukrainian village, probably by Tatar horsemen. She was sold to the harem of the Sultan, and she became the great love of Suleiman, who was the greatest monarch of his time. You've got to remember, the Ottoman Empire then stretched from the borders of Iran to the borders of Morocco, from Budapest to Egypt. She's a fascinating character, and she protected her son who became Selim and made sure that he succeeded. But jump a century and you come to someone like Kösem Sultan, who was another amazing woman, also very beautiful, who was the widow of the Sultan and protected her sons and dominated the Ottoman Empire for over 50 years from when she was a very young girl to when she was an old woman. She coincided with James I, Charles I, Cromwell. We think of them as powerful. She was a million times more powerful and very interesting, witty, accomplished, and she had the acumen to run an empire. She also had to decide to have her own son strangled. Power is a messy business. In every absolute system, whether it's the Ottoman Empire or Russia today or China, the more absolute and personal power is, the more ruthless and unforgiving it is when you lose it.

SB: I was intrigued that Iran/Persia gets considerable coverage in the book. Your friend Andrew Roberts recently interviewed Henry Kissinger who said, 'History repeats itself by comparable events.' Now, I know you're not a forecaster, but there are changes afoot, one might think, in Iran? My question, I guess, is what would you say is the true Iranian or Persian character?

SSM: That's a very good question. One of the themes in the book is Persianate poetry and Persianate culture, which has been the very definition of refinement through much of the period that I cover. Again and again, whether it's the Mughal dynasty, whether it's the Ottomans, whether it's Tamerlane, everybody aspires to the refinement of Persian culture. So that's a very important theme of the book. But you're right, in cold power terms, Iran or Persia is a massive presence in the book, and I follow it all the way through. I studied it very closely. It's very important. Even in the twentieth century, it's very important with the last Shah, Mohammad Pahlavi, who was overthrown in 1979. Since '79, Iran's become even more powerful. The Shah would have been impressed, in some ways, with the way that the dictators of the Islamic Republic have managed to promote Iranian power ruthlessly. But it's been very much at the cost of the Iranians in terms of economics. They've spent an enormous amount of money, and they've also only controlled Iran with incredible repression. There's a very strange phenomenon afoot where the Western media, Western opinion, is very reluctant to criticise Iran in the same way that it's quite happy to criticise Putin, for example, or China. I think that's partly because in our secular societies, we're very nervous about how to deal with religious societies and Islam in particular. The BBC is incredibly reluctant at the moment to call it a dictatorship at all. But let's look at this regime. It's really a kind of medieval monarchy. Ayatollah Khomeini, the first Imam of the Islamic Republic, ruled as an absolute dictator for 10 years and then he just handed it over. He chose his successor, and he gave it to his student and henchman, Ali Khamenei, who has been in power since 1989, so for more than 30 years. Of course, the BBC and other Western media always calls it the Islamic Republic very respectfully and even when their agents have stabbed someone like Salman Rushdie. It's Salman Rushdie who's described by the BBC as controversial, his works are controversial, but the Islamic Republic is completely uncriticised really. It's a very weird thing. I think it's partly because the West so bought into the fall of the Shah, and the Shah as a villain. The Shah was an autocrat. He was a dictator. He did screw up royally and fall from power. He did waste many of the proceeds of oil that he could have used better. I'm not a supporter of the Shah, but it's undeniable just in terms of the massive number of people tortured and killed since, that the Islamic Republic is one of the most vicious and evil dictatorships. And Ali Khamenei, the Supreme Leader, is in effect, one of the most unpleasant dictators around today. At the time we're talking, there's a revolution going on in Iran. The Western media is very keen just to say this is all about women's rights, which started that way, but now it's a revolution against one of the most murderous regimes in the world today. And in terms of those killed, much worse than Putin's

repression within Russia, for example. And of course, they're allied with each other too in a sort of axis. So we're living in exciting times. It's very important that we know about Iranian history, and there's a lot of it in the book.

SB: You've discussed sources of danger, and you quote Han Fei Tzu, who said calamity will come to you from those you love. George Osborne recently interviewed you at the British Museum. I happened to run into him and asked 'Any questions you didn't ask Sebag? And he said, 'Doesn't all of this give you a sense of a dark reflection on humanity?'

SSM: Good question. I mean, it was very nice talking to George. Of course, one of the fun things is talking to politicians who are also aware of history. One of the themes of the book is the number of historians who were also prime ministers and statesmen. Henry Kissinger is one. He's now 99 and still as sharp as a tack. That's a theme that runs through history. Some of the great historians are also politicians. I was thinking of Ibn Khaldun, who's a very important one. But you're absolutely right. The book is a chronicle of humanity. All human drama is there right up to the day that Putin invades Ukraine when the book ends, and then we look ahead to what happens next. You could say that much of the dark matter of history is in the book. There are cities falling, empires rising and falling, there are massacres, there are pandemics, there's slavery, there's Empire. Of course, as we're seeing with Ukraine today, it's when these super propellants happen – war, pandemics – that huge changes happen. In history, it's the changes we're very interested in. So yes, it has a lot of the dark history.

But it also, I think, is a celebration of humankind. It's full of poetry, it's full of art, it's full of love, it's full of sex, it's full of food, music. By the way, it was very fun writing about Frank Sinatra, and the Stones and David Bowie, who are all in the book. For those of you who like music, I say in the book that I think the Stones' 'Sympathy For The Devil' is the greatest history pop song of all time. I've got a playlist on Spotify, which you might want to look up, which has the great history songs. I think the book is both an indictment and a celebration of humankind. It's really a celebration of human ingenuity, creativity, and family, you know, love. It's got all of those things in there. And it has to be both that, an indictment, but also a celebration.

SB: I don't think I've ever read footnotes in a book to the extent that I've read your footnotes. They just open up great sources of information. You say over 20 million immigrants arrived in America between 1850 and 1920, the greatest migration in history. Migration as an issue keeps coming back, this migration that changes the character of a nation.

SSM: Well, one of the great themes of the book, the wider themes, is migration, and all nations are created by migration of some sort. Invasions generally mean invasions of armed males. But migrations are the invasions of families. For those who think there are any pure nations, there really aren't. They're all the creation of migration, including Britain, of course, but especially America. America was made possible by migration, and by migration carried by steamships. So, the steam revolution made possible the conquest of America. The conquest of America is much later than we think. The interior of America was still unconquered at the beginning of the nineteenth century. It was still controlled by people like the Comanches, who are big characters in the book and have their sort of empire which we call Comancheria. We often forget, America is a conquest state. You often see that in the nature of America. We think of America as the East and West Coast, which are very Anglo, in a way, very English. And then you realise that the nature of America is different, and that reflects its origins. Migration is really important. And, of course, migration is going to be the great challenge of the coming century in an even bigger way. But we cover all sorts of migrations. We have the Huns and the Goths, and the change that they made to the Roman Empire. One of the rules about empires is that the more open and more liberal the empire, the more tolerant an empire, the longer it lasts. So, the least tolerant empire in history, the Nazi empire in Europe, lasts four years. The reason for that is that they did many terrible things, but one of the stupider things they did was alienate everybody. In an ideology of racial supremacy, they excluded everybody. Then look at the Roman Empire where they gave everybody citizenship in the whole Roman Empire, which was brilliant, because of course, it meant that everybody then became Romans. You had people living in the North of England in Roman villas thinking they were Romans even though they had no Italian or Roman blood at all. So, it's all about migration. It's all about hybridity.

SB: Joseph Conrad, the writer, years ago wrote, 'My task, by the power of the written word, is to make you hear, to make you feel. It is, before all, to make you see.' I think you capture events and characters beautifully. I'm going to quote one extract here. 'An attractive well-spoken public schoolboy and Oxford barrister polished the encompassing charisma to discipline his Labour Party and win three elections. He and Bush had little in common, but they shared a Christian faith and missionary vision drawn to America at its plenitude despite soaring opposition and suspicion about the dubious intelligence. Blair committed Britain to the war.' Now, apart from that very intriguing observation, and I don't think very controversial observation, you write beautifully. Is that a skill that has taken years?

SSM: Thank you. I've really worked hard in these books to write histories that are readable by everybody. You don't have to know anything about style or Jerusalem or world history, in this case, to read the books. And yet, I try and work very hard to encompass the latest scholarship in the book. I've been very lucky in this book that I've had professors of Chinese history from Harvard check the Chinese sections, and so on, which is really important because one of the great things in all of life is to sit at the feet of masters and learn from them. The writing, I sweat blood to make these books both readable, and hopefully, well-written, but also accessible to everybody. I've really worked hard on that throughout my life. I've had wonderful mentors who've taught me how to do this and I've learned from them, but I'm trying to get closest to the nature of people. One of the conflicts in this book is another sort of skirmish in the old battle between whether history is made up of great trends, great movements or whether it's decided by individuals. Of course, it's both, and I want to reflect that. I want the people in the book to feel like living people that we might know.

SB: I first encountered you in 2003. I was sitting in the audience at the Royal Geographical Society and you walked on stage and said simply, 'I'm going to tell you about one night. It was the Kremlin, 8th of November 1932, the fifteenth anniversary of the Russian Revolution.' You described Stalin's wife, Nadya Alliluyeva, quietly leave the dinner, walk to the Kremlin apartments, go to her bedroom, lock the door, take out a pistol and kill herself, and you held everyone spellbound. And that book, *Stalin: The Court of the Red Tsar*, is utterly compelling, as is your book *Jerusalem*. These are great sweeps of history. Some could say that you're allowed to retire now.

SSM: Well, I don't think I'll ever retire. But I'll never write another book like this one. The *Jerusalem* book, of course, led to this book, because in *Jerusalem*, the challenge was to talk about the city without just telling you about buildings and the old siege. What I'm always trying to do is to bring things to life. The idea of tethering works well, so I often try and start the books with something that is incredibly striking, that introduces many of the themes and the worlds we're going to be in. With *Catherine the Great & Potemkin*, it's his death on the steps of Moldova, holding on to Catherine's love letters as he dies. Then with *Stalin*, it's the death of his wife in 1932 that you mentioned, which is politically in itself, irrelevant. But all the leadership are there, and they all live together in the Kremlin. So, it's a brilliant way of introducing the idiosyncratic and terrifying world of the Bolshevik leadership.

> "One of the rules about empires is that the more open and more liberal the empire, the more tolerant an empire, the longer it lasts."

In *Jerusalem*, I start with the fall of the city in 70 CE by Titus, as he takes Jerusalem and destroys the temple. One of the great apocalyptic set pieces of world history, which is fascinating. But also, in many ways, the moment that Christianity and Judaism – and, later, Islam – spiritually separated from old-fashioned temple Judaism, as had existed until then. So I always try and select a sort of key moment or a key character that really defines the book and the subject. But God, I just don't want to write another book. I'm exhausted. I really struggled writing this book just because of the sheer extent, the sheer ambition of it. If it wasn't for lockdowns, I don't think I'd have managed it. I think all successful books, all successful projects, maybe even podcasts, Simon, are the work of obsession. You have to be not just immersed but obsessed with getting these things right. And I think that's probably true of all great creative enterprises and businesses. This is a money podcast, and many of the people who create great businesses are obsessed with that business. We're living in the age of Elon Musk, for example, but in my book, you've got lots of these big business titans who were all obsessive, quite strange characters, going back to Edison or Ford or Rockefeller, very strange people. And there are others, the Rothschilds. So I think this book, like all other enterprises that hopefully are successful, is a work of obsession.

SB: You mentioned your playlist. My wife played it last week, and I wondered, who inspired you? Was it your amazing wife, your children?

SSM: Children are very inspiring, but they've had to put up with me writing this hellish book. My wife is also a writer. She's a novelist, and I think they're all pretty sick of 'The World.' I think they never want to hear the words 'The World' again. But the music is really important. As we said, to get close to human life, you've got to have writing, you've got to have sex, you've got to have food, you've got to have clothes. These are the things that give the grit of life, and so music is part of it. Take someone like Frank Sinatra, I listened to all his music while writing this. He's a fascinating character. He's at the nexus of so many things. In the consumer age, he's one of the first consumer stars with the bobby-soxers in the late forties. Then he becomes friends with the Mafia, he performs in Havana for Meyer Lansky. Then he's friends with Jack Kennedy and introduces Jack Kennedy to Sam Giancana's girlfriend, Judith Exner. He knows Marilyn Monroe, then he becomes friends with Reagan. He's a fascinating character. So listening to songs like 'New York, New York' were very timely. The playlist is worth listening to.

SB: Having researched all these figures, which historical figure would you want to have dinner with and where in the world would you want to have it?

SSM: Of course, I really would want to meet Jesus Christ, someone like that. But if I really wanted to live somewhere, it would have been around 800 CE, in the Abbasid Empire in their capital Baghdad. Of course, I'd want to be at the very centre of court life, even though that was an extremely dangerous place to be. But I think it was one of the apogees of human civilisation as well. And I hope your audience are not of a shockable nature, but I suggest that they go and read those chapters about Baghdad under Harun al-Rashid. This is the period of The Thousand and One Nights, of course, but you'll see that Islamic society could be so different from what we're used to seeing today. It wasn't very difficult to find. Look at their poetry and their writers, it's just outrageously saucy stuff that I think is quite shocking, even for Westerners in our puritanical age today. So that's when I'd love to have lived, please.

SB: How precarious was it becoming a writer given that the path is littered with corpses of wannabe writers?

SSM: It's a very unstable, precarious life. It's just very hard to make a success and make a living from it. I did other things before, as we've talked about. I also was a journalist and was a war correspondent. I did interviews for *The Sunday Times* in the 1990s. But I really wanted to do stuff that would last. I also love writing fiction. I've written a trilogy about Stalin's Russia, *The Moscow Trilogy*. But the history books, I've been very lucky with them. You just can't ever predict that. When you have success, I had it with *Stalin: The Court of the Red Tsar*, which was the breakthrough book for me, published on the fiftieth anniversary of Stalin's death, in 2003. I was very lucky with that. I had been one of the first people to get into these Stalin archives. With someone like Stalin, it's just fascinating to see what makes him tick and to be amongst his own people. So that was amazing. But it's very hard to make a living from this so long may it continue. So far, so good, but it's a fragile and precarious life.

SB: What advice would you give to a 20-year-old Sebag?

SSM: I would just say anyone who wants to write must just begin to write. The key thing about writing is just to start, which is the hardest thing. You'll never be ready, you've just got to begin. And the other thing is to have interesting experiences, to live an interesting life, to see things that other people don't see. I was very lucky that I saw these revolutions and coups and civil wars, the breakup of empires. Until then, my life had been very boring and very comfortable: English boarding school, Cambridge and a bank. So I would say seek interesting experiences. And thirdly, don't get it right, just get it written. That's the key thing, because all of success in writing is in the re-writing.

SB: That's really interesting advice. 'Don't get it right, get it written.' I have found *The World* just a gripping read. Thank you so much for your time today.

SSM: It has been really fun. Thank you, Simon.

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How Argentinians Deal With Very High Inflation

Is this our future too?

DEVON ZUEGEL
ECONTALK

Interview by Russ Roberts
Illustration by Vaughan Mossop

Russ Roberts: My guest is programmer and writer Devon Zuegel. She has two podcasts: Tools & Craft, and Order Without Design, which is with Alain and Marie-Agnes Bertaud. And some of you may have enjoyed Alain Bertaud's episode on EconTalk – one of my favourites. Her podcast is named after his book, *Order Without Design*.

We're going to talk about a remarkable piece that you wrote a couple of months ago at Freethink, 'Inside the Crypto Black Markets of Argentina.' Devon, welcome to EconTalk.

Devon Zuegel: Thanks for having me. I love this podcast so it's really exciting to come on to speak.

RR: This piece you wrote could probably be the basis for a semester-long course in economics related to monetary policy, trust, innovation, regulation, exchange. It's a really fascinating piece. But, before we get to it, tell us a little bit about yourself and how you came to experience Argentina.

DZ: Over the past few years I have spent about a month a year in Argentina because my fiancé is originally from Buenos Aires. We go down there to spend time with his family. Something that was just so striking to me the first time I went there was that almost every single dinner conversation ends up at some point coming to the topic of inflation, the topic of monetary policy. This is with people who are not economists. They don't find it interesting as an intellectual exercise. But they're all terrified, day after day, that their savings are going to be obliterated tomorrow. So, a basic aspect of survival is swapping tips about how to beat inflation, where to store your money so that the government can't take it.

Something that was especially striking to me was that Argentina actually works fairly well in some ways. For those who have never been there, you might imagine a place like Honduras, somewhere that's completely a mess, if you walk around you might get killed. Argentina is not like that at all. Buenos Aires, in many parts, actually feels a lot like a European city. The downtown is somewhat safe. Overall it feels quite safe. I think it's just very interesting that there's this underlying financial turmoil that is creating problems constantly. And, it's been the case for a hundred years or more.

So that's my education about Argentina. My personal background is that I'm trained as a software engineer. I also write a lot about urban economics in particular and the building and design of cities.

RR: Economists like to talk about Argentina because about a hundred years ago it was one of the most prosperous countries in the world, and now it's not. Your observation, which is interesting, is that it's not as

un-prosperous as one might think.

But, it has pursued a very high and erratic level of inflation that I presume – and you're welcome to comment on this if you want – is due to the fact that their tax system and their respect for, say, compliance with taxes is so poor that the government basically uses money printing as a way to finance government activities. But, part of its problem – if not a significant part of its lack of economic progress over the last century – is due to the fact that inflation has been a perennial problem.

DZ: People point out, as you did, that Argentina was one of the wealthiest countries about a hundred years ago. And, in monetary terms that was true. They had a high GDP per capita. But I always push back when people say that because, in some other ways, they were not so wealthy. I also think it was a bit of a fluke of the particular time period.

In the early 1900s Argentina was purely an agricultural economy. They had not really made much industrial progress at all. This also happened to be a time of very high commodity prices. And so, as a result, they were making a lot of money, in part because of World War I. A lot of grain production had shut down in other parts of the world, so Argentina's grain was much more valuable. And so, it made them rich temporarily. But I don't see that as real wealth because they weren't really moving on to the next economic stage of industrial development.

I think that a lot of people say, 'Oh, it's such a mystery that they were doing so well and then they stopped doing well.' Actually, they were never doing that great. There was a confluence of factors in the early twentieth century that made them quite wealthy for a while, but those factors went away. Then mismanagement of the economy, in part due to inflation and some other issues, exacerbated those problems.

RR: A fantastic observation; and always a good reminder to be sceptical when someone tells you about when something started, if they perhaps cherry-picked that. Arbitrarily saying: 'In 1922, Argentina was one of the wealthiest countries in the world,' may be misleading. So, that's an excellent point.

What we're going to start with is the reality that inflation has been a perennial problem. It alternates between high levels of inflation, or rising levels of inflation, or hyperinflation. Hyperinflation being times when the prices are rising so rapidly, money is usually being printed so rapidly, that people stop using money and turn to barter; and many basic economic things break down.

DZ: In the last hundred years, Argentina has seen an average of 100 per cent annual inflation. So, to put that into context, that means that on average every single year the currency has lost half of its value. That statistic could be a little misleading in the sense that some years it's much, much lower; and some years it's much, much, much higher and you see hyperinflation. So, if you pick any random year in the last hundred years, it could be a very different number. But, if you had money from Argentina a hundred years ago, it would be utterly worthless now. If you halve something a hundred times it gets real small, real quick.

Another interesting statistic is if you had had $100,000 worth of Argentinian pesos in 1995, they would be worth about $310 today. That means: if you held your savings in pesos, they're gone. So, Argentinians, they do not do that anymore. They tend to save in US Dollars. That's the typical preferred payment method.

Or, for people who are poorer and maybe don't have access to dollar markets, they will save in bricks. They will literally buy a pallet of bricks each time they get a pay cheque and they'll build their house brick by brick, so that that's their store of wealth. It's not fully monetised because bricks are hard to transfer. They're a little heavy. So, people don't really trade in bricks so much. Once you buy it, it's just like a savings vehicle. And, there's also no mortgage industry whatsoever in Argentina. So, people really do have to build things very incrementally. They can't build out into the future.

RR: That was one of my favourite parts of the article – using bricks. It's hard to carry if you're going down to the grocery. But what you're saying is that generally they are not used for exchange purposes. People are not swapping bricks. But – and, I didn't think about this when I was reading it – that example is so extraordinary. When you can't trust the banks, you put your money under your mattress. Which is creepy and scary: a fire comes, and you've lost all your money. A thief comes, you've lost all your money. The alternative, of course, is inflation comes and you've lost all your money. And that's what we're going to be talking about.

But, the brick thing is a fantastic money-under-the-mattress example because they're a lot harder to steal. Because you mortared them and you put them in place. It's good that they're not a currency. But, really if you're going to expand your house, you do have the option of using the bricks, and that's your store of value. It's your way of keeping some level of savings.

DZ: Another similar savings mechanism – I live in Miami and in Miami there's a booming real estate market. There's a joke that everyone in Miami is a realtor. And there's some truth to it. In part it is because wealthy people in countries like Argentina and throughout Latin America will purchase an apartment in the United States as a way to store their money. And so, wealthy Argentinians will have a $500,000 apartment in Brickell or downtown Miami as a way to save for their child's college education. This is very inaccessible to the average Argentinian. This is just for very wealthy people who can afford an expensive apartment.

> "In the United States people tend to be kind of bashful about breaking the law, at least in my friendship circles. In Argentina everybody breaks the law. Every single day. Because otherwise you get half the income, and you can't pay your rent."

RR: The advantage of an apartment in Miami is it could appreciate; and that way it's more than just a store of value. It's better than holding it in a bank with a very modest, if any, return. What you're paying for in a bank is just the safety of your money not being taken away from you.

You start off your article talking about some of the challenges for people in Argentina to have any international transactions. I have a daughter in London, I live in Israel, I have family in the United States. When you have any kind of international life and you want to transfer money to someone in another country, it's incredibly unpleasant in 2022. Which is kind of shocking. You'd think it'd be easy.

There are options now that weren't available 20 years ago. There's PayPal, which takes a pretty good chunk of your money to make that transaction. In Argentina, you don't just have the general challenge that international transactions have a high transaction cost to them, or a fee. Sometimes you just can't do it. There's no way to buy foreign goods, no way to transfer money, no way to invest if you're only going to be using the legal Argentinian monetary system.

DZ: No legal way or no easy legal way that doesn't result in you losing a tonne of your money. The list of challenges is extremely long. I will just name a few of them, but, trust me, that it's harder than what I'm about to describe.

One challenge is that Argentina has a fixed exchange rate. What that means is that the rate when you want to buy or sell dollars, when you have pesos, is not set by the market. It is set by the government. What that means is that the official exchange rate results in the government effectively taking half of your money when you try to exchange it. So, if you have USD – let's say you are an American company and you want to pay an Argentinian. You're paying them in dollars, and it's going to get transferred to pesos before it hits their bank account. The government has set the exchange rate such that they end up keeping more of the dollars and fewer of the pesos end up getting to the employee. Right now it's about 50 per cent, compared to a black-market rate. So, there's the official rate, the legal rate; and then there's what's called the black-market rate, or they call it 'dollar blue' in Spanish. This is a very, very different number.

In the United States people tend to be kind of bashful about breaking the law, at least in my friendship circles. In Argentina everybody breaks the law. Every single day. Because otherwise you get half the income, and you can't pay your rent. Everyone knows exactly what the black-market rate is at all times. Politicians will even quote it. Like, it's well understood that this is out there. Long story short: everyone tries to be in the black market as much as they can. There are certain transactions where that's really difficult, but for the most part people will try to exchange their money in the black market.

One tip if you ever travel to Argentina: do not exchange money at the airport. Instead, when you arrive, find an Argentinian that you trust and ask them to introduce you to their *cueva*. Cueva is the Spanish word for cave, which I like. Cueva is a person who is a black-market foreign exchange. It sounds really sketchy. It sounds like you're going to go do a drug deal or something. But it is not. It's totally fine. If someone introduces you to one that they trust, you're in safe hands. It's going to be some random office in a building and every Argentinian who has any money at all does this a few times a week.

That's one of the many challenges. The government also has a bunch of others – like, very high customs taxes that make it very expensive to move things around. It's also illegal to take out dollars at an ATM in Argentina. The list goes on and on of how the government makes it difficult to use money and move it across borders.

RR: Let's talk about the cueva for a minute. It's fascinating. I don't know if I've ever done a black-market monetary transaction in my life. But, in this case, because the real market – the true price – is so different from the set price, 'everyone' does?

DZ: Yeah, it's not everyone. Unfortunately, the average income of an Argentinian is quite low. There are lot of people who don't make much money in Argentina and so it doesn't make sense for them to move any money into dollars to save because they don't have money to save. I believe the median person in Argentina doesn't have enough money to save anything, and they're living pay cheque to pay cheque. And so, they just keep their money in pesos. But, anybody who has enough money to want to save will usually be transferring it into USD and then putting that USD in their mattress, or, like a hole in their ceiling, or something like that.

RR: With hyperinflation, nobody, after they cash their pay cheque, puts it anywhere other than into stuff. That is what's happening in Argentina – because stuff is useful and it doesn't depreciate – whereas in a hyperinflation your money is depreciating with every minute, or it certainly must feel that way.

What you're talking about is just so extraordinary and so alien I think to many Americans and many people elsewhere – the idea that you would want to convert your pay cheque out of your native currency, quickly, because it will lose value is not an experience most people have. And then, you're now holding a foreign currency, which exchanges on the street in all kinds of ways – it's very fungible. It's very easy to convert it back into pesos if you decide to reduce your savings or you need it for some unexpected cost.

But, as a general idea, if you're wealthy enough to save, the idea that you can't save in your home currency is peculiar. So, now you have a choice. What do you save it in? The dollars are one option. There are others.

DZ: Some people have saved in other currencies besides USD, but USD is by far the favourite. However, over the last few years, crypto is starting to make an impact and climbing up the charts in terms of how many people are using it to save. I asked my fiancé's brother at one point, 'Why do you hold crypto? Isn't it kind of stressful for it to be so volatile?' And, he said, 'Yeah, it's volatile, but at least its value goes up sometimes.' He's used to having a currency that just goes down. Like, it's just nosediving. And so, for him, the fact that it might go up is pretty exciting. He was kind of joking, but there's also some real truth to that.

> "A lot of people just could not access their money for almost an entire year. When they did get their money back at the end of the year and they were able to access it again, they discovered that all of their dollar deposits had been converted into pesos. And the pesos had lost two-thirds of their value in that time."

Crypto is starting to fill in a few gaps in the Argentinian economy. In particular holding a lot of cash is pretty dangerous. And, it's physically bulky. There are a lot of problems just saving in cash. Crypto solves some of those problems. It also creates some new problems. So, there are trade-offs, but for different types of contexts it might be useful.

So, for example, right now if you want to buy a house in Argentina, the typical way you will do this is you'll get a briefcase full of hundred-dollar bills and you will meet somebody, an escrow agent. I should say, the housing market is dollarised, which means that when you buy a house, people will put the price in dollars. This is actually against the law because the government wants you to use pesos, but people do it anyway.

The housing market is in dollars because it can take quite a while to close on a new house. Imagine that suddenly the peso loses 50 per cent of its value

Photograph: Sasha Stories

overnight. If you had denominated the sale in pesos, then you could get 50 per cent less for that house. So, this is a really big transaction, and so it's been moved over to dollars; and it's been like that for quite a while. You cannot really use a bank account to move that money because it's in USD. And, so people will bring suitcases full of dollar bills to buy a house from somebody. And, you can imagine all the issues with that. If you get robbed that day, there goes your life savings, there goes your house. It's inconvenient. They have to count it. There's a whole process just to count the dollars. It's not how you want to buy a house.

RR: ... the escrow part is also really interesting.

DZ: So basically, you have a third party who can serve as an observer to the transaction and say that this really happened, because it's not logged anywhere. That is actually a very challenging problem in and of itself, because both parties have to agree that this person is trustworthy. That person could pretty easily run off with the cash.

So, this is a place where I think crypto is just starting to make an impact. I think it's still very, very, very rare. But, there's no reason it couldn't become much more common.

RR: Let's talk about that for a moment because many people haven't heard of that; and I almost know nothing about it. Bitcoin, I know, of course. Long-time EconTalk listeners, many of whom bought Bitcoin back in 2011, I think it was, when we had Gavin Andresen on, or I think 2016 or so and we had Wences Casares. That's when I bought. I have a tiny amount. I didn't buy in 2011 because I didn't know how to do it effectively. I bought in 2016, because there was a wallet – and that meant you didn't have to be a programmer to be able to hold your Bitcoin in an effective way. For many people who have never used it, it's very scary. You have a great line from the grandmother who wanted to use Bitcoin when she heard about it from her grandson in 2016 when she said, 'Money the government can't touch? Help me buy it right now.'

So, for a lot of people in America or in a Western country with a banking system that's stable, Bitcoin is a possible investment with a possible upside. There are some people who have an evangelical feeling that it's going to change things in dramatic ways. But in a country like Argentina where you don't have a reliable banking system, it's a whole different set of motivations. One of the more interesting aspects of your article is that a lot of the aspects of Bitcoin that its advocates preach, turn out to be either used very

differently or there are different things that people actually care about.

DZ: There are lots of different paths to go down there.

So, for one, stablecoins in the US context don't sound so useful. A stablecoin is typically a cryptocurrency whose value is pegged to something. In the case of USDC (US Dollar Coin, aka stablecoin) it is pegged to the US dollar. And so, one coin of USDC equals one US dollar, and it stays that way. But from the perspective of an Argentinian, this is very exciting, because now, suddenly, they have access to digital banking again without having to use an actual bank that they trust.

I could spend the whole episode just talking about all the different times that Argentinians have been screwed over by their banks and by the government taking money away from them. But I will just stick with one that is particularly incredible. In 2001 there was a banking crisis, and the banks and the government responded with something called *el corralito* – the little corral – where they basically shut down access to the banks and anyone who had their savings in the banks at that time – which was a lot, because they had just gone through a ten-year period of quite a bit of stability, so a lot of people trusted the government more than usual. A lot of people just could not access their money for almost an entire year. When they did get their money back at the end of the year and they were able to access it again, they discovered that all of their dollar deposits had been converted into pesos. And the pesos had lost two-thirds of their value in that time. And so, people were very angry, as you might expect. Anyone who had had their savings in a bank account learned I can never do that again. Like, this will ruin my life. Some adults that I know and some of their parents had had their life savings in these bank accounts at the time. There were people who committed suicide. It was really a very dark time for many people in the country.

So, people learned: we don't want to put our money in banks because the government or the bank will do something that makes a huge problem for me. So, that's why they've moved to cash. But, the cash has all these issues.

And so, USDC, by being cryptographically secure and not something that the government or the local banks can tamper with becomes extremely attractive.

Stablecoin is nice because now it holds its value in a more predictable way, compared to the other cryptocurrencies like Bitcoin and Ethereum, which are extremely volatile, very difficult to plan your life around them. And so, those are more effective for speculative reasons and other reasons. Whereas USDC can be more useful for day-to-day transactions.

RR: So, the stablecoin, though – and again, I know almost nothing about this – is pegged to the dollar. Someone's got to do the pegging?

> "
> ... we know the peso will keep losing value. It has done so basically for its entire existence.
> "

You point out there's an irony here. Bitcoin is famous – cryptocurrency in general is famous – for its decentralisation. But, stablecoin has to have an agent – an institution, an organisation – that is making sure that it's stable, USDC to the dollar. Right? And, that's why there's still some uncertainty around it, because that might not be able to persist. You're somewhat at the mercy of whoever is moving that around.

DZ: This is a place where I think some people might read my article and think, 'Oh, she's a complete crypto bull.' And, other people might read my article and think, 'Oh, she's a complete crypto sceptic.' And, the answer is somewhere in the middle.

When I look at the Argentinian use of crypto, it's both much more than people realise, and much less philosophically pure than people realise. So, stablecoins, they can hold their peg in a variety of different ways. For something like USDC, someone has to basically have a dollar in reserve for every USDC coin that exists, so that if you want to exchange your USDC for USD, then you can.

This is something that needs to be audited. People have to trust the auditor. There is a lot of trust to say yes, this coin is equivalent to one USD. And, one challenge we've seen over the last few months os that a number of stablecoins have actually missed their peg. People are now valuing at 98 cents on the dollar instead of a dollar. Which doesn't sound like a big deal, but the entire purpose of a stablecoin is to be a dollar to a dollar. So, it's actually a very big deal. There have been some, like Terra stablecoin, which have just completely lost all value; and it's very much a trust game.

I think it's reasonable to look at the situation and ask: why is that any different than trusting Argentinian banks or the Argentinian government? I think I would trust USDC over the peso because we know the peso will keep losing value. It has done so basically for its entire existence. And, USDC has been fine so far. So, if I had to take a bet between the two, I would prefer the one that has not continually lost value every single year. But, there's no guarantee. Unlike Bitcoin and Ethereum and others that are not pegged to something, those are things where the value is actually just set by the market, which arguably you could trust more or less depending on your risk appetite.

RR: Yeah. But it raises the question – which you set up the answer to – if it's pegged to the dollar, why not just use a dollar? I mean that's so much better. But, when you're buying a house, you got to see the advantages, potentially at least, of the stablecoin.

DZ: To circle back to the house-buying example, in this case you could just put the private key for whatever cryptocurrency wallet you have, put it on a USB stick, carry that in your pocket to the transaction, and do the transaction that way. Now you don't have to carry a bunch of cash around with you.

I think there's also potential in the future – this is not something I've seen before but I think it's totally possible – to have a smart contract act as the escrow agent so that you don't have to find that third party that you trust. There's a lot of different ways that you could implement this, but there might be some ways to say: okay, I'm going to put my crypto in this escrow that is handled algorithmically and – I'm going to make one up – but maybe the algorithm is that there are ten people who all have to agree that the money was transferred for the money to be able to move and they all have to sign it with their private keys. And if they all do that then the money can move.

That's more secure because if you're just trusting one person to physically hold the cash, it's relatively easy for them to run away with it. But, if you have ten people who all have to agree – and if they don't agree then it just stays – then that's a much safer situation. I have not designed these things myself, so there's probably someone out there who will do a much better job. But, I think it would be a pretty cool product to use and I think that in Argentina it would be quite popular.

RR: The other thing I want to discuss, which you mention, is the Benjamin. The hundred-dollar bill – which has Benjamin Franklin's picture on it and so they're called Benjamins. As you point out, most of us in America never see a hundred-dollar bill. I've probably touched ten in my life. Maybe. You said they're all over Argentina.

DZ: Yeah I've seen more hundred-dollar bills in Argentina than I've ever seen in my whole life, by a very wide margin. There's a whole culture around hundred-dollar bills. For one thing people save in hundred-dollar bills. Whenever we visit Argentina, my fiancé's family will ask us to bring hundred-dollar bills. Specifically, they want crisp hundred-dollar bills. Ones that aren't crisp but are a little torn or folded are worth less. It's good for us because when we're in Argentina we need pesos; so we'll give the hundred-dollars bills to his family, his family will give us pesos; and it's a win-win situation.

Whenever Argentinians travel to the United States they also try to open bank accounts here so that they can store money here, which is legal. It's just not typical. Most banks don't love it because they're kind of confused about what's going on. They then try to deposit their hundred-dollars bills here so that they have their money sort of in a safe place.

The place where I've seen the most hundred-dollar bills anywhere is actually at a cueva.

I was able to go to one of the biggest wholesaler cuevas in all of Buenos Aires recently. It's a wholesaler in the sense that it processes a bunch of cash for retail cuevas, which have smaller shops all around the city and all around the country. This place had stacks of hundred-dollars bills, almost to the ceiling. They were all wrapped in rubber bands. And, they have a whole system of couriers who have to bring the money around the city. You can always tell who they are because they'll be on a motorcycle in the middle of summer wearing a giant trench coat and the trench coat will be stuffed with hundred-dollars bills all up and down.

RR: Of course, hundred-dollar bills have a long history in the United States, as well. You quote Edgar Feige, the economist, that hundred-dollars bills make up 80 per cent of all US currency by value and 34 per cent of all bills in circulation – is a puzzle of course, given that they make up about 1 per cent, much less than 1 per cent, – of the bills that I've touched in my lifetime in America. And so, where are they?

Well, they're in Argentina for starters. But of course, in America they are used quite extensively for – not surprisingly – illegal transactions. Drug dealers and organised crime use hundred-dollar bills in exactly the same way that Argentinians do. They've got to hide stuff from the government; they need to have a store of value; and it's much more pleasant to hold one hundred-dollar bill than a hundred ones. So, they're always a value for people who want to be avoided by the government. And sometimes it's criminals, and sometimes it's citizens of Argentina.

Photograph: Angelica Reyes

DZ: I actually have a funny story about that. So, last December I invited a big group of friends, about thirty people, down to Argentina and we had a big dinner at one of the most expensive restaurants in the city. It ended up being about $40 per person in dollars. So, by US standards, not terribly expensive, but super-expensive in Argentina. Very nice food.

Something that the Argentinian government does is they like to pretend that there is no inflation. Everyone knows that there's inflation. But the government has this sort of doublethink – doublespeak – thing where they're, like, 'Oh no, no. There's no inflation.' And, one of the ways that they express this is by not printing larger denominations of bills. So, I believe the largest denomination is a thousand pesos. That's worth, I think $3.

And so, at this dinner with all of our friends, was this huge pile of cash that we had to give to the waiter. It was like a mountain. Everyone was just laughing. Like, this is so ridiculous. And, it's simply because the government does not want to admit that there's inflation. And, if they were to print a higher denomination bill, that would be strong evidence of inflation.

One other aspect of inflation that I think Americans really don't understand – and, I really did not understand until I spent time in Argentina – was that inflation propagates very unevenly.

Our simplified economic model of inflation is if there's 50 per cent inflation in a year, suddenly all prices will be approximately 50 per cent more. But, that's actually not correct. What ends up happening is very different. Some things end up going up in price much faster than others. You can see this in cooking. Any given week there might be some random thing that's very weirdly expensive and so suddenly people will just stop cooking with that item. Last time I was in Argentina, this item happened to be cheese. I don't have a model for why cheese was randomly expensive, but all I know is that, like, all the pasta that my fiancé's family made for us that week had no cheese on it, just because suddenly cheese was five times more expensive than it normally would have been relative to other prices.

This also has some really harmful effects for individual people. Different types of jobs have much more pricing power in their wages. A rough rule of thumb that's useful is that as your wage is more a percentage of the prices that your boss sets, the better off you are. So, if you're a waiter and your tips are a percentage of prices, then the restaurant's owner is very motivated to update the prices as quickly as possible. But, they're less motivated to update your wage as quickly as possible. But, luckily if you have your tip as a percentage of the price, now you can capture some of that.

RR: Yeah. You're insulated. That's a fantastic example. I love that.

DZ: And, if you are on the opposite end of this equation – it would be someone like a retiree with a pension. So, there's a lot of people who have pensions. Let's say you retired in 1998. The value of your pension back then is completely worthless now.

A category that would be somewhere in the middle is something like architects or home contractors. This hits close to home because my fiancé's parents are an architect and a contractor and they have some stories of, I believe it was the hyperinflation of the late 1980s. They were building houses and there were some people who were supposed to pay them on a Monday and the people said, 'Oh sorry. Actually I'm out of town right now. I'm going to pay you on Friday.' And, by Friday that price that they had agreed on was completely worthless. When you work for large, big fixed fees like that, where you say, 'Here's my fee and you'll pay me six months in the future,' or even a week in the future, when you have hyperinflation, it can really affect what your effective income is.

Long story short, there's just a lot of heterogeneity in the way that inflation will impact different people in the economy. And, some people will be really, really, really hurt in a way that other people will not be. And, it tends to harm people with less economic power much more than people with more options and more economic power.

RR: The problem with inflation is partly what you said, the fact that it's erratic in terms of its impact. But, the bigger problem is that you can't anticipate the magnitude of it. If inflation was high but steady, then you could plan accordingly.

> "I wouldn't be surprised if we ended up seeing a lot of financial innovation come out of Argentina. Because, these are people who live and breathe foreign exchange rates."

When you make a contract and I know that prices are going to be going up 100 per cent a year, doubling, then when I make a contract for a year from now, I take that into account when I set my price and I don't get hurt. I only get hurt – or the person on the other side of the contract only gets hurt – when the actual rate of inflation turns out to be different than was anticipated. Which of course is almost always the case. You can't accurately anticipate it.

There is a level of uncertainty that exists in international transactions because currency rates fluctuate and people who transact in global markets have to anticipate that, and often will insure against it. But, when it's in your domestic currency, you have to do some things that are very costly, like buying bricks or doing other things that have no real economic value and are simply done to insulate yourself from the worst downsides of unexpected price changes.

That's why it's such a tragic but fascinating laboratory in how an economy works. Where inflation bites, your savings are wiped out. The work you did over the last six months turns out to be half of what you expected to get because prices have changed in terms of what you can do with the money. It's an amazing and tragic example of how money – which is a great lubricant for economic transactions – when it's abused, you get costs. And it's very sad.

DZ: At the beginning I joked that every dinner conversation in Argentina ends up on the topic of what to do about your money so it doesn't lose value. It's kind of funny, but it's also, if you think about it, really wasting the minds of generations of people. There are

all these really smart people who are spending half of their brain just trying to figure out how to store their money so that they don't get wiped out tomorrow. It's just really tragic. I see all these really smart people who I love who could be doing so much more, but they're stuck in this cycle.

I guess one last idea is that I think it would be excellent if Argentina, or Argentinians – not the government, because the government's probably not going to do this – could implicitly dollarise everything. I mentioned that housing prices are priced in dollars. A few other big goods, some things like cars will be priced in dollars. If the entire economy could switch over to dollars or to crypto or something like that and just get out of the clutches of the government, they could finally escape this trap. This is something that the government is imposing on them. I think that it is possible. There are countries that have done this. Ecuador also had a bunch of very serious inflation issues. I think it was in 2001, maybe 2000, they fully dollarised. That was actually triggered by the government because there had been a crisis. Maybe the Argentinian government could do it.

I would love to see a bottoms-up change where people – and I think this is possible now maybe with remote work where more people are earning in dollars – I think little pockets of the Argentinian economy could dollarise or move to some other currency without the government's oversight. And, over time those little pockets could grow. So, there are glimmers of hope, but it would take a lot of work. I think maybe some big philanthropists could work on this problem. I think it would make a big difference.

RR: It's fascinating. I think the other part that's interesting – this came up directly in my conversation with Marc Andreessen recently – is that when you talk about cryptocurrency in a developed economy, people like to make fun of it. But, it has a powerful role, potentially, to play in an economy like Argentina's, because the alternatives have their own problems that are quite horrifying. What's fantastic for me in thinking about this, is that the market – and by the market, I mean voluntary, uncoerced, bottom-up activity – has begun to create an alternative that, in at least the Argentinian economy – and we had a great episode on the Venezuelan economy as well – where the crypto side of it is an end around to avoid being abused by your government. It's incredible.

DZ: Yes, people do solve problems. I think the optimistic case for Argentina is that it's filled with very smart people who understand a lot of things about how the world works. And so, as soon as they get out of traps like that, they can end up doing some pretty amazing things.

I wouldn't be surprised if we ended up seeing a lot of financial innovation come out of Argentina. Because, these are people who live and breathe foreign exchange rates. My fiancé says, 'You embrace the darkness. I was born in it.' And, in that sense, the Argentinians really understand these types of problems and I think it equips them to solve other types of problems in the future.

RR: That's cool. A silver lining. The Venezuela episode, by the way, was with Jim Epstein. You can find it in our archive. My guest today has been Devon Zuegel. Devon, thanks for being part of EconTalk.

DZ: Thanks for having me. This was a fun conversation.

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What is Psychological Safety?

Fail well. Learn fast. Repeat.

AMY EDMONDSON
IN GOOD COMPANY

Interview by Nicolai Tangen
Illustration by Vaughan Mossop

Nicolai Tangen: We are going to cover a topic that almost all our guests have mentioned, namely, psychological safety. But what does it mean and how can a leader or employee create this in his or her team? We are lucky to have the world's leading expert on this topic, Amy Edmondson. Amy, you were on my reading list when I was doing my Masters in Social Psychology. Just to make sure we are on the same page, for people who don't know much about it, what is psychological safety?

Amy Edmondson: It describes a climate or a group where people believe that candour is welcome.

NT: And why is it so important?

AE: It is important because today nearly all of us do knowledge-intensive work. We do work that requires problem solving and creativity and innovation. And catching and correcting errors so that the quality of the work is not harmed. That kind of work is dependent on our ability to notice things and to have ideas and to offer them.

NT: If you don't have it in an organisation, what happens then?

AE: Two big risk factors. One is that you will have preventable business failures. That you will launch products that a handful of people knew were not going to work but they were afraid to speak up. Another is that you will fail to innovate. They're related problems, but one relates to kind of visible, sometimes catastrophic business failures – bad decisions that got made that didn't need to get made. And the other is harder to see but shows itself over time. Like we're just not innovating, we're not coming up with the new ideas and services and products that customers want, and slowly but surely we become less relevant in the market.

NT: Social psychology came into my studies on the creativity side. But why do you become more creative by having this?

AE: Well, you become more creative not as an individual but as a team because a team is creative when it's able to access the diverse expertise and ideas of its members. The 'all of us are smarter than any one of us', kind of thing. Especially for innovation, where you might have an idea, it's kind of half baked, but then it makes me think of something else and then someone else and then we're sort of tying these ideas together and it takes us somewhere new. So teams will be more creative when people are unencumbered and they're not worried about 'how do I look'? Are people going to like that idea or are people going to reject me for saying that.

NT: Tell us about some companies where it really works.

AE: I would say one of the more delightful companies where it works well is Pixar, which is in the innovation domain. Their products are creative films that delight people of all ages and that are not just good storytelling, but beautiful computer graphics and storytelling and colour and ideas. This company has accomplished the remarkable feat of hit movie after hit movie after hit movie. So they've been persistently innovative. The only way this actually works is that they have trained themselves to be unafraid to criticise the evolving product.

When a movie is just partway there, it's boring. In parts, it's sappy. In parts it's not good enough yet. But in organisations, sometimes it's not very easy for people to say, especially in hierarchies, this just isn't working for me. Because it doesn't seem very nice to say things like that. So, they've created processes and norms whereby you have to criticise the heck out of it. We get to do that behind closed doors so that by the time it gets out for primetime, it's ready to go.

NT: If you are a new CEO in a company, how do you go about establishing this?

AE: I'm going to say something I don't usually say – you start with passion. You start with passion about who the company serves and why it matters. You're talking about purpose. Why it matters that we exist, and why I personally am excited to be here and to be leading this organisation so that we can do X, Y and Z.

NT: You normally don't start with passion. I think passion is completely underrated.

AE: I do too. But it's not the first thing you think of when you think of psychological safety. I'm saying it's really important to create psychological safety, which is another way to talk about what is a learning environment. Really important. But learning for what? Because learning is effortful. Speaking up is effortful. Taking risks is effortful. So the first job is passion about who we are, whom we serve and why it matters. Then the leader has to be very humble. Passionate and humble at the same time. Humble about the fact that I'm passionate about where we're going. That I don't know how to get there. I need your help. I have some ideas and I will be listening. They're conveying the message that they know that they are dependent on the brilliant men and women working for them. And they are overt in their quest to learn more. They ask good questions, they lead good team processes. They empower and enable others in the organisation to ensure there are the right kinds of training programs or structures or systems to help people have great teams and create learning environments throughout.

Because as a leader, depending on the size of the company, I don't get to interact with everybody directly. But I can ensure that I try to set a model whereby those who are interacting with others directly are showing up with a similar level of energy, humility and curiosity about harnessing people's ideas and perspectives.

NT: You often say that leaders need to show weakness and mistakes. You need to be pretty confident to do that.

AE: You do. Exactly. But note what you just said. It's almost paradoxical that showing weakness is actually a sign of confidence. I think intuitively we understand that there's a little part of our brain that worries, well, if I admit a mistake, then people will think I'm incompetent or less good at something. When in fact they go, wow, she's confident enough to say, oh, I got that wrong. So there's a confidence in being willing to say, I missed that. I didn't see that coming. Then there's also the reality that any leader is vulnerable, any individual is vulnerable to the actual uncertainty in our environment. In other words, anything can happen. A global pandemic can happen. So, once you recognise that vulnerability is a fact, not a choice, then you realise that your only choice is whether or not you admit it. And I think it's a sign of strength to admit it.

NT: If you speak to somebody like Rachel Botsman, she claims that when you admit mistakes, you also establish trust.

AE: That's right. In a funny way, you're more likable.

NT: Absolutely. Nobody likes perfect people.

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... once you recognise that vulnerability is a fact, not a choice, then you realise that your only choice is whether or not you admit it. And I think it's a sign of strength to admit it.
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Transparency is another thing you talk about. Why is that so important?

AE: Transparency is important in part because of trust. It comes back to trust. When you are being transparent, you are more trustworthy. You've put it all out there. I think that the art, the leadership challenge, is how to be transparent about reality, which is sometimes grim, without making people despondent. You have to be transparent. Here we are, this is what we're up against. Whilst also conveying hope. And that's the creative part.

NT: One thing you don't talk so much about is humour. At the fund, we start all leadership group meetings with a short, funny video clip. It's a leveller. It's shown that it creates more creativity and it gets people to relax. Why are you not spending more time on that?

AE: I don't know. I think that's a tremendous point. I've experienced all those things you just said. But you're right, I haven't emphasised it. The only thing to keep in mind with humour, whilst it's a great leveller, it's a great energiser, you have to be very aware that it's not humour that is mocking others.

Self-deprecation is fine. Humour is fine. But the kind of humour – and you often do see it in work environments – that is inadvertently gearing at someone does exactly the opposite. It makes people feel more anxious and less comfortable.

NT: Yeah. I think you need to be careful with irony because you can really fire the wrong way.

AE: And sarcasm. It's a big no. And I'm guilty too. I will occasionally be sarcastic because it's an easy one.

NT: Absolutely. So bad news for the English, basically.

NT: You talk about all this, but at the same time if you read Machiavelli, and see some of the classic, fantastic CEOs at Apple, Walt Disney, Henry Ford – they've been successful. There wasn't much psychological safety there.

AE: Not at all. Not at all.

NT: How come?

AE: Well, different answers for different people. Probably with Ford and Jobs, they have in common that they were both geniuses. Ford was a leader at a time when the name of the game was to tame complexity, get people in line, not listen to them, make them follow the formula that you and your buddy Frederick Taylor came up with. That was the way to get excellence.

NT: Taylor invented a very strict way of working.

AE: So-called scientific management. Which worked when the project was to tame complexity and conquer production at scale. But with knowledge-intensive work that management style would not work. Now we come to Jobs. So, Steve Jobs was famously unkind to different points of view. Not known to be a great listener. And yet created one of the most successful companies in history. There is a way to think about that – that Apple succeeded in spite of that, not because of that. There are two counterfactuals you can do. One is if you think you're Steve Jobs and you're always going to have the best answers and the best designs and the right everything, you want to boss people around. Tell them to just do it your way. Yell at them if they don't. If you think that you can get away with that, by all means, go for it. I'm sceptical. I think it's unlikely. Then the other is, what could you have done if you listened a little more in that setting?

However, there is plenty of evidence of sort of not good people getting ahead. I don't think too many people are buying into that mode anymore. But here's the sort of model I want to share. There's getting ahead, which is succeeding in your career. Doing well in the world and in society's eyes. And then there's making a difference. And we can fill out all four quadrants of that model. You can not get ahead, not make a difference. And that's sad but frequent. You can make a difference in the world, but not get ahead.

You could be a health care worker toiling away really having an impact on people's lives, but not in any way having success. And you can be someone who gets ahead and has tremendous success, but doesn't really make a positive difference in the world. I think where most of us would aspire to be is to get ahead and make a difference. And I think if you want to be in that quadrant, you have to listen to others and you do have to keep holding yourself honest.

AE: Ask yourself 'what am I missing'? It's the difference between 'I'm sure I'm right and I don't need to listen to anyone', compared to 'I kind of think I'm right, but what am I missing'? Even selfishly, I ought to care about what I am missing?

NT: So, what can organisations do? What can the HR department do? I know our HR department is really working on this. What are the things they can do?

AE: I think they can keep emphasising both the importance and the nature of the work we do. That this is the kind of work that depends on all of us bringing our A game. And, by the way, our A game, not as individuals running a race, but as team members coming up with new solutions every day to delight our customers. That's a team sport. Emphasising that the nature of the work is that it requires innovation. It requires problem solving. Therefore it requires your brain, not just your being here.

Then, importantly, modelling at the top the kinds of learning-oriented behaviour we need and then putting in place systems and structures and trainings and reminders that help people become more self-aware, more other aware, more curious, about the quality of the work rather than about self-protection. I think we are naturally about self-protection unless we overcome that.

NT: So I can see what leaders can do. But let's say now you're a normal employee.

AE: Same thing.

NT: Say I just joined the company and we produce some kind of gadgets. I come straight from school. What can I do?

AE: Well, since you're new, I'm hoping you have some new ideas that we haven't thought of before. So what you can do, oddly, is the same things that the CEO should do. Ask questions and respond productively. You should ask questions of your new colleagues because you don't know them yet very well. You need to learn about them, you need to connect with them and you should respond productively to people when they say things you disagree with. You should say

> "I think that the art, the leadership challenge, is how to be transparent about reality, which is sometimes grim, without making people despondent."

like, 'That's an interesting perspective, I'd like to learn more.' In other words, your job as an individual or as a CEO is to control the things you can control and not spend a lot of time worrying about the things you can't control.

NT: Your work resonates extremely well with the times we live in. Because we care a lot, and everybody is extremely politically correct and we have to be very careful. And the young generation is more kind of psychologically fragile and so on.

AE: It's true.

NT: So is it kind of symptomatic of the fact that we live in a culture where there is less focus on excellence and drive?

AE: The way I'd like to think about it is if we want to truly be excellent, which I think we do, we need to be learning oriented because yesterday's excellence is not tomorrow's excellence. We're playing a game where the challenges keep intensifying and the goalposts keep moving. So the only way to achieve excellence is through learning, and the only way to achieve learning is through speaking up and taking risks and trying new things. But I think you touched on this sort of fragility, or the brittleness we could say of younger generations, or we could say many humans. To me that's the biggest challenge that we have to overcome, because if we're brittle, we'll be tiptoeing, and if we're tiptoeing, we won't be doing great things.

NT: We talk about an environment where we need to be more agile, have more confidence, change more and be more resilient. Yet other people, for example Angela Duckworth, say that the new generation has a lot less grit. So we need more grit, but we have less of it going forward.

AE: So we better get to work.

NT: Absolutely.

AE: How do you develop grit? I think you develop it through baby steps. You give younger people, or anybody, the opportunity to have a stretch assignment, a stretch opportunity. Maybe something doesn't go well. They have the experience of failure and guess what? They don't die. So they learn oh, that wasn't so bad. Part of the challenge with many young people is that they haven't had a failure experience. They've had nothing but good marks. They get a trophy for participating in sport rather than for being the winning team. And when you had less experience failing, you have more fear of failing. So we have to give them opportunities to fail in a safe way. To then think, hey, that wasn't so bad. What's next?

NT: How does it fit in with feedback and the importance of feedback culture?

AE: It's crucial. Feedback is probably the most important activity for learning, and psychological safety is the kind of climate in which learning can happen. And, by the way, I'm more receptive to feedback when I'm in a more psychologically safe work environment. But feedback is critical. And the challenge of feedback is none of us really like it. We all need it, but none of us like it. And in organisations, a lot of times, it's not very high quality for one of two reasons. Either the person giving it hasn't really thought very carefully about it, they aren't really being data driven or concrete in their feedback, or they believe you don't want to hear it. So they sort of give you some nice, you did great. This is a small thing and they barely mention it. So you go. Wow, I'm great. You walk away. It wasn't very useful. I mean, it was nice, you had a nice conversation, but you didn't learn anything.

NT: It's a tough one. How do you get feedback in the best possible way?

AE: My husband gives it to me. My grown sons give it to me as well. One of the downsides of being more successful in any career is you become more insulated. It's a good question. And I think we all need it. None of us like it, but I think we're able to withstand it because of the greater joy of becoming more effective at the things we care about.

NT: Do you think there is more psychological safety in societies where the power ratio is lower, so where there is less power in the top and more at the bottom?

AE: Yes, on average. You'll still see enormous heterogeneity. You'll see teams that have very low psychological safety, maybe because they just have a tyrant or a bully as the leader.

NT: When you look at corporate structures, for instance, the Nordic region is really flat. And in Germany or France there is much more hierarchy, and a huge power distance. Do you think there is less safety there?

AE: Yes. And not just at the bottom. The top is anxious too, because they know I'm at the top of this hierarchy, or I'm near the top of this hierarchy, I'm supposed to know things. And when you have a deep belief in hierarchy and in the roles that are represented in that hierarchy, then you have a kind of anxiety about the gaps that you know you have, but you believe them to be undiscussable.

NT: What about gender differences?

AE: The one robust gender difference that I've found and seen in other data that relates to psychological safety is on average, there's always variance, but on average, women are less likely to speak up with something uncertain at the same level of confidence as a man might be. A woman will often set the threshold for when it's okay to speak up quite a bit higher.

NT: How does it change when you're working from home? What are the challenges?

AE: On the one hand, you're comfortable at home. Home isn't scary for most people. But on the other hand, the technology that mediates our communication is a hurdle for candour and honesty and jumping in. We're seeing this depressing effect of people working from home being less likely to collaborate with people they haven't worked with before. They are also less likely to be teaming up across organisational silos than they were before the pandemic. So we're still collaborating, sending lots of emails, having lots of meetings and, slowly but surely, I've been having fewer meetings with new people. And new employees are getting less mentoring and

less exposure to people they didn't know because of the casual interactions.

NT: I've also seen research that if you are already insecure this way, working just makes you more so.

AE: That's a good point. It's a very good point.

NT: And you risk taking comments the worst possible way.

AE: Right. And you have too much time to stew over it. Absolutely.

NT: What are you working on at the moment?

AE: I'm working on a new book called *Right Kind of Wrong: The Science of Failing Well*. It's related to psychological safety, where psychological safety describes the nature of the environment, the climate that we need to innovate and problem solve together. This book looks at some of the technical details of failing well, like what does a good failure look like compared to a bad failure, and how do we avoid the bad failures and how do we increase the frequency of the good failures? Then I dig into three competencies that I think are necessary not just for failing well., but for thriving in the new world. One is self-awareness. One is situation awareness. What kind of context is this? What are the stakes, and so forth. Then the third is system awareness. Trying to overcome our very natural tendency to be preoccupied with me, and now, so that I can be interested in the larger system.

NT: Now we have thousands of young people listening to this podcast. What advice do you give to your students before you send them out in the world?

AE: Aim high. Go for gold. Play to win. Don't play not to lose. It's very human and very spontaneous to play not to lose – by which I mean, like a non-growth mindset, to only engage in things you know you can win. But go for the things that you may not win, which is, of course, related to grit. Aim high. If you are really passionate about solving some important problems in the world, you can't do it alone. So, team up. Team up with people who are different than you. That's not easy. There will be failure along the way. That's okay. Fail well. Learn fast. Repeat.

NT: Aim high. Team up. Fail well. Learn fast. Repeat. Sounds like some good rules to have.

AE: Easier said than done.

NT: That's for sure. Well, it's been amazing to have you on. We are going to take this home and work on it. A big thanks for coming.

AE: Thank you for having me.

In Good Company

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The Science of Self-Improvement: Sleep, Caffeine, Impulse Control, Breathing

The beauty and utility of human biology

ANDREW HUBERMAN
THE KNOWLEDGE PROJECT

Interview by Shane Parrish
Illustration by Vaughan Mossop

Shane Parrish: Let's start with light. Light seems to impact the way we feel, how we learn and how we sleep. How does light exposure or sunlight exposure impact the way we sleep? During the day we have the opportunity to interact with light in various ways and our cells use that information. Maybe you can take us through how we can use light to get a better night's sleep.

Andrew Huberman: Light is perhaps the most powerful stimulus for our mental and physical health, and for our performance in every endeavour. We often miss this point because the effects of light are what we call slow and integrative. If you look at a particular colour of light, it's not that suddenly you're going to be endowed with superpowers. If you don't view light for half a day, or for a day, you're okay. But what light does is it sets the foundation of our abilities and it does that indirectly, and directly.

It does it indirectly by controlling when we are asleep and when we are alert and it also has direct effects on the way that our nervous system functions. The way we function is by way of our nervous system. Our nervous system links all the organs to the brain and body. Brain, spinal cord, but then, of course, spleen, heart, lungs, etc. The nervous system is the system that coordinates all of those. The nervous system, therefore is, without question, the most powerful organ system of our body and it acts as a conductor. It is locked inside of our skull and body, and it has no knowledge of the outside world. Vision, which involves photons, light energy reaching the eyes, getting converted into electrical signals is the way that the nervous system decides when to be alert and functional and when to be asleep. It also is what determines all the various little oscillations in ability to focus, and creativity, and all the other things that we consider life.

When you wake up in the morning, your brain and body have effectively been in the dark, regardless of what sleep environment you happen to be sleeping in. You have a set of neurons, nerve cells in the back of your eye in a little structure called the neuroretina. What they are looking for, what activates them, is

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Basically what you want to do is get as much bright light as you safely can in your eyes all day long, and then as little bright light in your eyes as you can between the hours of about 10.00 pm and 4.00 am.
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bright light, ideally from sunlight. When bright light reaches the eye, those particular neurons send a signal often to the vaulted dark of the brain. They do that by way of a little wire called an axon, and they communicate with an area of the brain that's vitally important called the hypothalamus. It sits right above the roof of your mouth and it harbours a bunch of structures that are responsible for hormones like testosterone and oestrogen, and for cortisol release in other locations in the body. Basically, it controls when you're going to be alert, when you're going to be asleep, your hormones, your immune system function and your appetite and your mood.

So, this morning signal of getting bright light in your eyes is absolutely vital. Now, how does one do this? The best and ideal way to do this would be to wake up, go outside and get some bright light in your eyes without sunglasses. Now the ideal situation would be a nice, bright, clear day. You get 5 to 10 minutes of sunlight. You go inside and get ready for your day.

By doing that, you do a number of things. First of all, every cell in your body has a 24-hour clock. Meaning there's a timer that goes from zero to twenty-four and then repeats, and that's true from the day you're born until the day you die. However, every cell in your body has its own separate clock and the way that those clocks are coordinated into coherent action is from a signal from this brain structure called the hypothalamus. The only way that signal can arrive properly is if you are getting light to trigger the hypothalamus to say, okay, it's the start of the day. Everybody start. Otherwise, your body slowly over time becomes a little bit of a clock shop where every clock is on a different timer and it's alarming at different times.

This is actually what happens when you travel and you get stomach issues, or you're not feeling right from jet lag. The individual clocks of the cells in your body are falling out of sync. However, many people, including me, wake up before the sun is out. In that case, it's very simple. Flip on as many bright artificial lights as possible. Ideally overhead lights.

But sunlight is really the key and so once the sun is out, it's very important to get outside and get anywhere from 5 to 20 minutes of bright light exposure. A lot of people can't afford the time of 20 minutes. If it's a dim overcast day, the remarkable thing is there is more photon light energy coming through that cloud cover than there is from bright indoor lights. Now, some people live in an area of the world where it is very dark in winter or their schedule is arranged such they just can't do this within 30 minutes of waking. In that case, there are daylight simulators that are commercially available. They're very expensive. What I recommend is actually something quite low cost that works just as well, which is that you get a ring light. The selfie ring lights that the YouTubers and the Instagramers use. Just put that on a table or facing you as you work in the morning. Actually, you could leave that on all day.

Basically what you want to do is get as much bright light as you safely can in your eyes all day long, and then as little bright light in your eyes as you can between the hours of about 10.00 pm and 4.00 am. Bright light exposure through windows or windshields will not suffice. Those don't focus the light to your eyes. In fact, they're designed to filter the very light that triggers activation of these neurons.

So, throughout the day, you want to get as much bright light in your eyes as you can. If you need to use one of these ring lights, great. Some of them are very low cost. I realise everyone has different budgets, but the daylight simulators are kind of ridiculously expensive, considering that all you really need is a bunch of bright light in your eyes. However, sunlight is best and so if you have breaks during the day, go outside. Even if you're going to be on your phone texting, if you can take calls outside, do it. If you can get out onto a balcony, do it. If the sun is on the opposite side of the building and you are on the balcony taking a call, you're still getting more photons, more light energy.

A fun little free resource that's out there is an app called Light Meter, and the photographers will know about this. You basically open up this app, point it in the direction that you're looking and you can press the little button and it'll tell you how many lux, how much light energy, is coming from that location. It's approximate, but it's pretty good and you'll notice that on a dim overcast day, you're getting 8,000 lux of light coming to you. Then you'll point at one of these very bright artificial lights in your home and you'll look at, and it'll say 800 lux. You'll go, wow. How is that? Well, it's because there's a lot of light scatter in the outside. So, you don't perceive it as a focused beam.

So this behaviour, this activity should be done every day. If you miss a day, it's okay. There's a slow integrative system, but you don't want to miss more than one day. Why? Well, one of the key features of every cell in our body is that it's coordinated to a general hormonal signal. Hormones are chemicals that are released in one location in the body that go and act at other locations in the body. A key hormone for health is cortisol. We always hear about cortisol as a stress hormone, but cortisol every 24 hours, there is going to be a peak in cortisol release. That's non-negotiable, it's a healthy peak and it's the one that wakes you up in the morning, increases your body temperature, which is part of waking up, gives you focus and alertness. It activates your immune system in a positive way, provided you don't have too much cortisol throughout the day.

That peak is going to happen no matter what. If you get light in your eyes early in the day, that peak will arrive early in the day. This is vitally important because one of the key findings in the field of psychiatry, biological psychiatry, is that when that peak doesn't derive early in the day, it starts drifting later and later and later in the day. People start getting mood issues, they start feeling irritable, and actually it's a hallmark physiological signature of depression to have a late-shifted cortisol peak. In addition to that, many people who have depression or even mild depression wake up at 2.00 or 3.00 in the morning and can't fall back asleep. In fact, that's one of the first things a psychiatrist will ask about.

It doesn't mean that if you're waking up at 2.00 or 3.00 in the morning that you're necessarily clinically depressed, but it's one of the hallmark features. Many people report that just simply getting bright light exposure in their eyes early in the day, ideally from sunlight corrects a number of these issues. Will it cure clinical depression? Probably not if it's very severe, but many people actually feel better all day long. They sleep better. These cells and circuits are there for a purpose. They have no other function except to bring information about when there's light in the environment to the brain, and essentially to convert that into a bunch of hormonal signals.

I want to talk about the other hormonal signal, because this is really key. Many people have heard of the hormone melatonin. This is a hormone that is secreted from a little pea-sized gland in the brain called the pineal. The pineal is the only source of melatonin in the body, and melatonin's role is to make us feel sleepy and fall asleep. It does not actually keep us asleep. I'm not a fan of melatonin supplementation. But light viewed by the eyes inhibits melatonin. So much so that if melatonin levels are at their peak and you walk into the bathroom at night and you flip on the lights and it's really bright, if you spend more than 10 or 15 seconds in that light, your melatonin levels will drop to zero. So, this is a remarkable relationship between the external world and melatonin.

This is why in the evening, you don't have to be paranoid about lights. But what I recommend is that starting around 8.00, 9.00 or 10.00 pm, start dimming the lights in your environment. Just dim the lights as low as you can safely have them. People have different lifestyles and different needs. If you're on screens, dim the screens. What I do is in the evening, I start dimming lights and if I use lights, I use lights that are set low in the physical environment. That's because they won't trigger activation of these cells quite as much. You really want to control your transition into wakefulness by viewing bright light early in the day and throughout the day. And then control your transition into sleepiness by dimming the lights in the evening. If people do those two things, they are going to see an outsized effect on their mental and physical health. That's without question.

Then there's one other kind of tweak to all this, that's if you can try and get outside in the evening or late afternoon, when the sun is headed towards the horizon. It doesn't have to be a sunset. If you can watch the sunset great. But what we call low solar angle light has particular wavelengths that are optimal for activation of these cells. What happens then is very interesting. You're giving it two signals. You're giving it a morning signal saying, ah, it's morning. Then you're are getting an evening signal and this clock in the brain, it gets a little technical, but it has two oscillators. It has a morning oscillator and an evening oscillator and then your system really knows where it is in time.

We all fall off every once in a while. You go to a show or you go out and it's bright in the restaurant, fine, no big deal. But if you do this most days, your system starts to hum along with the natural rhythms of the rise and falling of the sun. It's no coincidence that we have a 24-hour clock in every one of ourselves because the earth of course spins on its axis once every 24 hours. In addition to this, if you start doing it regularly, something really beautiful happens, which is that melatonin signal – remember light inhibits melatonin – the longer the day, the shorter the melatonin signal. So, in the summer months, your body releases very little melatonin. In winter months, because days are shorter and there's less light overall, you release much more melatonin.

So, you actually have a calendar system in your body that relates to the orbit of the earth around the

sun once every 365 days. What happens is when you start getting regular about morning light viewing and evening light viewing, what happens is your system starts to fall into a very regular pattern where you feel sleepy when you expect to and want to be sleepy. People actually report the subjective experience of going outside in the morning, and as the sun comes out or as they get this bright light exposure from an artificial light, they can actually feel their system charging.

That's not a placebo effect. That's a real effect of the release of cortisol and adrenaline into your body. The release of dopamine is controlled by light, a powerful neuromodulator that makes you feel good. I could go on and on, but it's very simple. Get as much bright light in your eyes, ideally from sunlight throughout the day, when you want to be alert. Really limit the brightness of light and the amount of light as you head into the nighttime.

SP: What's your evening routine? Walk me through 5.00 pm until you're lights out falling asleep in bed.

AH: I generally go to sleep somewhere between 10.00 and 11.00 pm. Although, lately I've been going to sleep much earlier because I've been finishing my last meal sometime right around 6.30, 7.00 pm. That's not because I'm on some extravagant nutritional routine. I've just started getting up earlier for social reasons. My partner goes to bed really early and just for coordinating schedules it just makes sense. But I think most people go to bed somewhere between 10.00 and 11.00 pm, or 9.00 and 11.00 pm.

I'm not an evening exerciser. I like exercising in the morning or the day. The way I like to exercise, I like to exercise pretty intensely for about 45 or 50 minutes and that requires caffeine for me. I don't want to drink caffeine too late in the day. So, I stop drinking caffeine around 2.00 or 3.00 pm and oftentimes earlier.

But a couple of things happen in the evening. First of all, my evening meals are more laden with carbohydrates than proteins, typically. Not every day. There are times when I'll have a steak for dinner or something like that, chicken soup or whatever it is. But it's very clear that fasting and low carbohydrate meals lend themselves to more alertness and focus. A lot of people say, well, how can that be? The brain uses glycogen, you need carbohydrate. Well, when you eat a meal that is slightly devoid or devoid of starches, it creates a sense of alertness because there's actually a mild adrenaline response.

Rewinding a little bit into the earlier part of the day, I fast until about 11.00 am. I usually get my exercise at some point before noon. I'm not super strict about that. Then my meal is generally some meat, a salad, something low carbohydrate. If I train really hard, I might have some rice or oatmeal or something like that

“This is why we eat comfort foods. Most comfort foods involve eating foods that are pretty carbohydrate laden because there's a pathway involving carbohydrates and the amino acid tryptophan that converts to serotonin. It essentially blocks the cortisol response.”

and some fruit. Then in the afternoon I have a snack which is also pretty low carbohydrate because I want to have that alertness and I'm drinking caffeine. So, I'm kind of humming around doing my work and trying to get into that high-focused state. For dinner, I generally will eat pasta or something that includes more starches because starches are known to actually reduce cortisol levels in the body. This is why we eat comfort foods. Most comfort foods involve eating foods that are pretty carbohydrate laden because there's a pathway involving carbohydrates and the amino acid tryptophan that converts to serotonin. It essentially blocks the cortisol response.

A lot of people are on very low carbohydrate diets. I have no problem with that. If people do ketogenic diets or low carb diets, those people often have a hard time sleeping. So, in the evening I tend to eat pastas, and rice and soups, and I still eat some protein from clean animal sources, because that's what works for me. I might do a little bit of work in the evening. We are not big screen people in the evening. I do read books. Generally, we end up hanging out, just talking and listening to music and things like that. I might do some writing on the computer.

So right around 8.00 or 9.00 pm, I start bringing the lights down. In fact, I have a real sensitivity to the

overhead lights because I'm so used to this pattern. I start dimming overhead lights in the evening. Then for the transition to sleep, I keep my phone out of the bedroom as much as possible. Sometimes I'll use it as an alarm, but I'll put it on airplane mode. The biggest peak in alertness actually occurs about 90 minutes before your natural to sleep time. A lot of people don't know this. There is beautiful work from Chuck Czeisler's lab. He's an MD out of Harvard Medical School. He discovered, in tracking people's wakefulness and activity patterns, that they're buzzing around all day, but then right before their natural pulse in melatonin takes off, they have this peak in activity. This, I think probably hearkens back to some need to tamp down all the safety leaks that might be in one's environment and get everything prepped. Because when you're asleep, you're actually pretty vulnerable to predators, attacks and things of that sort. That's the rationale. Nobody really knows. But you can essentially figure out your best bedtime by when you have this big peak in activity and then it kind of subsides. So sometimes if I'm feeling a little too alert and wide awake, I'll just remember that that's going to pass naturally. One of the most powerful tools that has come into my life in the last decade and that my lab works on, and that people in psychiatry at Stanford are also working on, is a practice that I call non-sleep deep rest, which is NSDR.

Non-sleep deep rest is an umbrella term that admittedly I created to include things like yoga nidra, which actually doesn't involve any downward dogs or handstands or anything. Yoga nidra is an ancient practice. There are some scripts online, many of them are very good. You can find one of these scripts on YouTube. Put in headphones or put your phone next to you. You lie down and it's a 10 to 30-minute script that walks you through a progressive relaxation of your nervous system. There's some breathing. What this practice does is it teaches you to deliberately turn off your thinking and to relax your body, and it makes it easier for people to fall asleep and more easily de-stress. Now the question is when to do NSDR? You can do NSDR first thing in the morning, if you ever wake up and you did not get enough sleep. I often wake up and feel, ah, I didn't get enough sleep. I'll do a 30-minute NSDR and I come out of that feeling terrific, as if I got a full night's sleep. I do this almost every day at some point. I might do it in the afternoon, or if you wake up in the middle of the night and you're having trouble falling back to sleep, I highly recommend doing this. Because even if it doesn't put you back to sleep, it's better than being awake and ruminating. You're teaching yourself to fall back to sleep.

The other resource that's really wonderful is something called Reveri. Reveri is an app for Android and Apple. It was developed by my colleague, David Spiegel in the Department of Psychiatry at Stanford. He's an MD, he's a world expert in clinical hypnosis. Not stage hypnosis, but self-hypnosis for, you'll find a number of things in the app, improving sleep, focus, chronic pain, anxiety. I should say every one of those scripts and Reveri on the whole, has excellent peer review data, clinical data, scientific data that we know which brain areas turn on and off as a consequence of doing these things. It's a really powerful tool and these are only 15-minute scripts.

Again, the best time to do them is first thing in the morning, before you go to sleep at night or any time of day is the kind of joke that I make. Which is just get in the habit of doing NSDR or a Reveri script. You don't have to do it every day. You could do it maybe once or three times a week. What you're doing is you're learning how, when you wake up in the middle of the night, you go to the bathroom, you come back and you're like, oh, now my mind is racing. What do I do? Instead of getting on your phone, you can start to use some of the progressive relaxation that you learned from those scripts, or you can actually do those scripts. So I tend to do those in the evening or when I wake up in the morning and that greatly facilitates my transition to sleep and just being a more rested person.

Waking up once in the middle of the night to use the restroom is perfectly normal. I'm a big fan of sleep trackers, but I don't use one. I go on subjective feelings of wakefulness during the day. Just remember insomnia clinically defined is whether or not you're falling asleep during the day because you're having trouble sleeping at night. A lot of people think they have insomnia, what they actually have is anxiety about waking up.

Obviously, you don't want to drink so many fluids before sleep that you're waking up all night to use the restroom. One of the nice things about a carbohydrate-rich meal in the evening is carbohydrates actually hold water. Anyone on a low carbohydrate diet will notice that they lose a lot of weight. They think they're leaner. They're actually excreting a lot of water. The temperature thing is really big. We haven't talked about temperature, but second, to light, temperature is the most powerful stimulus for wakefulness. Actually, when you wake up in the morning, it's because your body temperature is rising.

In order to fall asleep and stay asleep, you need your body temperature to be about one to three degrees lower than it was in the afternoon. So one thing you can do is you can keep the temperature in your home a little bit lower at night and just stay under blankets. We actually dump heat mainly through the palms of our hands, the upper half of our face, and the bottoms of our feet. There are special portals between the blood and the skin there. Beautiful name was discovered by my colleague Craig Heller at Stanford,

> An appropriate amount of physical exercise each day is going to help you get the appropriate amount of sleep.

these are called glabrous skin. For the aficionados, you have arteries, capillaries and veins, and in these particular locations, it only goes from arteries to veins. You skip all the little estuaries that are the capillaries between them and you're able to basically dump heat more easily. During the middle of the night, the best thing to do is to have warm blankets on top of you and be in a cold room. And then if you get too warm, you will just naturally in your sleep extend a foot or a hand out.

SP: It seems common at least among people that I know that they can fall asleep almost instantly, but then four to five hours later, they're wide awake. What is going on there?

AH: So, a couple of things. One is they might not be getting enough physical activity during the day, or they're getting too much, they're overtrained. If you train too much and too often, you'll find that you can't get enough sleep and you're always tired. If you train too intensely, you'll often find that you'll have this waking-up agitated thing. People that are doing tonnes and tonnes of miles on the road find that they're always exhausted. Well, your body's just not recovering. And likewise with work, if you just work, work, work, you're just burning yourself down. An appropriate amount of physical exercise each day is going to help you get the appropriate amount of sleep. And the rule of thumb from the literature is about 150 to 180 minutes per week of zone 2 cardio.

This is cardiovascular exercise of any kind where you could have a conversation, but you're a little bit strained. You'd prefer to be quiet to keep it going. Zone 2 cardio, 150 to 180 minutes a week approximately, broken up into various sessions. And then it's very clear that the body and brain and the skeletal system and the muscular system benefit from a minimum of six sets per body part, per week, just to maintain muscle. I'm not talking about people building muscle. I'm talking about people like my mum who's in her late seventies should be doing six sets a week of quadricep work. That will help sleep, the 150 to 180 minutes of zone 2 cardio and getting resistance exercise three or four times a week. You're going to be a much more fuel-efficient, better sleeping, more focused system, without question. There's tonnes of science to support why that's the case.

In fact, there's this really cool study by my colleague, Tony Wyss-Coray at Stanford recently, where they take the blood from exercised individuals and they infuse it into non-exercise individuals and all sorts of aspects of brain function improve. There's actually stuff secreted from the muscles that goes off to the other organs. You think, well, how could that be? But the rationale is that the other organs of the body don't know what the other organs in the body are doing. So, they need to receive signals. So, when the muscles are working, the brain says, oh, I need to keep the neurons that are responsible for motor function and memory. They saw improvements in memory in Alzheimer's patients in this study. Really amazing.

So there's that – the exercise and effort component. I don't think we were designed to just think and scroll and text. I think we were designed to move and that's vitally important. The other thing is that many of the people waking up after four, five hours were supposed to go to bed earlier. Remember melatonin puts you to sleep but doesn't keep you asleep. So many of these people might be going to bed at 11.00 pm waking up at 3.00 or 4.00 am, going, ah, here I am again when actually they need to go to bed at 9.00 pm. Now there's this weird asymmetry in the way that our system is built, in that we can push through fatigue, but it's very hard to make ourselves fall asleep. So, some people need to discover that they actually were meant to go to bed earlier. I know people think about night owls and morning larks and this kind of thing. That's a big idea in industry. And to some extent, it's true. They're genetic polymorphisms that relate to these things. But for the most part, most people were evolved under conditions where they went to sleep shortly after the sun went down. I do think that there is something powerful about going to bed a little earlier.

I find, and many people find, that every hour of sleep before midnight, recharges them more deeply than the hours after midnight. And I don't know what this is, but I find if I go to bed at 9.00 pm and I'll sometimes wake up at midnight and I'm like, ah, it's only midnight. What am I going to do? But then I fall back to sleep, then I'll wake up at 3.00 or 4.00 am and I'm ready to go. And that's great. I mean, you can get so much done in the hours between 4.00 and 7.00 am, fewer distractions, your focus can be very high.

The problem is most people are going to bed late. They're waking up four or five hours later, then they're scrolling on their phone because it's a very kind of passive sensory input. They're trying to get themselves back to sleep. It doesn't work. And then throughout the day, they're working at about 75 per cent capacity. I would encourage those people to just start going to bed earlier.

SP: I want to briefly touch on caffeine and alcohol. Maybe we can start with alcohol. What happens when someone has a glass or two of wine or an after-dinner cocktail, how does that impact our sleep? And is there anything we can do to counterbalance the effects of booze to get a better sleep.

AH: I think that the key is to not do it too close to sleep. I think obviously hydration is key because alcohol is dehydrating. Remember a lot of the negative effects of alcohol on sleep are by way of the temperature system. Alcohol actually lowers your body temperature, but your perception of that lower body temperature is disrupted. So part of the reason you can fall asleep when you drink alcohol is because it lowers your body temperature. Now there's a dosage component and so on, but one idea would be if you're going to drink alcohol, hydrate.

Obviously, the deadly combination is alcohol and any kind of barbiturates or sedatives. There's a strong incentive for staying away from sleep medication if you're drinking. I mean, a lot of deaths have occurred just because people combine prescription sedatives with alcohol.

There's a loss of sodium in your system when you drink alcohol because you secrete a lot of fluid. Neurons, the way they're able to function, is from three main electrolytes – sodium potassium and magnesium. The actual firing of your nerve cells is because sodium enters the cells, potassium goes out. So, a lot of people will feel better if they'll drink water with some electrolytes. That will make a big difference in terms of reducing hangovers and improving sleep. You want appropriate amounts of sodium, potassium and magnesium in your system.

Salt has gotten kind of a bad rap. There was an article published in *Science* magazine, which is one of the premier three apex journals in science, about the whole myth around salt. It's true that people with chronic hypertension need to avoid salt. But for most people who are consuming enough fluid, salt is great. I mean, salt is something that keeps your blood volume up, keeps your brain feeling alert and focused. A lot of times people will feel jittery during the day. They'll think they have low blood sugar. Take a pinch of salt, put it in some water, maybe a little lemon juice to kill the taste and drink that. You notice you're just rock solid. Why? You might have been low blood pressure or low sodium. Sometimes people can't focus and they are low sodium. Sometimes we crave sugar and we're actually low sodium.

This isn't wishy washy, new age-y, California stuff. This goes right down to how our kidneys function and blood volume and how the brain requires a certain amount of blood pressure in order to have enough blood going to our brain in order to be able to focus. So when we drink alcohol, we're inhibiting all these things. You're excreting sodium, you're lowering body temperature. And, of course, it makes you feel kind of drowsy. Now about 10 per cent of people have a genetic predisposition to get a big dopamine increase from alcohol. Alcoholics have to be afraid of this and people who have this need to be on the lookout for alcoholism. I have a good friend who, when they drink, they experience this dopamine surge. So, they can drink and drink and they feel alert and they feel great and they want to party.

It's not that their tolerance is high. They actually have a dopamine response to alcohol whereas most people it's more of a GABA sedative-type response. And after one more drink than they normally can handle, they're just ready to pass out. Or they're kind of heading into the blackout type drunk stuff, which is really bad. So just keep in mind that alcohol can have different effects on different people. But, for most people, a drink or two is fine, followed by hydrating with electrolytes. And then when you wake up in the morning, you also want to hydrate with electrolytes. That's really key. I think they can offset some of it.

SP: What about caffeine? Maybe you can walk us through what we know about it and how we can use this knowledge to get better performance while minimising the impact on sleep.

AH: Caffeine works. It's a competitive agonist of adenosine. Caffeine parks in the adenosine receptor. Remember adenosine is this molecule that builds up the longer we've been awake. So it parks in that receptor and it's an agonist, meaning it can park there, but it out-competes the adenosine. So it creates an artificial state of alertness. But it also triggers the release of adrenaline, also called epinephrine. Epinephrine and adrenaline are the same thing, from the brain and body, two sources. You have your adrenal glands above your kidneys. That's one source. And then you have a collection of little neurons in your brain stem called the locus coeruleus. Locus coeruleus is an amazing structure. It sends those little wires we call axons often to different areas of the brain, acting kind of a sprinkler system, releasing epinephrine and creating states of alertness in the brain.

Photograph: Dex Ezekiel

Caffeine stimulates those neurons to release adrenaline. It creates wakefulness in the brain and wakefulness in the body through locus coeruleus in the brain and the adrenals in the body. In addition, it does something really cool, which is that it increases the sensitivity of the dopamine receptors. Now, we haven't talked too much about dopamine, but dopamine is perhaps the most powerful neuromodulator. It's involved in movement. That's why people who have Parkinson's are deficient in dopamine neurons, and they have trouble generating smooth movements. So, they shake. In severe cases, they can't speak. They feel depressed because dopamine controls motivation, craving and drive. Dopamine makes us feel good, but it really makes us feel motivated.

People who are deficient in dopamine have trouble with focus. They have trouble with motivation. No disrespect, but they are the people that can sit around thinking about the things they need to do forever. They are chronic procrastinators. Dopamine can be enhanced by taking various things and doing certain things, but caffeine increases the sensitivity of dopamine receptors. Increasing not just the tendency to move by release of adrenaline, but it makes us more motivated to go out and pursue goals. In fact, the major effect of dopamine is to place us into a mode of what we call exteroception – of focusing on things that are outside our immediate experience or the confines of our skin. Create the company, get the grades, find the mate, forage for food. This is an ancient generic mechanism that was designed to carry over to almost every pursuit activity of any kind.

Caffeine increases dopamine function by increasing dopamine receptors. I am a fan of taking caffeine or drinking caffeine early in the day. I think yerba mate is one source that's great. Some people like coffee, some people like espresso. Just make sure you hydrate and make sure you're getting enough salt as you hydrate. You don't need to buy any fancy electrolyte solution. You can just take a little pinch of salt and put it in water for every coffee or espresso

> "... keeping the blade sharp on both sides, getting up, making your bed, getting into action, doing things, but also forcing myself to not check the phone, to not check email, to stay in a groove of focus."

that you drink. You'll find you feel much better. In fact, in some South American countries and in Europe, they'll give you some water with your coffee. They sort of understand this relationship of dehydration. Caffeine causes the excretion of sodium by way of the kidney.

I would stop drinking caffeine around two or three in the afternoon. Many people find that they can drink caffeine until 8.00 or 9.00 pm and then still fall asleep. But the quality of your sleep will be greatly disrupted. So try and taper that off towards the afternoon. There are some other fun things that you can do with caffeine. One is to become an intermittent caffeine user. It's a little hard to do. If you are somebody who really relies on caffeine, you can try deleting caffeine for a morning and then doing it the next day. You'll immediately feel the rewarding properties of it, of how great it tastes and how charged you get. So if you get to the point where you're drinking more and more caffeine, and you're not getting the great sensations and motivation from it, you're probably too caffeine adapted. What's happening is the caffeine isn't working anymore because you've saturated all your receptors. So avoid overuse, stagger the use. I think it's a good resilience exercise every once in a while to skip caffeine for a day. Some people get headaches and that's because caffeine affects blood flow. This is interesting. If you have a headache, sometimes a little bit of coffee can help that headache. It depends if you are caffeine adapted or not. For people that are caffeine adapted, the way that caffeine works is that it's going to help dilate the blood vessels of the brain and body. So it's going to actually allow more blood flow.

If you're not caffeine adapted and you don't drink caffeine very often, it's going to constrict those blood vessels and, essentially, make it harder to relax. So this gets a little technical, but there are some fun things you can do with caffeine. Like mix it with theanine. If you feel like you're over stimulated, you could take 100 milligrams of theanine and you could adjust down your level of jitteriness. Some people really like the caffeine plus theanine combination, because it's that alert but calm. Whereas when they just drink caffeine, they're too buzzed and they can't focus.

SP: Let's chat about subordinating impulses, which I think is sort of a good segue here. It seems like the source of almost all of our problems comes from a lack of impulse control. What I find interesting about this is it's not that we're not capable of making rational choices, but more, we're not even aware in the moment that we're being irrational. We're reacting without reasoning. In popular books, it seems like they make it easy and say, well, if you're driven by feelings, you're reactive. And if you're driven by values, you're proactive. But I'm curious to hear your take.

AH: I'm fascinated by this. Most of the disorder and dysfunction in the world is caused by lack of impulse control. People have a hard time suppressing their behaviour and they lose things that they've invested tremendous amounts of resources in. Some of this relates to biological drives, or primitive drive. You hear about people who have made fortunes or have wonderful families and then they go and have a one-off affair with somebody and they lose a lot. They lose relationships, they lose reputation. You just think, wow.

So, do we conclude that the forces of the hypothalamus that drive us towards certain types of behaviour are more powerful? Maybe, although maybe we should look at it from the other side and just say, well, perhaps they were just actually far weaker in terms of impulse control across the board. And maybe that's what made them effective because they were very action oriented. I have someone in my life who likes to say about themselves they're all tactics, no strategy. And they're an extremely effective person. They can make more happen in 45 minutes than anyone else I know, but they have no long-term strategy. It's really gotten them into some serious hot water.

There's an area of our neural circuitry called the basal ganglia. The basal ganglia are vitally important for controlling and integrating thought and action. They have two main circuits that are both regulated by dopamine, but they use different receptors for

dopamine to have different effects. In fact, opposite effects. Some of the circuitry in this basal ganglia pathway are involved in what we call go functions, like pick up this thing or lean into the work. It's go, it's action oriented. That includes thought. And then the other one is no-go. It involves certain neurotransmitters, including dopamine to suppress behaviour. So what we learn as kids is actually a lot of no-go-type behaviour. Sit still, don't interrupt. It's not just clear your plate from the table. It's not just be kind, say thank you. Those are go-type behaviours. It's sit there. It's the two-marshmallow task, where they give the kids an option to have one marshmallow now or two marshmallows if they wait. Those videos are very cute and fun to watch. The kids will sit there. They use all sorts of distractions, strategies. One of the kids gets close to the marshmallows, some turn away, others sniff them. They've tracked these kids over time and there is some data to support the fact that the kids that were able to defer gratification do better in life. The studies are not as robust as we once thought, but adults have a lot of problem with delayed gratification. They're just not very good at it.

One thing I've done over the years to try and reinforce these circuits in myself, based on my understanding of how they work, is every day I try and have somewhere between twenty and thirty no-gos. The no-gos can be trivial. Like I'm ready to pick up my phone – I think, no, and I force myself to not pick it up. All I'm doing is trying to reinforce that circuit because the thing to understand about neural circuitry is that it's generic. It's not designed so that you have a strong no-go response just to picking up your phone. It actually carries over to multiple other things. And this is also true of the go circuitry. The way I try and visualise the waking portions of my life – just getting up and doing something without rumination, or consideration, or thought, just getting into action – sets your whole nervous system into a mode of go.

When we drink caffeine. It's a go stimulus. Then we move towards the things that are important to us. We're emailing. We're always doing – go, go, go, go, go. Even if you're scrolling on your phone, it's go, scrolling Instagram or something, it's a go type function. We rarely rehearse our no-go functions and no-go functions are simply about suppressing behaviour. So if you have a meditative practice, there's a little bit of that where you think, ugh, I don't want to do it, but I'm going to force myself to sit still, even though I want to get up, that's a no-go. But think about it. If you get better at meditating, you have less of an opportunity to get into this no-go mode, to trigger this circuitry.

What I try and do is introduce twenty or so no-gos throughout the day that I deliberately impose on myself as I'm about to get into reflexive action. It could be delaying a bite of food for a couple of minutes, but

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there are all sorts of ways that we can do this. We find ways that we are short circuiting this process. I think we need to keep these no-go circuits trained up. I think nowadays there's so much opportunity and so much reward for go that we don't train the no-go pathways.

The no-go is to not default to something more spontaneous. It's to force regimen. As we become adults, there isn't anyone supervising us, making us do these things. Phones have allowed for so much context switching and so much opportunity for go, go, go, go, go that pretty soon, you've got hours of your day that are gone that were not structured. So, I'm not talking about becoming neurotically attached to these no-gos. What I'm talking about is keeping the blade sharp on both sides, getting up, making your bed, getting into action, doing things, but also forcing myself to not check the phone, to not check email, to stay in a groove of focus.

I'm a big believer in 90-minute focused work bouts. Of course, in that time attention drifts, and there's the temptation to get up, use the bathroom, get a cup of coffee, do anything but what I'm meant to be doing. But I try and create tunnel vision, not allow myself to do something else unless there's a real urgent need. This is the way I trained myself to study in college. I used to sit down, set a timer and I wouldn't let myself get up for any reason, for any reason whatsoever.

I think I've lost some of that over the years. So, I'm trying to build up the circuitry again.

A good friend of mine, Pat Dossett, did nine years on the Navy Seal teams and he's a big believer in keeping these circuits tuned up. We always do a certain challenge each year. The other day he said to me, how about in 2022 we do the hour of pain? It turns out the hour of pain is where you sit in a pretty uncomfortable position and you have to remain in that position for an hour. That sounds like a really great low-cost miserable way to build up these no-go circuits.

SP: Breathing and vision seem to not only affect our state of mind, but also our body. When we're stressed for example, our field of vision narrows and we have blind spots, not only with what we can literally see, but also with what we can cognitively see. Can you take us through the relationship that vision and breathing have on our internal state and any behavioural practices that we can use to feel better and see more?

AH: We'll start with vision. When we are relaxed, we are in panoramic vision. Even without moving our eyes or head, we have a wider aperture field of view. Those from special operations communities will understand this as situational awareness. You have to be relaxed in order to see what's going on. The moment you have adrenaline in your system your field of view actually narrows. The pupils dilate. If people are super relaxed, their pupils are very small, and if they're very agitated, their pupils will be large. When the pupils are large, there's a movement of the lens of the eye and your visual field narrows. You get a soda straw view of the world.

There's a simple practice you can do if you need to see more broadly, if you want to dilate your gaze. What you're trying to do is see the periphery of your environment. Your motion detection goes up fourfold when you're in panoramic vision mode because of you shift to a different category of neurons that are much better at detecting motion.

Whereas when you go into watchmakers mode, you are looking for things that are happening over a very small space. In the visual system and in the brain, space and time are linked. So if you have a narrow field of view, you are actually measuring smaller time increments. You are micro-slicing your environment and you're micro-slicing it in space and time. Whereas when you have a broad swath of vision, you have bigger time bins. Here's a good example of it. If you need to get home and you're in line at the grocery store and the person in front of you returns something. It's going to seem like time is going by very, very slowly because you're micro-slicing, you're getting a higher frame rate. However, when you're relaxed it doesn't bother you at all. You're actually batching time in bigger swaths. So, the visual system drives your time perception system. If you're feeling stressed in conversation or public speaking or anything and you want to relax in a way that's covert, dilate your gaze. Just try and open up the aperture of your field of view. The other thing you can do is exhale. In a very straightforward way, inhaling speeds up your heart rate and exhaling slows it down. You have a muscle called the diaphragm. The diaphragm is unique to mammals. It's incredible because it's a skeletal muscle, it can work voluntarily in the background or you can take control of it.

When you breathe in, your lungs expand and the diaphragm moves down. Because you create a change in the amount of space in your thoracic cavity, you change the flow of blood through your heart. As you inhale, the diaphragm moves down. There's a little more space. The heart gets a little bigger and the brain sends a signal to the heart to speed the heart up.

When you exhale, the diaphragm moves up. There's actually a contraction of the heart and the thoracic cavity. It's a little smaller. The blood flows faster through that smaller volume and the brain sends a signal to slow the heart down. A simple way to remember it is inhales speed your heart up transiently, and exhales slow it down. So if you get stressed, exhaling is the key.

SP: Brains deteriorate with age. What exercises for the brain have demonstrated either slowing or reversing some of this natural process?

AH: There is great data from the Nobel Prize winning neuroscientist, Eric Kandel's lab at Columbia, showing that when we do certain forms of exercise, there's a hormone-like molecule that's released into the bloodstream called osteocalcin. Osteocalcin is known to provide support to neurons in a brain area called the hippocampus, which is involved in learning and memory. The 150 to 180 minutes of zone 2 cardio per week will support overall brain health and function by way of improving blood flow. So, a lot of cognitive dysfunction happens over time and age-related dementia is just poor perfusion of the brain. This is why people who have general cardiovascular issues also generally have issues with thinking.

In terms of brain function, a couple of things. One of the ways to improve cognitive function is to make sure that there's appropriate amounts of lymphatic clearance. The brain has its own lymphatic system. This lymphatic clearance happens during sleep. One way to enhance it is to have the feet slightly elevated, 10 to 15 degrees. I put a pillow under my ankles when I sleep at night. Usually in the middle of the night, I realise I kicked it away or something like that. But

feet elevated naps of about 10 to 15 degrees are very useful. It increases the lymphatic clearance. There's beautiful data to support lymphatic clearance as an important process.

In terms of exercise. Exercise during the day increases the rates of lymphatic clearance at night. The direct effects of exercise on brain function and health come from stimulation of the skeleton and load-bearing exercise. This is something that I think is underappreciated. When we do cardiovascular work again, you support blood flow, lymphatic clearance, but also osteocalcin is made by the bones. A hormone that's made by bones, that's released into the bloodstream and then goes to the brain and improves brain function. How does this work? Well, when the skeleton is load bearing, osteocalcin is released and it makes perfect sense. Why would the brain continue to support its own function if the body isn't being used? Well, you can say, how does the brain know that the body is being used? Because osteocalcin is that signal. Again, the brain and body have to communicate and it's not like the body says, 'Oh, I weight trained today or I did calisthenics today.' No, it doesn't work that way, there's a hormone signal to communicate that to the brain.

This can be achieved a number of different ways. I think body weight exercises can be quite good. There are a couple of online sources. I think Ido Portal is doing incredible work. He's big on movement, he calls it Movement Culture. This is not just doing push-ups and burpees which are very linear, but a lot of non-dynamic, non-linear movement. He talks about explosive suppleness.

It's well established that cognitive function in aging can be assessed indirectly by grip strength. Now, why would that be? You have lower motor neurons which are neurons in your spinal cord that control contraction of the muscles, thereby releasing neurotransmitter onto those muscles. But you also have upper neurons, which control deliberate motor action, and grip strength is something that involves those upper motor neurons. You can do this as a test if you're lifting weights. Let's say you're doing a unilateral movement. If you clench the opposite fist really, really hard, you'll find that you can move more weight for more repetitions because you're engaging the entire upper motor neuron to lower motor neuron system. So, there's a chain of neural events.

People should be doing three to four days a week minimum of some sort of load-bearing exercise. That could be weight training with machines or free weights, but it could also be push-ups, pull ups, dips, jump squats. The ability to jump and grip strength are highly correlated with cognitive function later in age. Overwhelming emphasis has been placed on cardiovascular exercise and improvements in the brain. Turns out that's true for mice but not for humans. I wouldn't focus so much on adding new neurons to the brain. It's more about getting the ones that you have already to be more functional.

There was a beautiful paper published recently showing that when people do resistance exercise, little micro RNA are released in little vesicles, little bubbles from the muscle, and travel to the body fat and help facilitate burning body fat. So many reasons to both do cardiovascular work, 150 to 180 minutes a week, minimum, and to do three to four days a week of resistance exercise.

SP: I have one last question today on mental performance and learning. One aspect of mental performance that doesn't get a lot of attention is that we often get into ruts in response to feeling slighted or wronged by someone that undermines us. Is there a way that we can use the body to control the mind and let go?

AH: That's an interesting question. I agree we get into ruts. I think there are a couple things to remember. One is that most people are not mentally healthy. Doesn't mean they're mentally ill but most people have not done a lot of self-reflection work in a way that translates to their behaviours. A colleague of mine who's a psychiatrist years ago when I started teaching, gave me some great advice. He said, 'Just remember 1 per cent of people have clinical schizophrenia, 4 per cent are bipolar, 5 to 10 per cent are clinically depressed. Another 10 per cent have anxiety. So please understand that as you move through life, you're dealing with people who are struggling.' If you're somebody who's really into self-optimisation and you're doing a lot of work on yourself, you are in a very small category, unfortunately, of people that's really trying to be healthy for yourself and for others.

The second thing is after age 25, the brain doesn't change unless it's self-directed change. So don't expect anybody to change unless it's self-directed. Forget trying to get people to change, it does not work. As we move forward in life though, if we are healthy and functional, it's our job to step into leadership roles and to demonstrate healthy behaviour. How do we do this? I think that one thing that we can do is raise our stress threshold.

I think that trying to reduce the amount of problems in the world by forcing or encouraging other people to change is just generally not that good. You offer tools, that's what I do, that's what you do, and you just hope that people will take them. But we can increase our stress threshold so that our trigger threshold is much higher.

SP: Let's end with what is success for you?

AH: That's a hard question but a really good one. I place tremendous value on certain things, and I think some of those will be obvious. Feeling physically and mentally well is our own individual obligation. No one can do it for us. There's no magic pill or fairy or stork that's going to deliver the solution.

I place tremendous value on keeping my physiology where it needs to be. I want to have endurance. I want to have strength. I want to have mental strength. I want to have kindness. I want to have openness. I want to be open to learning. Friendship to me is the bedrock of my wellbeing because I depend very heavily on it for the feeling that life is moving forward. Friendship is a wonderful and important part of my life. I feel my duty as a human being is to always try and be better, do better for myself and for others. That involves having tools and protocols, being reflective. There are so many ways that we can improve.

I'm a big believer in the psychologist Erik Erikson's stages of development. He talked about different stages of development that at every age, we're working through some fundamental conflict and if we can resolve that conflict then we can advance to the next stage. The ages are somewhat plastic because of changes in culture and life, and your whole life is one big developmental arc. I'm 46 now. And I try and think, what have I managed to accomplish? And then what's my work. What do I need to do?

For instance, I don't know much about spirituality. I intend on learning. I feel like at this stage of life, according to Erikson, if you've resolved a career, you've resolved relationships to some extent, you've resolved your relationship to yourself to some extent, what's the next thing that we face? We try and understand how our short lifespan, relatively speaking, fits into a larger and more coherent whole. And so that's the work I'm doing.

Success to me is looking at life as a series of developmental milestones and making sure that if I didn't hit any milestones in the past, for whatever reason, that I take responsibility for meeting those milestones. And looking forward and where I'm at now, I just try and say, well, what are the milestones that I should be working on now? So that I find myself at 50 and 60 and 70, hopefully beyond that, having checked off the boxes that make for a full life. It's hard to go back and take care of things in the past. We can't be super performers at everything, but I believe that Erikson was quite correct in understanding that our nervous system changes over time and that we need to meet these milestones.

In terms of my professional life, I have a very simple and, to me, important mission, which is I want to share the beauty and utility of human biology. That's my goal. That's why I have a podcast, that's why I go on podcasts, that's why I have social media. I just want people to understand the body and brain in ways that can help improve their lives and the ways that they interact with others. And so that's my singular mission and I'll continue as long as that feels like the right one.

SP: Andrew, thank you so much for taking the time today. This was an amazing conversation, so informative and so deep.

AH: Thanks so much for having me on.

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Why the Transition to Renewable Energy Will Cost A Lot Less Than You Think

The power of learning curves

DOYNE FARMER
VOLTS

Interview by David Roberts
Illustration by Vaughan Mossop

David Roberts: A group of scholars at Oxford University's Institute for New Economic Thinking have released a working paper that made a considerable splash in the world of energy nerds. It has now been peer reviewed and published in the journal *Joule*. It is called 'Empirically Grounded Technology Forecasts and the Energy Transition'. At the heart of the paper is a new way of forecasting technology costs that is more grounded in history and empirical data than the integrated assessment models used by organisations like the IPCC and the IEA. Those models have notoriously overestimated the future costs of clean energy technologies and consequently counselled insufficient climate action for decades now. The Oxford scholars take a different approach centred on technology learning curves, sometimes called experience curves.

They begin by noting, 'The prices of fossil fuels such as coal, oil and gas are volatile. But after adjusting for inflation, prices now are very similar to what they were 140 years ago and there is no obvious long-range trend. In contrast, for several decades the costs of solar, photovoltaics, wind and batteries have dropped roughly exponentially at a rate near 10 per cent per year.'

Those clean energy technologies are on learning curves. For technologies on a learning curve, costs drop as a power law of cumulative production. Another way of saying that is, for every doubling of cumulative production per unit, costs fall by X per cent. What that X figure is will vary among different technologies. And for many technologies, if not most, there will be no learning curve at all. But the somewhat eerie thing is, for a given technology X, the rate of learning tends to persist over time within a relatively narrow band. Learning curves historically have been quite predictable and steady. Learning curves are the subject of a rich and longstanding literature. What's novel about the Oxford paper is that it develops a new method of forecasting technology costs grounded in established historical learning curves. The forecasts make probabilistic bets that technologies on learning curves will stay on them. If that's true, then the faster we deploy clean energy technologies, the cheaper they will get. If we deploy them fast enough to reach net zero by 2050, as is our stated goal, then they will become very cheap indeed. Cheap enough to utterly

Photograph: ThisisEngineering RAEng

crush their fossil fuel competition within the decade. Cheap enough that the most aggressive energy transition scenario won't cost anything. It will save over a trillion dollars relative to baseline. We've gotten the sign wrong. The transition to clean energy is not a cost, it is a benefit. The implication is that it makes overwhelming sense to rapidly transition to clean energy technologies without even counting climate and air pollution benefits. Doyne Farmer is one of the coauthors of the Oxford paper. He is a longtime scientist and entrepreneur who has studied complex systems in physics, biology and economics.

Welcome to Volts. Thank you for coming. There's so much to discuss in this paper and your research but let's take a step back and start with the basics. Let's start by explaining what is a learning curve, or an experience curve, and what is Wright's Law and how do those relate?

Doyne Farmer: Sure. So Wright's Law and learning curve are the same, they're different names for the same thing. It's called Wright's Law because Theodore Wright was the first person to propose this hypothesis. He was a Second World War veteran who went into the aviation business, and in 1936 noted that for a specific type of plane produced at a specific factory the cost of making the plane tended to drop by about 20 per cent every time the cumulative production of the plane was doubled. He actually became head of aviation for the US during the Second World War and used his own law to forecast aircraft production prices during war. So it's come to be called a learning curve also because the hypothesis is that cumulative production is a proxy for experience, and that the reason that costs drop is because people learn. Now, there's other evidence, there's also something called the power law practice in psychology which says that when people do routine tasks – the original paper was on summing up numbers – that the speed with which they can perform the task drops as a power law of the experience that they have.

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... noted that for a specific type of plane produced at a specific factory the cost of making the plane tended to drop by about 20 per cent every time the cumulative production of the plane was doubled. Things that have come down in a really steady way in the past tend to keep coming down in a really steady way. Things that come down in a bumpy way tend to come down in a bumpy way.
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DR: Wright's Law isn't pegged at 20 per cent specifically? It's just the idea that you get a predictable percentage improvement based on a doubling of capacity.

DF: That's right. If you write it in mathematical terms that means that the cost goes down according to what's called a power law, which means slower than exponential but it still keeps dropping. It drops more and more slowly per amount produced as time goes on because, remember, it's cumulative production doubling. So it takes an exponential increase in production to get the drop in whatever percentage it will be to happen.

DR: So, is the idea that the actual percentage will be bespoke to every different product you're talking about?

DF: Yes, that's right. And that's essential here because it turns out that fossil fuels have a very different percentage than renewables.

DR: Right. So how do you determine a learning curve?

DF: The only way to do it is to look at history. Sometimes you can guess at the learning curve by looking at a related process that you think is enough like the one you've got to be a good proxy. But mostly what you really want is history, and the longer the better.

DR: So, you grow more confident in the precise learning curve, the longer historical data you have, presumably?

DF: That's right.

DR: There is a long and rich literature on learning curves out there in the world. Learning curves are even sort of incorporated into current climate change models, albeit in limited ways. So tell us what is new about this research that you've just published in *Joule*.

DF: The new thing is that we reformulated the way learning curves are used to produce a reliable and empirically grounded probabilistic model.

DR: My next question is what the heck is an empirically validated probabilistic forecast?

DF: I'll explain. The problem is if you just take the learning curve and make a forecast, well, fine, you have a forecast, but how accurate is it? It's not going to be perfectly accurate, but what are the error bars? And if you don't have error bars in a forecast, then it's not much good because you don't know whether you can count on it. So to do that, we had to first change the way it's formulated. So we made it what's called a time series model, meaning that we assume we have points that are ordered in time and we make a forecast for the cost next year and the year after that and so on.That's rooted at the current time. Another way to say it is we reformulate it as what's called a random walk with drift. So in other words, we allow for the fact that the forecast is never going to be completely accurate. And a random walk is something where you have steps and there's some randomness in each step. There can also be some determinism in this step. The random walker may like to walk to the left more than the right. And so we recast the formula for Wright's Law so that it can be used in that kind of way. Furthermore, we derived estimates for the distribution of likely possibilities in the future, assuming that model. So that's what allows us to make it probabilistic, because we don't just say in 20 years solar energy prices are going to be X.

DR: If you have a particular percentage learning curve, the straightforward thing to do is just say based on that percentage X doublings, you can get theoretically a pretty precise number.

DF: That's right. But that number in reality is not going to be very precise and it's going to depend on things like how accurately do you know the percentage of the learning curve. You'll never estimate it perfectly. Part of our hypothesis and part of our reformulation is to allow for that inherent variability, which also varies from technology to technology. So transistors, for example, have very little inherent variability. Solar cells have more inherent variability. And we fit that to the data because we see that that matters. Things that have come down in a really steady way in the past tend to keep coming down in a really steady way. Things that come down in a bumpy way tend to come down in a bumpy way.

DR: But you go and look at historical data and you find these learning curves and one of the things you emphasise in your research is that these learning curves tend to be quite regular. They seem to hold over time. So that raises the question of what is the causal story here? Why does tech development follow this very regular pattern? What is it about solar cells, for instance, that means a 20 per cent drop in cost for a doubling of capacity, when anytime you look closely at solar cell development, what you see is a multiplicity of different environments, different economies, different sorts of larger circumstances surrounding it. There's so much variability in circumstance and yet this regularity emerges out of it. Why?

DF: I can answer this in two different ways. My first answer would be I don't know, nobody knows. But then I'll give you the answer for what we do know. First of all, I would never say that we know what the percentage is exactly for solar energy. In fact, empirically it's a bit higher than their error bars on that number. And our formula takes that into account. So that amplifies the uncertainty. In fact, the short term uncertainty is always just the inherent bumpiness. The long-term uncertainty is always the uncertainty in parameters because that grows faster with time. Now the other way I would answer this is to say we're just looking at the long term view here. We're not saying anything about the bumps, what's causing the bumps in the road. So for solar energy, for example, the cost of a solar panel is about 1/5000th of what it was when it was used in the first Vanguard satellite. And it's come down reasonably steadily. But there have been periods where the price went up due to material shortages. There have been other periods where it dropped faster than usual, say when the Chinese stepped into the game. So there are bumps around that. And we don't say anything about what those bumps are because those are a lot harder to forecast. It's a little bit like when Wright made his original statement, he didn't know what the improvements in the factory floor were going to be that caused this to happen. He just observed that it happened. We have taken it from something that was originally about a specific airplane in a specific factory to something that's about the global cost of PV panels from all places that make them. So the use of this has been generalised.

> "One of the reasons the 20-year time scale that we assume works out well is that there is a built-in time that we're replacing infrastructure."

DR: In your previous research, you went back and looked specifically at a bunch of different technologies looking for these patterns.

DF: Yes we looked not just at energy technologies. We looked at fifty different technologies spanning a gamut of chemical processes, electronic manufacturing and many others. And we gathered all the data we could. The data allowed us to make about sixty forecasts. We pretended to be in the past, so knowing nothing about what happened from the point in the future. And then we tested our formula by testing to see how well it did making those predictions.

DR: A lot of models don't do that, and they don't perform particularly well if you do do that. So it's notable at least, that you guys went back and actually tried to look and see. Would this have worked if we had made exercise at that time.

DF: That kind of testing is essential, though, even here one needs to be careful because if you do that kind of testing enough, then you aren't really testing out a sample anymore and your results can become invalid. One nice thing about this is it worked the first time we tried it.

DR: The argument you make in the *Joule* paper is there are sort of two sets of technologies. One set that don't seem to demonstrate learning curves and another set that do. Can we say anything on a general level about why technology is in one set rather than another? Why, notably in our case, fossil fuel technologies? As you say, fossil fuels are inflation adjusted, roughly as costly as they were 100 years ago. They haven't seen a learning curve. But do we know anything about why technologies fall on one side of the line or the other.

DF: Again, my first answer would be no. But we do know something. There are some patterns. For example, things that we mine out of the ground don't seem to improve through time. You can look on the US Geological Survey website where they have data for the price of minerals and the quantity produced over more than a century or more for 100 minerals. And minerals in this broad sense includes oil and natural gas and things like that. And none of them improve with time by a statistically significant amount.

DR: The practice of mining is improving with, for example, automation, but it's working against the other phenomenon of you're getting all the easiest minerals out first. So they sort of balance each other out.

DF: They seem to balance each other out. Now it's a bit peculiar that they balance each other out in that way.

DR: Why does that regularity hold across all these minerals, all these different kinds of mining practices?

DF: The answer is we don't know. I don't know and nobody else does. But there do seem to be families, like I mentioned, chemical processes. Chemical processes all tend to have fairly similar properties, vis-à-vis Wright's Law and the electronics performance of the transistor, the performance of hard disks. Those all tend to drop and behave similarly.

DR: With minerals appreciate the dynamic of why they don't get on learning curves. And I sort of understand why a modular technology like solar panels does get on a learning curve. But what's up with nuclear? Why hasn't nuclear power gotten on a learning curve when it seems like you're building up this technological thing? It seems like it ought to but it doesn't. Do we know why?

DF: Part of the story is probably that nuclear reactors are not cookie cutter items. They're things you construct. They are not things you manufacture. You don't build them in a factory so they aren't really mass produced. Now there have been attempts to mass produce them. The French tried to make it more cookie cutter and the Koreans have had some luck in bringing the cost down, but only very weakly. Korean nuclear reactors have dropped in cost about a per cent per year, which is pretty slow. There are proposals to make modular nuclear reactors, to make small nuclear reactors, and manufacture them. Now, there are inherent scale arguments that work against that. There's a reason why they make nuclear reactors big – because it's intrinsically advantageous to make them bigger. So for modular nuclear reactors, you're starting at a really high point and not everything that's modular obeys Wright's Law.

DR: But that's sort of the bet. I think the reason there's so much enthusiasm around smaller modular nuclear is the idea that you're going to get something like Wright's Law kicking in if you're manufacturing smaller units.

DF: Yeah, but I will bet 100 to one against that succeeding.

DR: Really?

DF: Yeah. Anybody that wants to take my bet, I'm happy to make a formal bet.

DR: Is there a particular reason? Is it specific to nuclear?

DF: Yeah, there's a string of arguments as to why modular nuclear reactors are inherently more expensive than big nuclear reactors. So that's a big gap that has to be overcome. And just because you make them in a factory doesn't mean that Wright's Law is going to hold. And we have other technologies that are way ahead of them now and that are coming down at 10 per cent per year, satisfy Wright's Law really well. So they're coming from way behind.

DR: They're chasing a receding target. Well, let's turn into how this all plays out in the modelling. So you note in the paper that the conventional models that are used by the IPCC and the International Energy Agency, they're integrated assessment

models, IAMs. You note that they actually do apply Wright's Law in those models, but they attach some restraints – like they put a floor on the amount that the price can fall or they put a limit on the rate that production can double, etc. So your model ends up projecting much lower costs for these key renewable technologies than traditional IAMs. Does that explain the difference, those sort of restraints that they're building in to Wright's Law in those models?

DF: We think that's the biggest difference. We haven't been able to peer inside the guts of these models to really see or do the experiments you need to do because these models are complicated. But we think that's the main difference because, of course, if you put a floor, then you know, a floor is a floor, you're not going to go below it. And similarly, if you put a constraint on how fast stuff can happen, that's as fast as things can happen. And the predictions of those models depend sensitively on those assumptions. Now, you know, we have a nice figure in our paper that makes people chuckle because we show the historical floors that have been proposed over the last 20 years and we just show solar energy prices punching through those floors again and again and again. There's still models out there with floors in them, people are still using them.

DR: You make the point that if you go back in time and project forward just with Wright's Law, with no restraints on the pace of doubling, no restraints on the pace of price declines, that following that gets you the most accurate prediction.

DF: That's right. In fact, I published a prediction in 2010 in *Nature* that by 2020 solar energy would be cheaper than coal-fired electricity or nuclear power. And at the time that was viewed as a wacky prediction. *The Economist* said in 2014 that solar energy is the most expensive way to deal with climate change. But hey, I was right.

DR: Yeah, it's sort of legendary in my circles now that if you look at predictions of solar's spread, the only prediction that got it right in the early 2000s was Greenpeace. And it wasn't based on sort of empirical anything. It was just an aspirational prediction. And even they undercounted. Even they sort of undershot by a little bit.

DF: Yeah, well, I undershot by a little bit too. So my prediction was based on just looking at the data and fitting Wright's Law to the data.

DR: Let's talk about your model then. You model three scenarios: firstly, no transition where fossil fuels retain their position, and then a slow transition and a fast transition to renewables. And you find that the fast transition is the least costly. I guess maybe that's not the way to put it – it's not costly at all.

DF: It saves us money.

DR: Yeah, it saves the most money. If we're talking about Wright's Law which says as you double production, you drop the price by X per cent it seems to me to follow from that as a matter of logic that the faster you go, the cheaper it is. It's sort of like you don't even really have to dig too much in the empirics. It's just a logical consequence of the law that the faster you raise production, the faster the price is going to fall and the cheaper the overall transition is going to be. Can we sort of generalise that way? Like faster is always cheaper?

DF: Yes and no, because there are other things going on that we also look at. In order to make the transition, we have to build out the grid. We need charging stations for electric vehicles, so we have to change our infrastructure. Now, the 20-year time scale that we picked, there are two things about it that are nice that just happened to work. One is that it corresponds to just extrapolating the rate at which the technologies have already been rolled out. So solar energy has been increasing in usage at about 40 per cent per year for 30 or 40 years now. Wind has been increasing in usage at 20–25 per cent per year over the last 30 years or so. And batteries, similar story. Electrolysers, similar story, although not as long. So those are the four key technologies that we use in our scenario. Those technologies have a history and we just pretty much extrapolate that history, or even slow it down. But we don't speed anything up relative to how it's been speeding up, other than the fact that an exponential increase is inherently speeding up in linear terms. In other words, photovoltaics or the deployments rising exponentially. That means if you plot it on a graph, the slope gets steeper and steeper over time. And, in fact, this is typical for technologies. They tend to improve on what's called an S-curve, where they rise exponentially over periods of time that can be ranged from 20 years to a century. And then they flatten out once they saturate, so they reach maturity and fill up the market that they can filled up.

DR: I want to highlight this: just the fact that all your model is doing is saying that what has been happening is going to continue happening.

DF: Right.

DR: The conclusions are so stark and shocking, and different from mainstream modelling that I think people assume there must be something fancy going on. But really, you are just assuming that things are going to keep happening the way they've been happening, which seems so obvious and intuitive. It's a little baffling that no one has done that before.

> "So the thing that makes solar and wind and batteries and electrolysers unique is that they have a really rapid exponential rise in deployment and a rapid drop in costs at the same time."

DF: It is. I sometimes joke that the people at the International Energy Agency don't have any logarithmic paper because you plot the data and you can see it in our paper. All four of these technologies have very steady exponential improvement curves. Now, we know at some point they have to start rolling off of them. And that's where the debate comes.

DR: So, the debate about where these four technologies are going to end up has to do with where they are on that curve. As far as I can tell, what you're saying is for the next 20 years, all four of them are going to be on that upswing. None of them are going to hit the levelling off.

DF: Not quite. Solar and wind are well up on that curve. And if you just extrapolate the exponential curve for solar and wind, they become dominant in less than a decade. So they have to start to roll off pretty soon. They start to roll off at a point where they're already in the fast transition scenario. In fact, in all of them, we have it rolling off starting now, but it rolls off slowly in the fast transition, rolls off more precipitously in the slow transition, and it comes close to flattening out in the no transition.

DR: Is there debate about where it plateaus? How do you know? Or how do you go about guessing where that will happen?

DF: There are two questions. When will it start to plateau and what level will it plateau at?

DR: Right.

DF: Nobody really knows either of those. And I can stress in our paper we're just taking scenarios that we think are at least plausible. Then the prediction part is saying, if that scenario holds, this is what the cost will do. The second part is the part we're pretty confident about. The first part we're just saying that we think this is plausible and looking at a range of possibilities. Now, how far it will go before it plateaus depends on how deep the technology penetrates. In our paper, for the transition to happen, we have hard to decarbonise sectors like jet flight.

DR: Right.

DF: So is jet fuel going to come from solar energy? In our fast transition scenario? That's not something that happens in 10 years, but it happens in more like 20 years and it happens more slowly because electrolysers are on an earlier stage of the S-curve. So we have to assume electrolysers, hydrogen, electrolysers that take electricity and water and make hydrogen, that they have to stay on their exponential rise for 20 years. Solar and wind don't even stay on it for a full decade and batteries are kind of in between.

DR: One of the big enduring ongoing debates in this space is what does saturation looks like? What is the sort of 'nut' of fossil fuel use or emissions that can't be eliminated?

DF: We assume that eventually they all get eliminated, but some more slowly than others. And in particular, they take something like jet fuel that relies on having much bigger rollout of electrolysers and having the cost come down to the point where it can become cost competitive to make liquid fuels like ammonia. It's going to require more time to get to the point where those are cost competitive. But we do the whole business, we do everything. And we do assume that the final levelling out point is really elimination of fossil fuels.

DR: Is there something general you can say about how long of a historical record is required to get a confident reading on a learning curve? As you say,

wind and solar go back at this point 40 years, which is pretty robust, but electrolysers are much newer. How long does the technology have to hang around before you feel confident pegging a learning curve on it?

DF: Well, it depends on how steady the decline is, because if the technology really declines at a very steady pace, then it's easier. You're going to get a cleaner fit with less data points, and with as few as five data points, you can get a forecast that's useful.

DR: You just have bigger error bars if you have less.

DF: Yes, exactly. So as you get more data, the error bars narrow down. Now, with electrolysers, we don't have a long history and the data is kind of noisy. There are a lot of problems – is the data even good? Are the measurements reliable? Because these data are not easy to find in many cases. Now, with electrolysers, let me say I personally have more confidence than what we have in the paper. The paper we just stuck to using the data that we have. I think because electrolysers are a chemical process and we have data on other chemical processes, I think it'll behave like these other chemical processes which tend to have percentage drops for doublings around the one that electrolysers have shown so far. So, I'm personally more confident than what we show in the paper. But in the paper, we just bite the bullet. The big source of unconfidence in prices 2050 and beyond comes from electrolysers and storage.

DR: When this paper first came out as a working paper, you made a bit of a splash and I think a lot of people ended up taking away this notion that clean energy is going to get so cheap that a fast transition is inevitable. So I think it's worth just sort of pausing and noting what you mentioned in passing a moment ago, which is unlike the IPCC models you are not attempting to predict the rate of deployment.

DF: Right.

DR: All you're saying is for a particular rate of deployment, this is how much cost would fall. So if you deploy really fast, costs will fall really, really fast. You're not saying we are going to deploy really, really fast.

DF: In fact, we want to emphasise that there are bottlenecks out there. There are bumps in the road that we need to get over. The biggest one is the grid. My son works for the Federal Energy Regulation Commission and he told me that they have enough renewable energy projects proposed that if they approve them all and they could all be put online, that we would more than double the electrical capacity of the grid.

> “Whenever we were faced with estimates we tried to be conservative and give fossil fuels every benefit of the doubt and tilt the deck against renewables. We didn't want anybody to accuse us of fudging the numbers, so we really bent over backwards to be conservative.”

DR: Yeah, I think it's like over a terawatt now that's waiting in these interconnection queues.

DF: Yeah, but they can't approve them all because they need grid capacity to put them online. So building out the grid is a big deal and that requires political will. People say building the grid is going to be really expensive. That's true. But our expected values, because we spent a lot of time looking at what it costs to build a grid, too, and because we didn't have historical data, we assume that it's going to cost the same per unit of capacity as it costs now.

DR: So you're not assuming a learning curve for transmission buildup.

DF: No. So we think this is pessimistic, but we try to be conservative across the board. Under the Fast Transition in 2050, we anticipate that we'll be spending about $670,000,000,000 a year on grid. But it's worth noting that even on the No Transition, we anticipate spending $530,000,000,000 a year on grid. And that's another key point to emphasise here. People say it's going to cost so much for us to make the green transition. Well, it's true, but we're spending money all the time. Right now, we're spending $4 trillion a year to make energy. So you have to really weigh those things across. So it's true that we're anticipating $140,000,000,000 a year more expenditure on the grid. On the other hand, we drop the total system cost from $6.3 trillion under no Transition to $5.9 trillion under Fast Transition. So the savings more than offset the expenditure.

One of the reasons the 20-year time scale that we assume works out well is that there is a built-in time that we're replacing infrastructure. For example, we replace gas stations every 25 years. So if we start putting in charging stations now, we just do that instead of building gas stations, then we can make the transition without stranding assets.

DR: Speaking of the sort of practicalities of it, you don't forecast deployment, you just sort of set these scenarios but you do say that in your judgment, the Fast Transition is possible. It's in the realm of possibility and there's no obvious impediments.

DF: Yes, we think it's plausible from a physical point of view. There are no impediments to doing this in terms of rolling out the hardware and building what we need to build and all that. The impediments are political. We do have a powerful industry that's trying to keep it from happening because it threatens their existence. We have a lot of political impediments to doing it. It's worth noting that if you look right now, solar energy, you might think, oh, people deploy solar energy where it's sunny first. But that's not what's happened. People deploy solar energy where it's politically favored.

DR: Yes, Germany is legendarily not particularly sunny.

DF: That's right. So over the long haul. My best guess would be that Russia is going to be really slow. They'll be using fossil fuels for a long time there just because they've got them and because even though renewables are going to get cheaper, they're going to be reluctant to bite the bullet and give up. But they're going to reach a point where they're going to have a hard time selling their oil to anybody else. So I think there'll be some countries like that that will hang on.

In America we have a rather irrational debate about these things, with a high fraction of climate deniers and so on. But even if you're a climate denier, you should be on board with making a fast renewable transition because it's just economically profitable to do so.

DR: I think at the very least the fast transition that you model would be faster than historical precedent, right?

DF: Yeah, but it's already faster than historical precedent. If you look at the first figure in our paper where we show the prices and the deployment of energy through time, what you see is that renewables look completely different than any of the other energy sources that have gone before.

DR: Yeah. A new thing in the world. I think that's a very striking feature of the paper.

DF: Nuclear power had a very fast rise for a few decades, comparable to solar and wind, but it didn't have exponentially dropping costs. So the thing that makes solar and wind and batteries and electrolysers unique is that they have a really rapid exponential rise in deployment and a rapid drop in costs at the same time. And that hasn't been seen before. It's also the case that solar and wind are both highly modular technologies. You can build a small farm or a big farm, the components get produced in a factory and you just put it up wherever you can. They have low environmental costs and so they're relatively easy to permit compared with nuclear power. So I don't think nuclear tells us anything about what's going to happen and really fossil fuels don't either. This is really something new.

DR: One thing you also emphasised towards the end of the paper is that despite the sort of startling conclusions about the cost of a transition, in fact you view that cost projection as kind of a lower bound. You view it as kind of a pessimistic prediction. Tell us why you think that even this sort of super cheap fast transition in a sense could be in the real world even cheaper than you project.

DF: I'm glad you view our results as surprising, but one of the things I would like to do is just make a plot of estimates through time. Because what you see is that through time, the estimates about the cost and the rate of deployment of renewables, while persistently too pessimistic, have been persistently getting better.

It's economically the way to go irrespective of climate change. I think that really reframes the debate to make it an opportunity rather than a burden and means that countries should be jumping on board and firms should be jumping on board because it's the way things are likely to go and they should be eager to profit from it.

DR: Right. So insofar as it's startling, it's that it's the sign error. It's not a cost. It's literally not a cost at all.

DF: Yeah. It's a change of sign. But back to your first question. We tied our hands behind our back constructing our scenarios by restricting ourselves to technologies where we had data on their performance. In some cases, like the grid, we

couldn't do that because we didn't have data, and just assumed costs would stay constant per unit of capacity. But as a result we think there are very likely better ways to do this than what we have modelled. So, for example, we don't assume any load sharing in the sense of you can geographically diversify and use transmission lines to carry power long distances. There's good evidence that that may be reasonably cheap thing to do and I think most people think that's going to be part of the mix in the future. We didn't put that in. We didn't put in several other things that we think could be beneficial.

DR: The whole cluster of distributed energy demand management, microgrids and subtransmission distribution level management of energy from my perspective has huge potential. But we don't have a big historical record for it. So it didn't play a part in this model.

DF: Yes, we didn't put that in there. Whenever we were faced with estimates we tried to be conservative and give fossil fuels every benefit of the doubt and tilt the deck against renewables. We didn't want anybody to accuse us of fudging the numbers, so we really bent over backwards to be conservative. So yes I think our estimates for renewables are actually overly pessimistic.

DR: Are there technologies that you suspect are probably on or going to get on learning curves, and are going to make a big impact that you had to leave out because of the lack of historical records? Are there particular technologies that you think are going to mirror this kind of trajectory?

DF: Yes. For example, I think one should keep an eye on solid state energy storage. You know, it's striking. If you look at the learning curve for capacitors, for example, you look at Moore's Law for capacitors, capacitors have dropped like 30, 40 per cent per year in terms of cost per energy stored. They have improved at that same rate in terms of energy that can be stored in a given volume at a given weight. People are designing nano technology, storage technologies that show great promise. Now, probably not over the next 10 or 20 years, but I think in 50 years, I bet that's the way we're going to be storing energy. So if you look at what could be done that way, it's going to be dramatic so that the battery in your electric vehicle is not going to be that big.

DR: And that's going to make things even cheaper. Sorry, not cheaper, but more profitable.

DF: Yes, that's right.

> "You say that the speed of the transition itself would drive costs down so much that doing that would save us $12 trillion dollars or more relative to baseline."

DR: In the fast transition scenario you model solar and wind and electrolysers and batteries getting very cheap. What do we mean by very cheap? Give us a sense of the scale here.

DF: I'm not good at memorising numbers, but there have already been sales for solar energy farms in the desert, in Middle Eastern countries that came in at something like two cent per kilowatt hour. And I think it's going to go even lower than that. I think it may go to the point where the actual generation cost is fairly negligible. The main cost is going to be distribution and storage. When you look at the things people are talking about doing, we may have paintable panels – so you can paint solar panel on your roof.

DR: Or windows. Transparent solar panels that use windows, or clothing. We had Saul Griffith on the podcast awhile back and he made a note of saying that in Australia right now, the cost of delivering energy from a centralised power plant to a house already exceeds the cost of rooftop solar. Even if you discount the price of the energy itself. Just the transmission costs are more than the cost of rooftop solar panels in Australia. So in some parts of the world you can already see solar generation prices coming down where they're scraping zero. Coming down to where they are negligible. I think that's kind of mind blowing. Who could predict what we'll do with them?

DF: If distribution becomes a dominant cost, then that's going to be a driver to have more decentralised power generation. My guess is we'll be in a world with a hybrid of personal power gathering and commercial scale power generation.

DR: You model these three scenarios, including a fast transition which gets us to net zero by 2050 in the US. You say that the speed of the transition itself would drive costs down so much that doing that would save us $12 trillion dollars or more relative to baseline. That's purely talking about the cost of energy, saving us a trillion dollars in energy costs. Doing so would also reduce to negligible proportions air pollution – particulate pollutants and proximate air pollution, and would reduce the amount of climate change. Neither of those two benefits are priced into this model. So when we say save $12 trillion, we're not even talking about the health benefits of reducing pollution and the global benefits of reducing climate change.

DF: That's right. We're just talking about the pure economic benefits. You're leaving a couple of others out in that. We can also get energy security this way. Any country that wants to can have energy security with renewables. And secondly, we're getting rid of price volatility. Fossil fuels are inherently very volatile. Why? Because the cost of producing them ranges from Saudi oil at $2 a barrel to shale oil at $100 a barrel in some places. And demand and supply fluctuate, this can lead to huge swings in the price of fossil fuels.

Whereas renewables have very steady prices because it's just inherently a different story. Their costs are pretty uniform. So if we have nice, steady, cheap energy, then that's going to have other side benefits for the rest of the economy. So we're really looking at a fairly long list of benefits. Of course, climate change being the biggest one of all and we haven't priced any of those into this.

DR: The point being, if you include any of those benefits then the advantage of a fast transition becomes overwhelming.

DF: That's right. We do quote some numbers. If you include the social cost of carbon, then the savings are really enormous.

DR: Is there a next step for this kind of research?

DF: No, we're definitely moving along, doing new things. One is we want to regionalise the model. We are also thinking a lot about occupational labour transitions. We have a model for how people transition from one occupation to another and which occupations they can transition to from where. We're also thinking a lot about supply chain issues because in the course of making the transition, we're really going to make a fairly dramatic change in the production network of the whole economy.

DR: Speaking of bottlenecks, the capacity for producing those minerals and processing those minerals is going to have to jack way up way fast.

DF: So that's another one of the things we want to look at in more detail. If you look in this USGS website that I mentioned, the rule of thumb is that while for the price of minerals the long-term trend is flat, the production of all of them goes up exponentially. Is that good enough for us to ride up to where we need to be? And also we may need to be thinking about substitutions. Historically, there have been many cases where people say, oh, we can't do this because we need this material X and we don't have enough of it.

DR: Turns out people are pretty clever.

DF: People are pretty clever at finding material Y that is just about as good as material X and, in some cases, better. Chlorofluorocarbons were a good example where when the refrigeration industry was put under the gun to stop the ozone hole, they moaned and groaned and said, we can't do this. There are no good substitutes. But when they had to do it, they found good substitutes. So those are the kinds of issues we're thinking about trying to build a better economic model to really act as a guide through the transition so that we can do it as quickly and cheaply and profitably as we can.

DR: This has been so illuminating. Thanks for coming on and walking through it, and thanks for the research.

DF: Thank you.

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Words That Grab You By The Wrist

Why we should read more children's books

KATHERINE RUNDELL
CONVERSATIONS WITH TYLER

Interview by Tyler Cowen
Illustration by Vaughan Mossop

Tyler Cowen: Today I'm chatting with Katherine Rundell. Katherine is a fellow at All Souls College at Oxford University. She is the best-selling author of numerous children's books. Every morning, she wakes up and does a cartwheel. But most prominently for me, she is the author of the recent book *Super-Infinite: The Transformations of John Donne*, which is, so far this year (September 2022), probably my favourite book of the year. Katherine, welcome.

Katherine Rundell: Thank you so much for having me.

TC: John Donneis an English poet, born in 1572. What is the origin story of how you became obsessed with him?

KR: I have parents who believed in the power of memorising poetry and in the idea that even if you memorise poetry that you don't understand there will be a time in your life when it will come back for you. So I was paid to memorise poetry, and my mother used to put it on the wall next to the sink where we would brush our teeth. A lot of it was T.S. Eliot's *Old Possum's Book of Practical Cats*, but there was also some John Donne poetry. Even though I didn't fully grasp it, I found it to be faintly alchemic. I loved it. I loved its strangeness and its difficulty. I've loved him for a very long time now.

TC: How old are you at that initial point?

KR: I was probably about 8.

TC: When does the flipping age come when you think, 'This is my thing. I'm going to do something with this.'?

KR: I think probably in my teen years. He became my favourite poet and a talismanic author. I found him a place of refuge against that which seemed to me often ungenerous. So much of popular culture now offers a quite unexciting vision of what your mind and language might be capable of. I found him a brilliant

> So much of popular culture now offers a quite unexciting vision of what your mind and language might be capable of. I found him a brilliant antidote to that, a bulwark against a kind of anti-intellectualism.

antidote to that, a bulwark against a kind of anti-intellectualism. Then also, of course, I had boyfriends who would send it to me, and I found that very romantic.

TC: The early John Donne writes poetry about the transmigration of souls. He writes a tract defending suicide that even suggests, possibly, Christ committed suicide on purpose. Was early John Donne a Christian?

KR: It's a really good question. The one that we will never know the answer to is what precise shape did his inner religious life take because, of course, the central thing that most people who know a little bit about Donne know is that he was born into a Catholic family at a time when to be Catholic was to be persecuted, and he died the dean of St Paul's Cathedral.

That necessitated both a conversion and an emphaticness in his allegiance to the religion of the crown. He didn't just cease to be a Catholic. He wrote two *major* tracts against Catholicism, *Pseudo-Martyr* and *Ignatius His Conclave*. The question of how far he ever believed, how far his Christianity, his Catholicism was real, and how far his later religion was real, and how far it was a necessity born of poverty or a questing ambition is something that a huge number of people will never agree on.

Personally, I am inclined to give him the benefit of the doubt. It was a time when many people changed religions throughout their lives. I think that his writing, the passion and fervour in his religious poetry, the focus and intelligence in his sermons, the breadth of dedication of thought, and the time it will have taken–I find it very easy to believe both in the reality of his Catholicism *and* in the reality of his Protestant conversion.

TC: Just a general question for perspective: if you take poets and intellectuals in the early to mid-seventeenth-century, Donne's time, in England, what percentage of them do you think believed not in God, but in the Trinity, in literal Christian doctrine?

KR: I think belief is such a difficult word because it will have meant different things. You will have had someone like Kit Marlowe, who played very openly with the idea of real atheism, the idea that we live in an empty universe. Of course, some people believe that he was murdered for it. Other people believe that it was a brawl in a pub when he got knifed in the eye for not paying a bill, and we'll never know. Do you ask me to put a number on it?

TC: A number, yes.

KR: Okay, I'm going to say 70 per cent. If you read the letters that we have of the time, people are often, in their private lives, expressing very real comfort and hope from certain forms of religious doctrine. The amount of knowledge that people would've had about what the Bible *actually* said, the amount of access people would have had to Bibles in English, was of course, very limited. But I think a lot of people believed because it was offered as a way to put down your anxiety, your hopes, your chaos. It was a structure that gave people purpose and meaning.

Then, of course, I think there will have been a lot of people who went to church – it was against the law *not* to go to church–but who went to church out of conformity, out of duty, out of not really caring that much. I'm sure, in every church service, there were the passionate devotees and the people who were thinking about lunch–as there are now.

TC: For Donne, can the meaning of a suicide ever be truly transparent?

KR: No. I think, for Donne, suicide is one of the things that dogs his life. It was illegal during Donne's lifetime to commit suicide. It was a crime, in that most strange of ironies, punishable by death. Suicides could be buried with a stake put through their hearts at the crossroads. In France, there have been accounts of dead bodies of suicides dragged through the streets as a warning. Of course, it was against religious doctrine.

John Donne's letters tell us about his very real and urgent keening towards death. He was a man who felt the pull of, he says, his own sword. And he wrote the first full-length treatise in the English language, *Biathanatos*, on suicide, which argues that in very specific, limited circumstances, suicide is not a sin, that Christ himself was the one great suicide. For Donne, to be pulled towards suicide was both, for him, to feel he was being pulled towards sin, but also to feel that it would be a shortcut, a leaping into infinity and into the presence of God. For him, it was never going to be, in any way, straightforward or transparent.

TC: What's the political meaning of *Biathanatos*, Donne's tract on suicide? Is it asserting a right of self-ownership? How do we think about it? Is it egalitarian, or what is it doing, politically, in a very political time?

KR: Politically, of course, it's complicated by the fact that he wrote it, but not to be read. He wrote a text that he explicitly told a friend, when he went to Germany later in life, 'Neither burn it nor publish it. Give it not to the fire, but show it to no one,' because he was aware that it was a text that could lead him to be put in very real peril, not necessarily of anything dramatic like court cases, but he would've probably lost his job.

For him, the politics of it was profoundly opaque and probably informed by a lot of his desire to justify his own suicidal tendencies. There are those within Donne's scholarship who think that *Biathanatos* was, in fact, a personal bid to write out of himself his desire towards suicide, that in some ways, those who talk about it a great deal are perhaps the least likely to commit it, and that he was in some way protecting himself in that way, so that it was a personal text in a way that it doesn't look.

I don't think that it is arguing anything as radical as absolute self-ownership because I think that would be anachronistic for the time. He is certainly saying all certainty has in it the peril of being not just wrong, but wrong in a way that will create misadventuring chaos. It famously says we have been sure about so many things, and we have been wrong about them. We have been wrong about the stars. He is doing something quite radical there. He is saying there is no single great truth upon which we can base anything, and that was bold.

TC: Whether or not you agree with it, what is the best Straussian reading of John Donne?

KR: I don't think I know the answer to that. Can you think of one?

TC: If you think he might be an atheist – I don't think he was, but I think it's a plausible reading that he never believed in the Anglican Church. He became a dean for survival and for income and for security. What he cared about was his art, and a lot of it was a charade. Even in the early work, he was a very high-class entertainer, and in some way, it wasn't sincere. I don't know if I would *defend* that, but I would give it a chance of 10 per cent.

KR: Yes, I think so. It's certainly a position that was very popular in the 1980s. John Carey's completely spectacular book, *John Donne: Life, Mind, and Art*, certainly gives truck to that as a possible position. One of the reasons that that vision has really been shifted in the last 10 years or so has been the discovery of new letters and the dating of old letters to suggest that, even after he had started to reach some form of real middle-class wealth and solidity, he still kept pushing in a way that could have, in fact, been detrimental to him towards being ordained. The king's favourite, Buckingham, was trying to put him off and was trying to offer him various forms of secretarialship–maybe going to Venice, maybe going to Ireland.

That he, in the face of these letters, was pushing back and insisting on the pursuit of God... Also, he reads to me, in his letters, like a man bent on some form of sincerity. For every letter where there is flattery and ornate rhetoric that seems to have, at the heart of it when you burrow through, *only* a joke. There are also letters that seem to express a man who wanted to be able to lay down truth in words. Therefore, I do believe in his religion.

TC: Now, there's a superficial but possibly true view of Donne that he wrote too many verses and epithalamiums for pay, and the world would've been better if he had just done more songs and sonnets. Do you agree?

KR: I absolutely agree. But then, you can say that of almost any poet of the period, for whom the need to make money meant that they had to compose in all ways which absolutely were, step by step, in the fashion of the time, and therefore held back their more radical and inventive impulses. So, when they weren't being paid, they often wrote their best work.

TC: For so long, why was Ben Jonson so much more popular a poet than Donne?

KR: Partly because he was more famous; partly because he wrote plays, and the plays pleased first the queen and then the king; partly because he wrote for the boys of the boy players, and the boy players had a real glamour at the time, and Queen Elizabeth was borderline obsessed with them.

TC: Was Jonson ever a great poet, or is it all just pretty good? None of it sticks with me. Am I missing something? Donne sticks with me.

KR: If you are missing something, I'm missing it too. I admire Jonson's structural ingenuity, and I admire his flair, and I *really* admire his capacity for gossip because it gave us a lot of the knowledge that we have of the time. But I have never managed to find him a poet who gets into your intestines.

TC: There's a recent book by Clare Jackson called *Devil-Land*, which I very much admire. It stresses how much British thought and life in the seventeenth century was, I think she even uses the word 'deranged', crazy. It was a highly ideological era. People started believing, writing, doing all kinds of crazy things. Do you agree? If so, why did that happen then? I know that's a big question, but I've been very interested in this issue.

KR: I think it does look, to us now, like a time where a febrile intensity of thought became not just commonplace but contagious. Certainly, you could wake up in the morning, and you could see acts of great devotion and great violence before breakfast. You could see a man burned for his belief. You could see a woman hung for hers. You could see people willing to push large beliefs on themselves to the point of death.

Certainly, I think it was also exacerbated by plague, by the fact that, every few years in Britain, the plague would come galloping through major cities, and thousands of people would die overnight. I think that closeness to death, to war, to pestilence, also to beauty, to an influx of money, to the fact that suddenly we had access to *far* greater knowledge because of the boom of the printing press–that's enough to create a febrile moment, both intellectually and emotionally, I think.

TC: Are we, in some ways, re-entering a time somewhat analogous to the seventeenth century in England?

KR: I think it does sometimes feel like we are, that there is a similarly explosive moment, where we have newly explosive possibilities and newly explosive fears. There feels like something similarly extreme happening, although I would say from different causes.

TC: What's your favourite word invented by John Donne?

KR: The reason the book is called *Super-Infinite.* I do love impossibility. I think it speaks highly to his sense of that which did not look impossible, but in fact, when you look at it closely, *is* so. But most of all, I love his talent for the 'super' prefix that he added to so many things. Insistence on things which lead outside language: super-infinite, super-miraculous, super-eternal, super-dying. These are the linguistic habits of a man who longs for immensities.

TC: I like just simple 'emancipation.' That's from Donne, isn't it?

KR: It is, although, of course, I think it would be amiss of me not to offer the caveat that often, the Oxford English Dictionary has always found first uses in canonical authors, in part because they're just the ones who survived fire. So of course, he may have just been noting down a word in common parlance rather than being its inventor.

TC: Why did Donne visit Johannes Kepler?

KR: I think, a fascination with the stars. I think that Donne was compelled by the idea of heavens and compelled by the idea, which he found deeply troubling, of scientific discoveries which were casting in doubt the great certainties of the previous generations. He had a complicated relationship with innovation. I think he went to Kepler to understand more about the ways that we moved around the sun and that the moons moved around us.

TC: In what ways was Donne a typical home-schooled child?

KR: I was very briefly a home-schooled child, so I take that personally.

TC: I figured as much.

KR: Of course, the vast majority of boys of his class and religion were home-schooled boys because it was very hard to go to school as a young Catholic. And, as the book discusses, going to school at the time would've introduced you to a ruthless brutality that would've been difficult to recover from. Boys were beaten, some of them to death. It was expected that you would fight your colleagues, your compatriots from the age of about twelve, and boys routinely died at school.

I think that he certainly has some of the idiosyncrasies of thought of someone who did not grow up with a huge cohort of friends, but also, he became a great maker and keeper of bosom friends. His love for his friends is something I believe very truly in. 'Letters, more than kisses, mingle souls,' he wrote to Henry [Wotton], a man who we know he would've given up a great deal to help.

TC: Now, you have two books, *Rooftoppers* and *Skysteppers*, about rooftop walking. Some might call them children's books. I'm not sure that's exactly the right description, but what is the greatest danger with rooftop walking?

Photograph: Compare Fibre

KR: Oh, it's falling off.

TC: What leads you to fall off? If you're rooftop walking, if you were to fall off, what would be the proximate cause of that event?

KR: Philippe Petit, who is, of course, one of the great roof walkers of the world and the man who strung the wire between the Twin Towers in 1977, talks about vertigo as a beast that has to be tamed piece by piece, that can never be overcome all at once. Vertigo, he says, is not the fear that you will fall. It is the fear that you will jump. That, of course, is the thing that, when you are roof walking, you are taming. You are trying to unmoor your sense of danger and of not being able to trust yourself not to jump from your sense of beauty and the vision of a city that you get up high. I roof walk for very practical reasons: to see views that would otherwise be not really available to me in an increasingly privatised City of London.

TC: You're also learning to fly a small plane. Is that correct?

KR: That's true, yes.

TC: For the same reason?

KR: Again, for the feeling of height. I come from a family of pilots. Both my grandfathers flew Spitfires in the Second World War, and my uncle can fly a plane. About five years ago, I started learning for the huge pleasure of being above the world and being given a vision of the sweep of it.

TC: If we're trying to build a unified theory of you, how does wanting to see things from above fit into the theory? I enjoy seeing things from above, but I don't put a lot of time into it, and that's not unusual. You're somewhat different, right?

KR: I think I love the idea. I think it might be connected to fiction. It is very difficult, when writing a story, to hold the whole of it in one's head. If you complete a book in which you feel you have achieved that, it feels like a great gift you have given yourself. It is very difficult to conceptualise a place that I have not seen from above. I like the idea of being able to understand the way a city works by seeing its movements from above. Also, cities are more beautiful seen from above.

TC: Does rooftop walking also improve your research at All Souls?

KR: I don't think that I could claim that rooftop walking really feeds into my research, on the grounds that most of my research is done in cold archives in libraries around the world, looking at manuscripts and hunting for traces of Donne in old books.

TC: My hypothesis is that, in the true unified theory of you, which I do not have, that rooftop walking does, in fact, improve your research, that there's somehow a convex combination of way down low and way up high that you need to maintain intellectual balance.

KR: There could be an argument that, if you are someone whose work necessitates dwelling entirely on detail – because of course, *academic* study of John Donne, which is slightly different from my book, requires just burrowing into these very small details to understand about the conditions of the moment. The flip side of that is the totalities of the view that you get up high in the cold, outside, alone in the dark.

TC: Where would you most like to do more rooftop walking?

KR: Paris has the best rooftops, I think, and they are quite easy to access. I have quite a few friends who have spent quite a lot of time – most of them are dancers or acrobats – on the rooftops of Paris.

TC: Should children be more mischievous?

KR: Yes, and I think we should have more patience with childhood mischief because children whose mischievousness is quashed become difficult, thwarted and sometimes quite vile adults.

TC: What are the most important lessons of governance from what are called children's novels?

KR: Children's novels tend to teach the large, uncompromising truths that we hope exist. Things like love will matter, kindness will matter, equality is possible. I think that we express them as truths to children when what they really are are hopes. I suppose the best politics of children's fiction will be those that argue that, as Ursula Le Guin would say, all that we have made, we have made by man, and it can be undone by man. That, often, the first way that we transform the world is through the art that she calls her art, the art of words. She would say it is the utopianism of children's fiction that allows us to imagine something better. She might be right.

TC: Should the rest of fiction be more like what we call children's fiction?

KR: I would say that people should read children's fiction, because the rest of fiction performs other urgently necessary tasks. I think the right to elongate and experiment are jobs more of adult fiction. I would argue, rather, that adults should occasionally read children's fiction for pleasure, but also for the unabashed politics of idealism that they have.

TC: If I think of some fictional works I read as a child,

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I think we should have more patience with childhood mischief because children whose mischievousness is quashed become difficult, thwarted and sometimes quite vile adults.
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like Isaac Asimov's *Foundation*. There was a thrill to the complete newness of it that I now find harder to create because things are less new to me. How can we get back to what it was like to read as a child?

KR: Of course, to an extent it's impossible because it is the freshness of new discovery that children – almost every scene they read feels to them unlike anything, they have so few collocates. But my argument – I wrote a book called *Why You Should Read Children's Books, Even Though You Are So Old and Wise*, which you very kindly have. My argument would be that reading books intended for people in the process of early discovery can remind you, if not what it feels like, then something adjacent enough to that to remember that it existed. Therefore, it might give you a galvanic push towards seeking out other versions of that feeling of discovery. Because, of course, although we feel like our discovery time has largely passed, that's fake. That's not real. Your discovery time has not passed. There are still astonishments that await.

TC: Should we let children vote?

KR: There's a very brilliant long read in the *New Yorker* by someone arguing that 6-year-olds should have the vote, and it's very impressive in its sweep of the objections. In England, I would like to lower the voting age to sixteen because I stand quite far to the left of centre, and the youth, of course, tend to skew more left and, currently, Britain skews right.

TC: What's your favourite UK bookshop and why?

KR: I live very close to a UK bookshop called Primrose Hill Books, which is very close to where Dodie Smith lived, the woman who wrote *101 Dalmatians*

and *I Capture the Castle*. It's both beautiful and in the sight of Dodie Smith's house.

TC: Are you up for a quick round of overrated versus underrated? These will be easy. First, Edmund Spenser–overrated or underrated?

KR: Underrated.

TC: Why?

KR: Because he is no longer read. I think the *estimation* we hold him in is correct, but nobody reads him, and people should put aside about a week of their lives and read *The Faerie Queene*. It's painful, but it's worth it when you come out the other side.

TC: I agree with that, but it took me much more than a week. Diana Wynne Jones –overrated or underrated?

KR: Underrated, only because infinite estimation is what she deserves, and therefore no matter how high her stock–

TC: Why is she interesting?

KR: I think she's a writer's writer who is somebody who believed that children should never be spoken down to. And I think a lot of her children's fiction is so weird and so full of the furies and anxieties that are extending from childhood into adulthood, that those books would also read as great texts for adults, the obvious one being maybe something like *Fire and Hemlock* or *Howl's Moving Castle.*

TC: Sir Walter Raleigh – overrated or underrated?

KR: Overrated because we have given him such credit for so many things he didn't do. He didn't bring back the potato. That's nonsense.

TC: Seventeenth-century British entertainment. How good was it? You read about bear baiting – it doesn't sound fun to me at all. There's a cruelty-to-animals issue, but it just *doesn't* sound fun. How good was it? Overrated or underrated?

KR: Bear-baiting – definitely overrated. I just don't believe it can have been that exciting. I assume it was partly just *faute de mieux*. People didn't have much to do.

TC: Mary Poppins – overrated or underrated as a *figure*?

KR: Perfectly rated. As a *figure,* or as a film or as a book?

TC: Whichever.

KR: I'm going to say underrated because the books are much stranger and wilder than we know.

TC: Let's say you're back in the time – some version of you – but you don't know how things turn out. Which side of the Glorious Revolution would you have been on and why?

KR: Oooh, I don't know because it's so impossible to forget the way it turned out. Which side would you be on?

TC: I would be very sceptical. I would think, these Dutch people are going to come over and rule us? I wouldn't think the resulting constellation of interest groups would be so stable, it would mean perpetual civil war, which is *not* how it turned out, so I think I would've been wrong.

KR: Yes, I think I might have had a wariness of the dramatic shifts. I might have been anxious about what might come, but then, again, we would've been completely misplaced.

TC: That's right. You cut out the word 'adamantine' from one of your books but kept the word 'renunciation.' Why did you make that decision?

KR: Because 'adamantine' was coming at a peak moment in the narrative. It was the key showdown between a child and a gangster figure, and I didn't want anything that would slow children. But my general stance is, with children's writing, you can use pretty much any vocabulary you want because they will either guess or step over or find out the word, and it rarely puts children off as much as we worry that it will.

TC: Children's movies – again, I know that's a fraught term, but what would normally be called children's movies – what's your favourite one?

KR: Oh, *The Railway Children*.

TC: Why is that interesting?

KR: Because of that final moment. *The Railway Children* is the story of some children whose father has been falsely accused and taken away, and they go to live by a railway. At the end, there is a moment in which the young girl – the oldest of the children, who has had to step into the adult world of secret keeping and adult care – sees her father return to her. She runs into his arms and she says, 'Oh, daddy, my daddy.' In that moment, she is allowed to return to childhood. It's a *staggering* moment of filmmaking, so beautiful.

TC: What is it that T.S. Eliot failed to understand about John Donne?

KR: Oh, that's a really interesting question because, of course, usually T.S. Eliot is given the credit of rediscovering John Donne after the Victorian period in which his fashionability had really waned. I think he got a lot right about John Donne when he says he's trying to picture in John Donne, somebody for whom every element of his life modifies his sensibility, that he is able to couple religion and body and the smell of a rose and the cooking of dinner into one great whole. That, I think, he got right.

I think what he got wrong was he did not accentuate the strangeness of John Donne. I think he offered to us a John Donne who was trying to make things whole but, of course, John Donne's poetry often carries with it a beautiful salute to human fracturing and human strangeness. He was writing at a time when people were offering a profoundly coherent vision of love: Walter Raleigh writing about Queen Elizabeth as the rose, or Philip Sidney constantly iterating this image of the woman as the white dove, that her shoulders are two white doves and her cheeks are two white doves.

John Donne stood up in the centre of that fashion and said, 'No, you are stranger than that. You deserve poetry that is stranger than that. You deserve poetry that uses the images of fleas and sucking fish and suns rising and compasses to express the vertiginous and labyrinthine quality of human desire.' I don't think that T.S. Eliot had a mindset at the time to recognise that.

TC: For you, what is most interesting in Donne's sermons?

KR: The thing I find most interesting would be the radical honesty that he has – that you will find in *so* few other sermons of the time – about the difficulty of finding God. He is a man who writes often with certainty about the idea of reaching the infinite, the divine. But he also writes this famous passage where he says, 'I summon God and my angels, and when God and the angels are there, I neglect them for…'. I forget what it is. 'The sound of a carriage, a straw under my knee, a thought, a chimera, and nothing and everything.' That sense that, even though he had a brain that could control incredibly rigorous poetry, he did not have a brain that would control itself in prayer. He offered that to his congregation as a vulnerability and a piece of honesty that *so* few sermoners of the time – who thought of themselves more as a regulatory ideal that should never admit vulnerability – would offer.

TC: How do you think your life has been shaped by having grown up in Zimbabwe?

KR: Oh, I think it was profoundly lucky to grow up in Zimbabwe. I grew up with parents who allowed me an enormous amount of freedom, and I don't know if they would've done that now, but we were allowed to vanish for the day without adult supervision – me and my siblings and friends. The shining quality of that childhood time, even quite young, say 10 or 11, spent entirely without the presence of adults – the freeing quality that gives your imagination, I imagine has *something* to do with the fact that I became a children's writer.

TC: What is it like to eat a tarantula?

KR: Not delicious. I hoped it would be because some children I met in the Amazon rainforest had told me that it was. But I think there's a *very* real difference between fresh and canned tarantula, and my tarantula was from a can.

TC: Who sells canned tarantula?

KR: The same people who stock Selfridges with little scorpions in whiskey. There's a big market for that kind of thing, it turns out. I was surprised.

TC: It's a markets-in-everything phenomenon. If you just eat a fresh tarantula, do you get poisoned or are you fine?

KR: No, you are fine. I think the poison is only dangerous when administered by the stingers immediately. I was not warned about any danger, and none came to me.

TC: As a kid, how was it that you broke your bones?

KR: Oh, I fell out of a lot of things, trees mostly.

TC: So, you wanted to see things from above, even early on.

KR: Even early on. Because I didn't have the skill to match the ambition, I ended up with quite a few broken bones.

TC: What, for you, is the most fun part of writing?

KR: The early stage, where there is no imperative towards structural cohesion, and you can just write scenes that seem to you vivid and funny and interesting and joyful. Then later, when you have to make it cohere into something where the narrative itself is a form of metaphor – that bit's harder and less fun.

TC: What is your most unusual writing habit?

KR: I no longer really have one. When I was younger,

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... even though he had a brain that could control incredibly rigorous poetry, he did not have a brain that would control itself in prayer.
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I used to have many in a bid to make myself meet deadlines that were broadly my own imagining. I would, when writing my PhD, have a pact with a friend that if we didn't do the requisite number of words– usually a thousand words a day of our doctoral theses – we had to give £100 to a donkey sanctuary. It was chosen on the grounds that it wasn't *harmful* to give that money to a donkey sanctuary, but it also wasn't particularly beneficial because we picked the richest donkey sanctuary in England, where they're bathing in ass's milk and covered in diamonds.

You couldn't tell yourself that it was good, but it wouldn't do harm if we screwed up. We wouldn't, for instance, give money to the British National Party or something like that. And it really does work. I didn't want the donkeys to have my money. I only failed once.

TC: So you've stopped doing it because you don't need to do it, not that you think it's a terrible idea.

KR: Because I no longer need to do it with quite such urgency. A PhD is the hardest form of writing, I think, in terms of galvanising yourself into wanting to do it.

TC: Why do so few writers use markets and self-constraint? So many people will say, 'I want to finish. I want to finish earlier, want to finish my thesis.' But very few people do what you did, I find. You claim it's effective. I suspect that's correct. Incentives matter, and no one copies that. What's going on?

KR: I think it might be that people want to keep their writing as a form of joy and delight, especially if it's not something they do professionally, and that adding those sharp-edged incentives will remove the feeling of luxury that writing often has, that it's a luxury to spend time with the imagination.

TC: Do you feel that the Irish still have an especially rich version of the English language, even today?

KR: I'm not sure I really have enough knowledge about that. Certainly, I think my Irish friends have a deep well of folk stories that they were given in a cohesive body in a way that perhaps English children are not, but I'm not sure about the linguistic portion. What do you think?

TC: It seems to me they are still more narrative, more engaged with longer trains of thought. The fact that, not too long ago, so many Irish people had to learn English as a second language, so to speak, I think still exercises an influence and makes people more self-conscious about language.

KR: Certainly, my Irish friends have a form of linguistic dexterity that a lot of my English friends lack. Of course, the stereotype that the Irish are witty – although my Irish friends find it profoundly annoying – does still push them towards enhancing that stereotype, and they are all *very* funny.

TC: And per capita, there's really quite a bit of excellent Irish literature. Even *not* per capita. If you thought, well, it was a nation of 30 million people, you would think, 'Well, this makes sense, how many good novels they have.'

KR: Yes, it is remarkable, and they keep coming too.

TC: If we think about continental novels of ideas, what is your true love in that genre?

KR: That's a really lovely question. I'm wondering what counts as a continental novel of ideas, though. What counts as continental?

TC: *Don Quixote*, Dostoevsky, Thomas Mann, Franz Kafka.

KR: Kafka was going to be the obvious one that I would say. I was wondering if *Madame Bovary* counts as a novel of ideas–

TC: I'll say yes.

KR: Okay. In that case, *Madame Bovary*, which I remember reading as a teenager and feeling like it kicked the knees from under me with a kind of awe at the speed and richness and occasional cruelty and generosity of that narrative. Also, Kafka – I

Photograph: Sean Ferigan

have a picture book called *My First Kafka*, which is a children's book retelling – I didn't write it, I just read it–of *Metamorphosis*. Now, I give them to all the toddlers I know. I think they need to start young.

TC: For the toddlers?

KR: Yes. I think it's an ideal time to get to grips with Kafka – the 3- to 4-year-olds.

TC: What's a book you can no longer stand to read? For instance, I find it very difficult to now read Dostoevsky. I don't think he's a terrible author, but it somehow doesn't click with me. It fascinated me in high school, but now it just falls flat.

KR: I still love Dostoevsky, but I can't read Dickens anymore. I used to be wildly in love with the atmospheres that he conjured of London and smoke and smog, but I now find very vividly visible the fact that he was getting paid per word.

TC: What do you think is both best and worst about the intellectual environment at All Souls?

KR: Oh, I think best would be the fact that it is a mix of old and young. Often, it's thought of as a place largely populated by older white men, but in fact, a huge proportion of the fellows are under forty. The thing that I loved about it, coming of age there – I was made a fellow at 21 – was that you would come down to dinner, and you would meet people who were unabashedly keen to talk about their work in terms that were not compromising in detail or technicality or passion, and that was a brilliant coming of age. The least good thing? We are still struggling with both the overwhelming whiteness and the overwhelming maleness of the place because of its inheritance. They only had women in 1980, and that does still show.

TC: Let's say, for a friend, you're designing a two-week trip through the British Isles. No London, forget about Stonehenge. It has to be something weird. Where do you send them and what do you tell them to do?

KR: I would tell them first, you need to go to Norfolk, a place that is underrated in its beauties. There's a place called Stiffkey where Rachel Cusk, the novelist, used to live. If you wade out, it starts to look like you could film Martian-like films, and indeed several extra-terrestrial films have been filmed on that beach. If you go right to the sea, there's a colony of seals who will come to greet you, and that feels faintly like being churched.

TC: That part of England is very interesting to me because it's one part where the Industrial Revolution never quite came, so it feels much older, still, in some ways.

KR: Exactly. Its landscape is often compared by people from places like Texas or South Africa. They often say that it has the same prairie feel to it.

TC: Not where you've been but, moving forwards, how do you think travel fits into your work and your writing?

KR: It used to be something that I would do in a way to offer rich detail and the plots that I was doing. I think that I will stay put more these days, in part because of fears of the burning world and what air travel does to that, and in part, a sense that I might be at a period of my life when rhythm and structure might be valuable. I get much more tired than I used to. The thing about doing a cartwheel every day – that was true when I was 25, but it's not true now I'm 35.

TC: It's become too hard?

KR: Actually, you can see my flat isn't big enough. I would hit the wall.

TC: You mean the ceiling or the wall?

KR: The walls. There isn't enough space for a cartwheel across without hitting that pole.

TC: You must live near Oxford.

KR: I actually live in London, and I commute.

TC: What is it that you plan on doing next that you are able to talk about?

KR: I want to write a children's book that I am truly proud of, and I'll keep going until that happens. I'm currently writing a children's novel that I've been working on for five years, and I *think* I might end up proud of it by the end. I'm not yet. I think that's what my version of success would look like – something that I didn't read and wince. That, I think, is my next step.

TC: If you think of your children's-novels side and your All Souls – John Donne side, how do those two fit together in your mind, but also in the minds of those at All Souls?

KR: In *my* mind, I think it's that John Donne's sense of the capacity of language to be something that you shake out of the confines of the day and use in a way that, as much as possible, fits the rhythms of your own imagination. He *insisted* on the necessity of building your own language. I think that I grew up with that, and it is why my novels are often referred to as idiosyncratic and literary. I want language that belongs to me, so I think they refer to each other in that way. Also, I think, a love of poetry. He taught me to love poetry and *other* poetry as well as his, and I think that probably affects my prose. All Souls–I think they would note that most of the novels have a John Donne joke in them, and that's a very obvious throughline.

TC: What do you find most frustrating about interacting with the world of publishing? It's commercial publishing in your case, right?

KR: It is commercial publishing in my case. There is a great deal that I love. Truthfully, it's the necessity of deadlines. I have never handed in a book without it being clawed from my hands, because I always want to do one last go, and I would love there to be an extra four months built into it so that when it looks like a book, I'm allowed to read it like it's a book and then make the changes that I would like to make, but I realise that would be ruinous for the publishing industry.

TC: That's the most rewarding side, but what's the most frustrating? Or is it both?

KR: Oh, that's also the most frustrating – the fact that I'm not allowed to do that, that they don't allow you to rewrite your books four years later. If they would let us do that, I know it would cause absolute havoc for both the reading and writing populations of the world, but my great dream would be to be allowed to look back at *Super-Infinite* in about three years' time. There are already some adverbs that annoy me. I would go back and take them out.

TC: Pierre Boulez did that with compositions. You could, in fact, do that. It may not be profitable, but is there *actually* anyone stopping you?

KR: My publishers wouldn't let me. I have asked my children's publishers, and they say, 'No, you need to write your next book. You can't just keep rewriting your past texts.'

TC: Now, let's say you're meeting younger writers, and you're looking for someone who, in very broad terms, is like you, and I'm not even sure what that means because you have quite an atypical career. But what would you look for in that person as a sign of their talent? Obviously, smarts, work ethic, and so on, but beyond the usual, what do you look for in young writing talent?

KR: The difficulty with that is you are asking an English person that, which requires me to accept that I would look for someone like myself. I wouldn't. I would look for someone different and better. I can't deal with a question that presupposes assuming myself to have excellence, but if I were looking for excellence–

TC: Looking for someone better than you, yes.

KR: It would be really important to me that somebody had understood that it matters as much or far more the way you say the thing as what you say, because the thing you want to say is probably a very similar thing that everyone else wants to say: love, patience, courage, valiance, attention. But there are only some people who have found a way to say those things with such flair and originality that they cut through your interlocutors, complacent inattention, and cut through time, cut through space, cut through cultural difference, and grab you by the wrist. So, it would be a sense that somebody understood – you are going to have to find a new and better way to say this.

TC: How do you value the King James translation of the Bible?

KR: Oh, very highly, because, of course, that is the version that infuses much of the work I love most. Not just, obviously, Donne and Shakespeare, but also Philip Pullman talks about being an atheist, but a King James atheist – someone who was informed by the language of the King James Bible.

TC: How about *The Book of Common Prayer*? Is that just boring?

KR: No, it's wildly–

TC: It's awfully widely read.

KR: But wildly underrated. *The Book of Common Prayer* is more beautiful, I think, than we give it credit for. Again, I think its cadences have informed a lot of the poetry that we hold dear. I don't think we would have Seamus Heaney without the rhythms of *The Book of Common Prayer*.

TC: So how do we approach reading *The Book of Common Prayer* so that it makes sense to us rather than boring us?

KR: Oh gosh, that's really interesting. How do you approach *The Book of Common Prayer*, which is, I agree, not an obviously galvanic text, particularly if you don't happen to believe in Christianity. I think you would have to remember the hope and comfort it was intended to give, and you would have to remember the *many*, many battles that were fought to have it. And that, I think, might make it feel alive.

TC: John Bunyan's *Pilgrim's Progress*. Is that book actually good?

KR: Yes, it is, in some moments. I think it is another one, a little like *The Faerie Queene*, that requires your patience, that requires you to do something to take the edge off your panic at the boredom that will ensue.

> "I have never handed in a book without it being clawed from my hands, because I always want to do one last go..."

For some people, that will be resignation, I'm sure. For some people, that will be – I don't know – alcohol. For some people, it will be a kind of exhaustedness, but something that will allow you to give in to being quite substantially bored on the grounds that it will slow down the beat of your heart, and it will force your imagination to grapple with something slower and broader. The way that Spenser talks about fashioning his ideal reader, the texts tell you how to read them.

TC: Katherine Rundell. I'd just like to recommend to you all, first, Katherine has a short book called *Why You Should Read Children's Books, Even Though You Are So Old and Wise*. She has a wide variety of best-selling children's books, but her most recent book is *Super-Infinite: The Transformations of John Donne*, which I recommend very, very highly. And of course, I recommend Donne as well. Katherine, who also goes by the name Kate, it has been great chatting with you. We thank you very much, and good luck with the books.

KR: Thank you so much.

Conversations with Tyler

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BITES

How Animals Sense the World

ED YONG
MINDSCAPE

Interview by Sean Carroll

Sean Carroll: There is a profound sense in which animals of different species perceive the world in wildly different ways, because they either have more sensory apparatuses or entirely different kinds of sensory apparatuses. There are animals that live off of sensing vibrations and can basically touch things far away via signals sent by air or water. Not to mention animals that have actual receptors to magnetic fields or electric fields in ways that human beings just don't have. So, all of these animals construct in their minds a very different kind of picture of the world than we human beings do. Our guest today, Ed Yong, has a new book out on exactly this topic, *An Immense World: How Animal Senses Reveal the Hidden Realms Around Us.*

Ed Yong: So the book is about this concept of the umwelt, the idea that every animal has its own sensory bubble and its own coterie of smells and sights and sounds that it can tap into and others can't. The man who pioneered this term, Jakob von Uexküll, thought of the study of Umwelten as an act of travel, as an act of adventure.

SC: I think that when you mention to the person on the street that different animals sense the world differently, there are easy examples that come to mind, and hard ones. Like different wavelengths of light.

EY: That's right. If you can see ultraviolet light then, yes, flowers look different. The plumage of many birds looks different. And some birds that look identical across the sexes to us actually look quite distinct to the birds themselves.

SC: But then there are also these wild examples of completely different kinds of senses. Like the mosquitoes sensing CO2.

EY: You are right that there are other kinds of sensing that do seem exotic and that really push the limits of our imagination, such as being able to sense the magnetic field of the earth as many songbirds and turtles can do. Being able to sense electric fields as many electric fish can do. Being able to sense body heat as rattlesnakes or vampire bats can. These all feel much more alien.

One easy example is a duck, sitting on a pond. Because of the placement of its eyes it can see the entirety of the sky without having to turn its head. I cannot imagine that. I'm so used to having my visual world be right in front of me and be 180 degrees of space directly in front of my head. It's really, really hard to imagine seeing behind me, to imagine walking in a straight line and have part of your visual world recede away from you while another part comes towards you. That feels very challenging.

Another example I give in the book is an octopus. An octopus has a large nervous system, but most of that nervous system exists in its arms. Its arms have a large number of neurons, more collectively than its actual brain in its head does. Those neurons allow the arms to work semi autonomously. The arms have a bit of their own agency and they can move and do things independently of what the main animal is doing. There's some connection between those two things but then when you think about the sensors, it becomes even weirder because the arms have taste and touch receptors on the suckers.

SC: I want to hit some of the highlights from your book. The fundamental fact is that it's not just a difference of degree. It's not just a couple of wavelengths here and there. It's a very different kind of sensing. You have this wonderful sentence in your book early on, where even if it's with the same senses that we know about, they can be deployed in different ways. So, you say there are animals with eyes on their genitals, ears on their knees, noses on their limbs and tongues all over their skin.

EY: When we eat, we put food inside our heads. If you are a very small animal, like an insect, food can instead be something that you land on and walk upon. And for that reason, many insects from butterflies to flies have taste receptors on their feet. So, a fly landing on an apple is tasting that apple as it's walking around it.

SC: It makes perfect sense. In some sense, the sense of taste for us comes too late to be a good warning system. The food is already in our mouth. But for a creature where taste is external, that can actually be useful information. Before you start ingesting the stuff.

EY: This incidentally is part of the reason why DEET works. DEET tastes repulsive to mosquitoes. If a mosquito lands on an arm that's covered with DEET, it tastes something foul and takes off.

SC: As a physicist, we think we understand what colour is: it's the wavelength of light. But, of course, almost everything we're looking at has multiple wavelengths coming at us and our eyes filter it just down to three. But then our brains have to reproduce or reconstruct what actually seems like a colour to us. And it's probably very different for different animals.

EY: Certainly. A wavelength of 700 nanometres feels like red to us. But it's not necessarily red to another creature. For my dog, it's going to be closer to a dark muddy yellow, because he has a different set of hardware in his eyes. There's nothing specific about 700 nanometres that makes it red. It's red because that's how our sense organs and our brain perceive it. So, for a dog the visual spectrum goes from a dark yellow to a dark blue, and in the middle where we have green, they just have whites and greys. For a bird it's going to be a lot more complicated. It's going to go from red to ultraviolet. I'm talking about the visual spectrum as if it was a linear thing, but it isn't. Birds have a whole other dimension of colour that we don't have access to, that's why the visual world of a bird is so difficult to imagine.

SC: Let's move on to touch. In some sense, touch is a very direct thing. We touch things. But one of the points you make in the book is that other kinds of animals have, in some sense, extended touch. They use the medium they're in, whether it's air or water or whatever, for all intents and purposes to touch things that they're not touching.

EY: We can do that to an extent. I have a ceiling fan blowing now. I can feel the current from that fan, but that touch at a distance is very much par for the course for a lot of other creatures. A shore bird probing into the sand can detect objects buried in the sand that are beyond the reach of its bill, by sensing the ways the pressure waves created by the probing bill are deflected by objects in the sand. Fish and manatees can sense the currents created by other things swimming in the water around them.

> "I guess the right way to say it is the world is the world, but you're sensitive to such a different part of the world that it might as well be a different place."

A seal has whiskers that allow it to detect the trails left behind by a swimming fish that still exist in the water after that fish is gone. Before writing this book, I would never have thought of a fish as leaving a track. But it does. It leaves behind turbulent water that an animal with the right equipment, like a seal with its whiskers, can follow. Even in the air there are examples of this too. Animals like crickets and spiders can detect the ludicrously faint air currents created by other critters around them. There are spiders that can detect the wind created by a fly precisely enough to then leap into the air and catch that fly. Then there are crickets that can sense the breeze created by a charging spider enough to run away from it. It really does seem like a lot of these creatures are pushing against the limits of physics. Their sense organs are about as sensitive as they could possibly be.

EY: And I certainly cannot imagine what it is like to be a cricket for exactly these reasons. The world seems like a different place. I guess the right way to say it is the world is the world, but you're sensitive to such a different part of the world that it might as well be a different place.

SC: Exactly. If you were in the same room as a cricket you would be sharing the same physical environment, but you would both have a radically different experience of that environment. And that is very much like the core of what *An Immense World* is about.

Slouching Towards Utopia

Photograph: Museums Victoria

BRAD DELONG
ECONOMICS EXPLORED

Interview by Gene Tunny

Gene Tunny: Your book *Slouching Towards Utopia* is an economic history of the twentieth century. I'd like to start by asking what motivated you to write the book and what message are you trying to convey with the title?

Brad DeLong: I was reading Eric Hobsbawm's *Age of Extremes* back in 1994 and thought that the story he was telling wasn't the big story. That what he was telling was only a relatively small part of the big story, and that someone should write a book that told the other big story of economic history after 1870. Then eventually I buckled down and wrote the thing. Then, after writing the first draft, I had to take the chainsaw to it, because it was twice as big as the book that was published. But now it's out there in the world I actually like it a lot, which I didn't expect to at this point. I expected to be sick of it and thinking there was a lot wrong with it but I'm not thinking that way.

GT: I think it's terrific. It's a big book at 600 pages or so. I was impressed by all the examples. One thing I didn't appreciate until I read your book was the role of the Saudis in ending the Soviet Union. I didn't appreciate how when they increased oil output in the eighties it meant the Soviets weren't earning as much income from their own production, and the implications of that.

BD: This was what the late Yegor Gaidar always insisted on. That as long as the Soviet Union could

trade oil for grain the system could continue. The fact that the system was so sclerotic meant they were unable to figure out a way to grow more grain. This was a problem, but not a crisis. But then the price of oil falls by two-thirds. And, in 1986, as the Saudis reacted to what was going on in the Iran, the Iraq War, and other things, all of a sudden, the Soviet Union has to start borrowing if it wants to import its grain. It starts borrowing from banks, and then the banks begin to say no. Then it starts asking for loan guarantees from Western governments, and then the demands come: well, we'll guarantee these loans, but we want you to be cooperative and open with respect to politics and democracy and things. And then the whole system simply collapses. It's really quite an interesting story. Yegor Gaidar gave a short speech, I think, at the American Enterprise Institute called something like grain and oil. It's very much worth reading,

GT: That's one of many examples of good stories in the book. You mentioned about Eric Hobsbawm, who was a Marxist historian. You're saying that he missed the big story of what happened after 1870. Could you please explain what was he saying? And what do you think the big story was, please.

BD: Eric's big story was that, once upon a time, there was Vladimir Lenin, there was the Bolshevik Revolution. And it created world communism, which was the world's only hope for utopia. And in the end, world communism was betrayed by enemies outside it, and by enemies inside of it, and it expired. But before it expired, it managed to defeat the worst tyranny in human history – the Nazis. Because without the Soviet Union, the Nazis would probably still be ruling Europe. And when it expired, that brought the end of human hopes for a really good society.

From my perspective, this is a story that is simply total bonkers. Unless you're a strong believer in world communism, as it was formed in the middle of the twentieth century, as Eric was. Eric was a young Jewish teenager in Berlin in the early 1930s. He watched The Nazis marched past calling for the immediate death of himself and all of his family in a time when everyone else was pussyfooting with the Nazis. And you know, only the Soviet Union and the Soviet-led German Communist Party was willing to say, these are horrible people, we need to fight them. And so he made that political commitment as a teenager and was never really able to outgrow it. I'm told that even at the end of his life, if you got a couple of drinks into him, you could get him to say that, you know, Stalin had been too harshly judged by history. He was a very smart guy, a very learned historian, desperately trying to get it right. The fact that someone like me thinks he could still get it so wrong is very much a cautionary tale about how I should not be proud. To be aware

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The fact that someone like me thinks he could still get it so wrong is very much a cautionary tale about how I should not be proud.
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that other people are likely to judge me in the future the way I judge Eric.

GT: So what do you think is the big story after 1870? You've got a more optimistic view of history, obviously.

BD: Maybe that 1870 really is the hinge of history. Before 1870, technological progress is slow, and infant mortality is extremely high. You're going to see half your babies die before they are five. Something like one-third of women are going to wind up without surviving sons, should they be lucky enough to reach fifty themselves. And in the pre-1870 high patriarchy world if you reach fifty without a surviving son, you have no social power whatsoever. You have no account, you have no one to advocate for you. Before 1870, pretty much whenever there was an improvement in human technology, the response was, great, now I can try to have more kids and raise the chances I'll have surviving sons above two-thirds. So, from minus 6000 BC, on up to 1870 there is a lot of improvement in technology. The upper class lives better. But for most people you simply have a farm size only one-fiftieth as large potentially at 1870 as your ancestors had back in minus 6000. You're still living at something like $3 a day, you're spending 60 per cent of your income on just getting your 2000 calories plus essential nutrients. And there were a lot of days when you can't think about much other than you're very hungry. That's the state of the world before 1870. And that means that unless you're in an extremely lucky place, or an extremely lucky class, that life is going to be kind of brutal, short, and without very many options. In most times in most places, governance is about how does an elite figure set out to grab enough for itself and maintain its rule over society.

After 1870, everything changes. Technological progress becomes rapid. The technological competence of the human race globally doubles every generation. You quickly get a world in which people are rich enough that infant mortality falls substantially. And with that falling infant mortality, and with the erosion of patriarchy, all of a sudden, you don't have to concentrate a lot of effort on having children, to be confident that if you reach the age of fifty, you'll still be able to run your own life. So, we get the demographic transition, now headed towards a stable world population of 9 billion. For the first time, after 1870, technology wins the race with human fertility and we begin to look forward to a time when humanity will be able to bake a sufficiently large economic pie so that everyone can have enough. Back in 1870 people thought most of the problems of society came because incomes were low and technology was underdeveloped. And you had this elite running a kind of domination and exploitation game on everyone. Once you can bake a sufficiently large economic pie for everyone to have enough, those things should fall away. The problem becomes one of properly slicing and tasting the economic pie. Equitably distributing it and then utilising it so that people can feel safe and secure and live lives in which they're healthy and happy. That those should be relatively straightforward to solve. We today, at least in the rich countries, should be living in a utopia, which we are manifestly not. So, the story of history after 1870 is how we are well on the way to solving the problem of baking a sufficiently large economic pie. While the problems of slicing and tasting, of distributing and utilising it, continue to flummox us.

GT: 1870 is several decades after what is traditionally thought of as the start of the Industrial Revolution, and a few things that come together around that time. Would you be able to explain that please?

BD: I'd say that the Industrial Revolution itself, steam power and metallurgy and early engineering, weren't quite enough. They got the average rate at which technology improves up to about half a per cent per year. And of that maybe one-third comes from the fact that you're concentrating all the manufacturing of the world in districts, most of them in England, where manufacturing is most efficient. One-third of it comes from the underlying engine of science and discovery and engineering. And one-third of it comes because we were lucky enough that the last round of glaciers scraped all the rock off the coal around a huge chunk of Northwest Europe, which left you with a lot of coal at sea level that you could just pick up off the ground and ship out. Come 1870 you've concentrated all the manufacturing and you're pretty much mining out the really easy coal and you have to go deeper, which is more expensive. The possibility was that the Industrial Revolution would be largely over, except that in 1870 we got the development of industrial research labs to rationalise and routinise the discovery and development of new technologies. Then the modern corporation evolved to rationalise and scrutinise the development and deployment of technologies, plus full globalisation, which provided enormous incentives to deploy and diffuse technologies. So, all of a sudden, instead of half a per cent per year, you had a 2 per cent per year rate of global technological change. While it was possible for humanity to be fertile enough to offset the half a per cent per year technology growth before 1870, after 1870 even the population explosion could not keep us poor. And then we go through the demographic transition and the population explosion reaches its end.

GT: So, these industrial research labs, you're talking about Thomas Edison in Menlo Park?

BD: Yeah, Menlo Park and others. I like Nikola Tesla. I suppose today we'd call him neurologically divergent. He's definitely not neurotypical. Which means that unless you can slot him in exactly the right place where he has lots of people surrounding him who will tolerate him being an A-hole, and pickup which of the crazy ideas he has that might actually be useful, unless you have George Westinghouse to build an industrial research lab to surround him and then the Westinghouse corporation to deploy his technologies... While Edison is General Electric, and others are frantically trying to keep up because, you know, Tesla knew how to make electrons get up and dance in a way that nobody else did. Without that Nikola Tesla would have been no use to humanity at all. He personally pushed the entire electrical sector forward in time by a decade. That's a wonderful set of meta inventions. That turns the process of technological development from being a difficult one in which you have an idea, but then you need to be a human resource department and an executive, a marketer and impresario, an advertiser, as well as an engineer, in order to get anything done. To one in which engineers can engineer and find people who are good at the other things to surround them and do all the things you need to do to actually deploy a technology and make it useful. That really only falls into place around 1870.

GT: What about the modern corporate form? Corporations have existed in some form since the East India Company and the Dutch East Indies Company.

BD: The novelty was the idea that anyone could set up a framework which would be a large, internal, centrally planned division of labour. Which could expand and copy itself. But which also had interfaces with the market economy so that it was focused on producing things that people wanted, or at least that people with money wanted. This is something that allows you to expand once you have a good idea. Once you've built it in one factory it's then very natural for the corporation to say, okay, let's build it over in the next town, then let's expand the factory, let's licence it, let's move it to another country. All of that only happens with management. The Business School professor Herbert Simon used to call these red islands of central planning connected with the green lines of market exchange. Those are very characteristic of the modern economy. We really need to have those islands in there and working very well in order to be even nearly as productive as we are.

GT: What would be the exemplars of that modern corporate form. Are you thinking of General Electric or DuPont or those sorts of companies?

BD: In the early days it was things like the great farm machinery producers. They were, I think, the first. Once you figure out how to make a reaper or a harvester, or a combine, demand for it is huge. You don't want to have one small workshop in some small town in Illinois or something, making a reaper when the reaper can be put into use from the Murray Darling River Valley all the way to Argentina. Later on, it was the Ford Motor Company and General Motors that were the classics. Now of course I think it is Apple Computer, which is simultaneously the most capitalist-driven thing in the world but also the orchestrator of this enormously complicated and centrally planned division of labour all over the world. A relatively small number of people in Cupertino, California, can conduct an economic division of labour that dwarfs that of the centrally planned Soviet Union at its most prosperous.

We haven't even gotten into its role as the pusher-forward of electronics technology, of the modern semiconductor, whereby Apple Computer pays the Taiwan Semiconductor Manufacturing Corporation $30 billion each year, which it then turns around and uses to invest in pushing semiconductor technology forward to make circuits smaller and chips faster and bigger, which it then sells to Apple, which then puts into iPhones so it can earn the $30 billion it needs for the next round.

GT: Can I ask you about full globalisation, and then what happened later in the nineties with what you call re-globalisation and then hyper-globalisation? Your book reminded me of the large flows of people and capital that occurred in the late-nineteenth century, before World War I. That's something I think Polanyi wrote about. Could you talk about that please?

BD: One thing is to say that from 1870 to 1914, 50 million people leave Europe and also 50 million people leave Asia. The people who leave Europe by and large go to Argentina, Chile, southern Brazil, United States, Canada, Australia, New Zealand. They go there and bring European biotechnology – crops and animals and so forth. In Australia, they find at least before the great drought of the 1890s that there is not a better place for European sheep than Australia. And so, Australia before the drought of the 1890s becomes the place with by far the highest standard of living in the world. They ship out wool in steam-powered ocean-going ships. They produce an amazingly rich and prosperous middle-class civilisation, and then Australia with its large middle class, powers the demand for Australian factories and Australia industrialises and becomes and remains an extremely rich and prosperous country.

Brazil might have been on the same trajectory. Australia has land that's wonderful for sheep. Brazil in the second half of the nineteenth century was the best place for rubber. Rubber tappers of Brazil were making a good living. You have the growth of the Brazilian economy, you have the construction. European singers like Enrico Caruso or Jenny Lind, when they went on world tours, they would go up the Amazon to Manaus and perform in the Manaus Opera House. Things worked very, very well, except that the British arrived and grabbed some rubber plants from Brazil and carried them back to Kew Gardens. Then the Belgians got a hold of them and took them down to the Congo, and King Leopold began cutting off the hands of people who didn't bring in enough rubber from the villages. And in Malaysia, the British Empire brought down workers from China who were desperate to get out of China, given how small farm sizes were and how poor China was, and combined it with British capital. So that Malaysia, the Malay Peninsula becomes the world's biggest rubber producing centre in the world by 1914. The Chinese plantation workers brought down from the Pearl River Delta, were extremely happy that the British could pay them a quarter of what the Brazilian rubber tappers were used to getting. They would say we're much better off than we would be back in China. It grew like a weed on the Malay Peninsula and caused the enormous crash of the Brazilian rubber industry.

This transfer of all kinds of tropical goods and plants occurred all around the world. For example, that Yemen finds itself suddenly faced with enormous competition from coffee grown in Indonesia and Costa Rica. Which means that if you were in the tropics between 1870 and, indeed, up until 1950, you'd find that whatever you export, its price was dropping like a stone because there was all of this extra competition from all of these extra sites for production opened up by Asian migration.

The rich first world countries did quite well in part because immigrants from India and China were, by and large, kept out, so wage levels stayed very high. They got the middle classes and the middle class demand so they could industrialise. While Brazil or Malaysia or Congo really didn't have a chance to industrialise because no middle class was large enough to buy the manufactured goods, and they had no ability to export given how cheap and how good at manufacturing Britain was back then, and how eager Britain was to export.

GT: The story we tell ourselves is that it was all about good governance and good institutions.

BD: Certainly, bad governance can make a country very poor very quickly. Indeed, the economist, Arthur Lewis, used to say Australia and New Zealand are not just cousins of Canada and the United States, but also of Argentina and Chile, and in some ways South Africa. Indeed, come 1914, Buenos Aires looks a lot like Melbourne. But then governance falls apart in the 1920s and 1930s, and even more so after World War II. Now no one thinks of Argentina as being a country that is on the same level of development as Australia or Canada, because it simply is not. And yet, it certainly has the land, it certainly had the resources, it had the education. In 1914 it had the technology base, but bad governance can do terrible things. You see this most with respect to communism. When the Iron Curtain fell in 1990, we could actually look and see that those countries that had been ruled by the Communists were only one-fifth as rich as the countries immediately across the border. And you know that where that border was, was principally determined by where the Red Army had managed to march in 1945. What's the difference between Czechoslovakia and Austria? Or Yugoslavia and Italy?

GT: Very good point. I'd like to ask about the what you call the long twentieth century. You talk about this period from 1870 to 2010. Is that the period where we were 'slouching towards utopia'?

BD: In every generation where we were doubling humanity's technological competence it was really clear that we were solving the problem of baking a sufficiently large economic pie. And we were trying to figure out how to slice and how to distribute and utilise it. People were trying various things, some of them reasonable, and some of them absolutely horrible and genocidally destructive. I'd say that's what gives 1870 to 2010 its unity is that we're solving what people thought was the big problem, but not at all solving what people before 1870 had thought would be smaller problems.

> “While it was possible for humanity to be fertile enough to offset the half a per cent per year technology growth before 1870, after 1870 even the population explosion could not keep us poor.”

GT: In your book you discuss the power of some individuals, and you talk about the power of Keynes and FDR. How do you think they would be diagnosing where we are today and what needs to be done? It's almost an impossible question but do you have any thoughts on that?

BD: By and large a number of the predictions that Keynes made in a 1930 paper, on 'The Economic Possibilities For Our Grandchildren', have indeed come true. And at least the global north is approaching the stage in which we do indeed have enough. That we're facing the permanent problem of the human race, which is how to take your wealth and resources and live life wisely and well. He would say that he had hoped that we would have made more progress on learning how to live life wisely than we have. That we do not realise how wealthy we are and how broad open our possibilities should be, but instead are mean and ungenerous to ourselves and to others.

GT: What's to be done, particularly in the US and other advanced economies? What are the levers for redistribution?

BD: I think the biggest and the best lever and, in fact, the one in which the United States and Australia have historically been most successful, is immigration. That, over time, we have been very good at taking in people from elsewhere whose parents were not Americans and Australians, and making them into Americans and Australians.

We have enormously powerful and strong cultures, that are based on both countries' willingness to take in large numbers of people from elsewhere. Australia taking in an enormous number of refugees after World War II has been a huge source of national strength. We are still largely empty countries. You can move someone from Mexico to the United States, from Malaysia to Australia, and you are going to triple their productivity just by doing that alone. That will generate a huge amount of potential wealth.

Otherwise, the problem is that we had a steam power economy in 1870, an electricity and diesel and chemical economy in 1900, a mass production economy in 1940, and a global value chain economy in 1990. Now we're headed into an info biotech economy. And whatever worked in politics, economics and sociology 30 years ago, when the technological foundations of the economy were different is probably not going to work well now. So anyone who says we need to go back to X is probably going to wind up unhappy. So we should try to move forward into the future rather than trying to pick up models from the past. Although what those forward and future models are is beyond me.

GT: You're telling the economic history story, but future policy that's for someone else.

BD: The big lesson of history is that trying to maintain social and economic systems past their sell-by date as the technology changes underneath it just doesn't work.

GT: Interesting point about immigration. I agree with you about immigration providing benefits. But in the short term there are absorption issues, in part related to housing, that we have to deal with.

BD: A lot of people think they have the right to insist that things need to stay as they are. The San Francisco Bay Area has seven and a half million people. If we'd had an 1800s view towards development, we might now have 20 million people, and it would probably be a better world because those other 12 and a half million people who aren't here are in other places that are less great to live in, and where they are likely to be less productive than they would be if they were here.

GT: There are huge gains from moving people around the world. Lant Pritchett has crunched the numbers on this. What's the benefit and where does it come from? Do you have thoughts on that?

> "You can move someone from Mexico to the United States, from Malaysia to Australia, and you are going to triple their productivity just by doing that alone."

BD: A lot of it is agglomeration, thick market agglomeration effects that we don't really understand that appear to be extremely large. But that also can very quickly turn into pollution and crowding effects if the local government is not competent at handling the process.

Throughout history, it's always proven much easier to move people where institutions are good, and where they can be productive than to somehow move institutions to where the people are. Attempts to build prosperity or build democracy in places where it does not seem to be strongly established rarely go very well. And I would say I do not really understand why that is the case.

GT: Well Professor Brad DeLong. It's been a real pleasure. I've really enjoyed talking with you very much about your book. Any final thoughts?

BD: Thank you very much. I think be hopeful. Even though individually, each of us is just a jumped-up East African plains ape who often forgets where he left his keys, together, there are 8 billion of us and if we talk to each other, we can be very smart.

GT: Absolutely. I think that's a great note to end on. Professor Brad DeLong, thanks so much.

Photograph: Chris Linnett

On Myside Bias, Effective Altruism and the Collective Brain

STEVEN PINKER
THE JOLLY SWAGMAN

Interview by Joseph Walker

Joe Walker: This question is intended in a spirit of sheer playfulness. So, like me, you locate yourself on the centre-left of the political spectrum. For example, you're on record as being the second largest donor to Hillary Clinton at Harvard. But within academia you're often attacked for not being left-wing enough. For example, there was a pathetic attempt to remove you from the Linguistic Society of America's list of distinguished fellows in 2020. So my question is why not bite the bullet and move to the centre-right, at least socially? Hang out with the Niall Fergusons of the world where you'll be at less risk of cancellation. Or is a form of myside bias holding you back?

Steven Pinker: Well, it could be. As with all cases of myside bias, I might be the last person to ask, because I would to be so immersed in it that I couldn't objectively tell. Niall Ferguson is a friend. I am binary, that being here at Harvard University and the People's Republic of Cambridge as it's sometimes called, I am immersed every day in not just left of centre, but often hard left colleagues and students. But at the same time, I do pal around with people on the right, libertarians. Not as many national conservatives of the Trump variety, but I certainly have a lot of friends who are right of centre.

Well, I try not to fall into a single tribe because it clouds your judgement. It maximises myside bias. I can't claim, just as no one can claim, to be free of it, but I do take steps to minimise it. I expose myself to opinions on different parts of the political spectrum. I subscribe to *The New York Times* and *The Guardian*, but also to *The Wall Street Journal* and *The Spectator* and try to pick and choose the ideas that I think are best supported. Over the course of my career, I've changed my mind on a number of things.

JW: This next question is also intended in a spirit of sheer playfulness. So, could the temptation to extrapolate the Long Peace – that is, the post-1945 decline of wars among great powers and developed states – into the future simply be the result of representativeness bias? That is, judging likelihood by similarity?

So to explain by analogy, Andre Shleifer and Nicola Gennaioli have some work where they apply representativeness to extrapolation in asset markets and they look at how people predict future uncertain events, like rises in asset prices, by taking a short history of data and then asking what broader picture the history is representative of. When people focus on such representativeness, Shleifer argues, they don't pay enough attention to the possibility that the recent history is generated by chance or a random process rather than by their model. So, to continue the analogy, if a company has a few years of earnings growth, investors might conclude that the past history is representative of an underlying earnings growth potential when maybe it's nothing more than random.

SP: It is possible because we're talking about a stochastic process in the sense of being probabilistic over time. In *The Better Angels of Our Nature* I raised that question and tried to deal with it as best I could with some pretty crude statistics. Namely, if you estimate the underlying rate of war up to the moment that historians identified as the onset of the Long Peace, namely at the end of the Second World War, and then asked what are the chances that we would observe a rate of war as low or lower as we have observed since then in a rather simple chi-square analysis it turns out to be extraordinarily unlikely on the assumption that the probability has not changed.

In the case of the Long Peace, I argued that it isn't post hoc, that the Second World War really did qualitatively change a lot. But still, a sceptic could say, well, maybe you only are saying that because that's when the frequency of war appeared to change.

JW: So you consider Herb Simon's essay on the architecture of complexity to be one of the deepest

> I try not to fall into a single tribe because it clouds your judgement.

you've ever read. Why is it mandatory reading for any intellectual?

SP: Well, it explains and unifies so many disparate phenomena according to a principle that is fairly easy to grasp but that has far-reaching implications. That being that any complex system is likely to be composed of a relatively small number of subsystems, each one of which is itself composed of a relatively small number of subsystems. That is the only way in which complexity can be self-sustaining, because a system that's just built from scratch out of hundreds or thousands of parts would be vulnerable to any degradation or damage, bringing the whole thing crashing down. Whereas if a system is more modular, hierarchically organised, such as the body consisting of systems, which consist of organs, which consists of tissues, which consists of cells, which consists of organelles, then one part can be damaged without bringing the whole thing down. This is true of societies, of corporations, of universities, of galaxies. Although Simon concedes that a possible limitation is that these might be the systems that are most amenable to human understanding, so there is a possibility that there's ascertainment bias.

JW: You've been critical of the effective altruism movement for lurching too far from its global health and development roots towards cause areas like preventing existential catastrophe and unaligned AI. I'm curious, what are your specific object-level critiques of longtermism?

SP: Well yeah, as a number of people have noted, effective altruism has gotten weird. That is, prioritising the existence of trillions of consciousnesses uploaded to a galaxy-wide cloud as opposed to reducing infectious disease and hunger now.

Among the problems are that our ignorance increases exponentially with distance into the future. That is, ten things might happen tomorrow, for each one of those ten things, another ten things could happen the day after tomorrow, and so on. If our confidence in any of those things is less than one, then our confidence in anything several years out quickly asymptotes to zero, and to make decisions now about what might happen in a million years, a thousand years, even a hundred years, even 10 years is probably a fool's errand. Therefore, it can be highly immoral to make decisions now based on a scenario of which we are completely ignorant, at the expense of things that we know now, namely people are starving and dying of disease who could be spared.

A lot of the scenarios having to do with superintelligence I think rely on a completely incoherent notion of intelligence. I explain this in a few pages in *Enlightenment Now*, that the notion of artificial general intelligence or superintelligence is a kind of mystical magic, it's not rooted in any mechanistic conception of how intelligence works. Many of the scenarios envisioned, such as a perfect understanding of our connectome and the dynamic processes of the brain that could be uploadable to a cloud are fantastical. Namely, they are almost certain never to take place as opposed to almost certain to take place given the scale of the problem, the vastness of our ignorance, the formability of the technical challenges together with our philosophical ignorance as to whether a replica of our connectome running in the cloud would even be conscious, or if it did, whether it would have our consciousness.

So the moral, since morality is driven above all by consciousness, that is by suffering or flourishing, to make decisions based on the enormous philosophical uncertainty of where our consciousness resides, together with the, I think, technological naivety of how likely these scenarios are to unfold, I think means that is an example of EA going off the rails.

Now, by the way, it doesn't mean we shouldn't worry about real existential risks like nuclear war or pandemics. But there, the short to medium term and the long term align, and longtermism is irrelevant. It would really suck if all life were to be extinguished by a nuclear accident. Even if 99 per cent were. This is something we should work very, very hard to prevent and the hypothetical disembodied souls in the cloud in a million years is kind of beside the point. You should still work to end to prevent nuclear war or a highly damaging pandemic.

JW: In a paper called 'Innovation in the Collective Brain', Michael Muthukrishna and Joe Henrich argue

Photograph: Maria Oswalt

that innovations aren't the work of lone geniuses but rather emerge from our societies and social networks, or what they call the 'collective brain.' Individuals who seem like heroic inventors can really be thought of as the products of serendipity, recombination and incremental improvement. What do you make of their argument?

SP: Oh, it's a false dichotomy. I mean, it's just obviously true that no solitary genius can invent anything from scratch, and no one ever said that that was true, so this is a true straw figure. But nor is it true that innovators are commodities, that any old person can invent anything. There are genuine differences in intelligence that have measurable consequences in the likelihood of producing an innovation. We know this from Camilla Benbow and David Lubinski, 'Studies of Mathematically Precocious Youths', they really do end up with more patents than non-precocious youth and together with the personality traits that are necessary for innovation, such as conscientiousness, self-control, perseveration. So this is a complete and utter false dichotomy. You need brilliant people working in networks of sharing information and building on past advances to get true innovation.

JW: If we are reasonable beings, why do certain true ideas that seem so obvious in hindsight take so long to appear in the historical record? For example, arguably, probability theory, or just simply the idea that all human beings are equal?

SP: Our instincts militate against them. That is, we do have tribalism that goes against the idea of universal equality. We have availability and representatives and so on that push back against probability, at least as abstract formal all-purpose symbolic formulas. When it comes to our own everyday lives, when it comes to giving equal consideration within the clan, when it comes to assessing probability of things happening to us that we experience, we're not so bad. But generalising them using an abstract formula depends on networks of global cooperation that make other people bring other people into our circles of sympathy and depend on the accumulation of knowledge, including tools such as literacy, mathematics that multiply the abilities that we have. These took time to develop as transportation, communication, literacy, written records, education were built, piece by piece, over time.

JW: Steve Pinker, thank you so much for joining me.

SP: My pleasure. Thank You.

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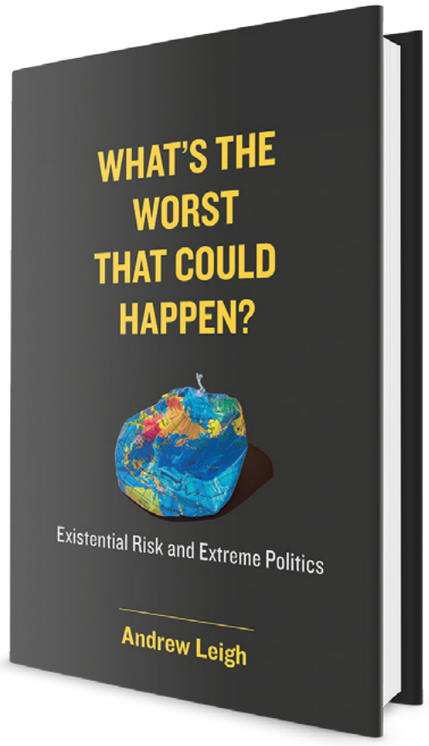

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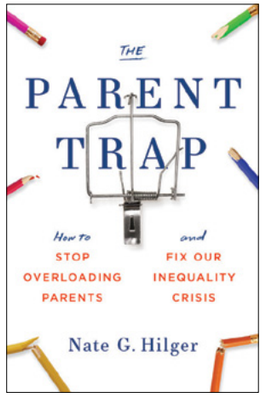

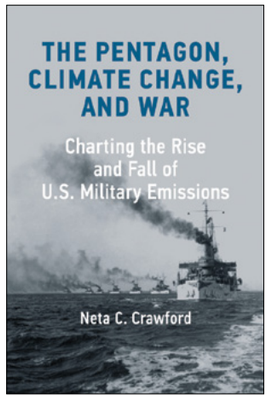

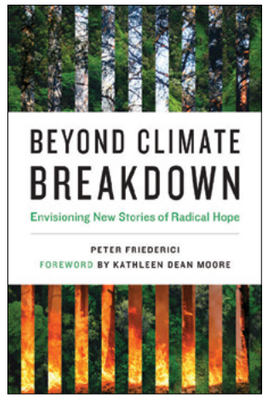

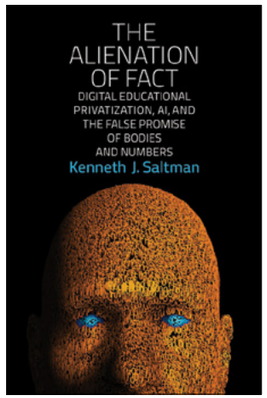

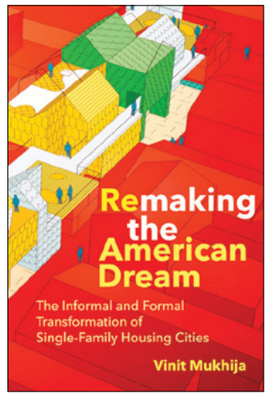

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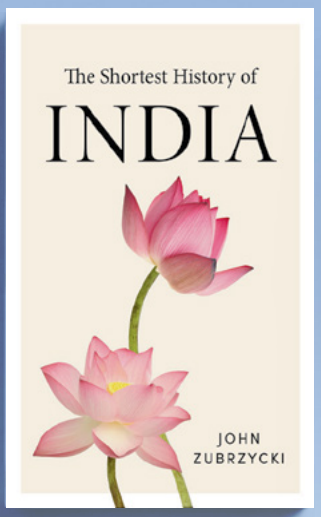

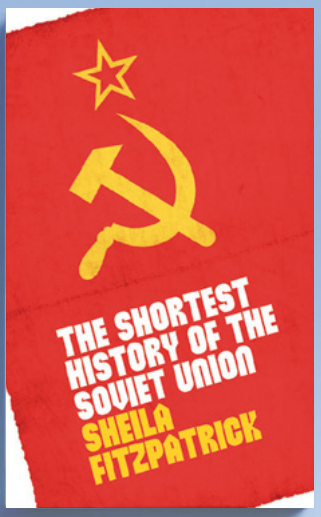

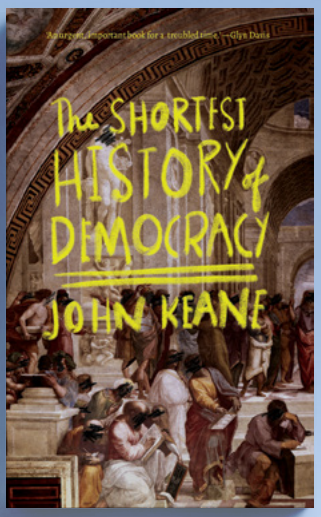

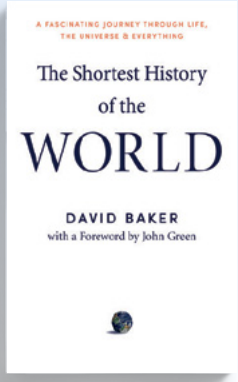

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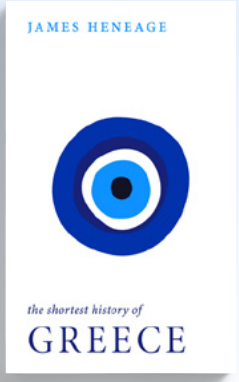

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