Numberphile Podcast Transcript
Episode: Crystal Balls and Coronavirus - with Hannah Fry
Episode Released April 10 2020

Dr Hannah Fry made a film two years ago which predicted the coronavirus pandemic with chilling accuracy.

Dr Hannah Fry's website - links to all her stuff

The BBC Contagion special on iPlayer

If it doesn't work on iPlayer, this is a version I found on YouTube!?

Numberphile video about the SIR curve with Ben Sparks

Numberphile discusses coronavirus mathematics with Kit Yates

False Positives on Numberphile with Lisa Goldberg

PAPER: Contacts in context: large-scale setting-specific social mixing matrices from the BBC Pandemic project

PAPER: Contagion! The BBC Four Pandemic – The model behind the documentary

BBC Horizon Coronavirus Special - the more recent film Hannah made with the Beeb

RI Christmas Lectures 2019: Secrets and lies

Mathematician/epidemiologist Adam Kucharski on Twitter

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Direct Download: https://www.numberphile.com/podcast/hannah-fry-coronavirus
Listen on Numberphile2: https://youtu.be/Xkqtcm3w7Vw

[gentle synthesizer music]

Brady Haran [BH]: I expect a lot you will know Dr. Hannah Fry. She's always a popular figure in Numberphile videos and she's also been here on the podcast before talking about her life and research, but what you might not know, is that in 2018 she hosted a special program on the BBC all about pandemics. [music continues] The show told us of a looming crisis, it even foretold a spiky looking flu-virus that would mutate, start in Southeast Asia and spread through the world with astonishing speed and devastating effect. It would take lives and alter our way of life. [music continues] It wasn't a matter of if, but when. Two years later and unfortunately the BBC and Hannah have been making, well, a sequel of sort and this time, it's for real. [music continues] Today's Hannah's sharing some of her thoughts about the current pandemic and why innocent mathematicians will probably end up getting some of the blame.

[music fades up and out]

BH: Hannah, last week I had hoped to be in London filming a Numberphile with you.

Hannah Fry [HF]: [laughs]

BH: And instead I'm stuck at home and I believe you're sitting in a car?

HF: [laughs] This is what our lives have become. [laughs]

BH: Tell me why you're in a car?

HF: Well, [laughs] because my children are… well, they're making my life extremely difficult.

BH: [laughs]

HF: I mean they're very lovely and I think in a lot of ways very lucky that… lockdown is made easier by their joyful laughter.

BH: Yeah.

HF: Unfortunately it's simultaneously made much more difficult by their unjoyful screaming. [laughs]

BH: They don't appreciate studio discipline?

HF: They just don't… they don't have any respect.

BH: No. [laughs]

HF: They don't have any respect for this kind of… this kind of output, Brady, and, you know.

BH: So the car has become like your home office has it?

HF: Yeah, I know it's so… [laughs] it's so pathetic, but every morning I'm like packing my rucksack, putting in my little pack lunch, putting in my little drink…

BH: Yeah?

HF: Gettin' my coffee in the takeaway cup and off I go to the car.

BH: [laughs]

HF: So… thus far I've been doing sort of four to six hour shifts but now it's getting quite warm and [laughs] the car's really hot. So…

BH: Yeah.

HF: I think I need a different solution.

BH: I can hear loads of birds in the background too, it sounds quite lovely in someways.

HF: I know, you know, I am actually in London so… I think…

BH: Yeah?

HF: …just they're normally drowned out by the sound of traffic. It's alright, I'm definitely in a lot better position than a lot of people I think, during lockdown, so I'm feeling quite fortunate and grateful to even have a car to be able to go and sit in.

[pause]

BH: So Hannah, a few weeks ago, before things got really serious here in the UK, I watched the Hollywood movie Contagion.

HF: Mhm.

BH: A lot of people have been watching that. And there's a… and a lot of people are watching it thinking, oh this is so prescient, there's so much sort of I Told You So about it.

HF: Hmm.

BH: Well, about an hour and a half ago…

HF: [laughs]

BH: …I watched another film called Contagion that was made by BBC Four, a great team of people…

HF: Mhm.

BH: …you are the presenter of it.

HF: I certainly am.

BH: It was broadcast in 2018 and that is crazy prescient, like it's almost like a joke…

HF: Yeah.

BH: …how much everything in that documentary and all the things you talked about, have kind of… are being exactly duplicated now.

HF: It's quite spooky, isn't it?

BH: Before we talk about it, for people who haven't seen 2018 film that you guys made on BBC Four, can you give like an executive summary of it so people can sort of get an idea of what we're talking about.

HF: So yeah, yeah. So, okay the thing is the thing is that everyone knew that something like this was coming. Everyone knew that something like this wasn't just… it was inevitable essentially.

BH: Hmm.

HF: And we knew that when it finally came we need to be as prepared as possible. You only get one shot at this. You don't get to rerun it and try and do a better job the second time. You only get one shot at it. So we needed to be

prepared as possible, and part of being prepared is having mathematical models that will accurately tell you what will change if you apply some kind of intervention like shutting down the schools or telling people to stay at home, that kind of thing.

BH: Hmm.

HF: The problem is, is that those mathematical models, they're completely based on our understanding of how people move around, how people come into contact with one another, how often people come into contact with one another, and the best possible data that we had at that point in time, in 2017, 2018 when we did this program, the best data we had for how people move around in the country was a paper survey that was conducted in 2006…

BH: Hmm.

HF: …where they asked a thousand people, oh, how many people do you reckon you've been in contact with recently? Which is just given that everyone's carrying mobile phones is like… the maddest maddest gap in our understanding of people. So the whole idea behind this program was that we asked the public to take part in this citizen science experiment where they download an app on the phones, they'd let us track them for twenty-four hours and we'd run a simulation essentially of what would happen if a flu like virus hit the UK and what that would mean and how fast it would spend and how many people would end up being sick because of it, and… yeah… I mean I didn't really expect it to be two years later, but here we are.

BH: I might even sneakily play a few clips from it.

HF: Hmm.

BH: Just to give people an indication of how like, all these things you're

saying about, you know, obviously it's, you know, it's not a matter of if but when and… it's… you know… they're even saying, it's gonna come from Southeast Asia.

HF: Hmm.

BH: This is what's gonna happen. This is what's gonna look like. This is what people are gonna have to do and it's like… part of me thought, did they recut this or reedit this like…?

HF: No, no. I think the only thing about it though. We're quite jolly about the whole thing [laughs] during the program. [laughs]

BH: Yes. Yeah…

HF: Like, it's quite playful so I remember doing, you know, at the time when we get people to download the app, I got loads of like messages from people who were sort of playing along and it was like this big game.

BH: Yeah.

HF: I got this one message from someone who was like, oh just downloaded the app, and like went and infected half of Sheffield Shopping Center, lol.

BH: Yeah.

HF: I think that you really, yeah, when you… if you do watch it back there's that innocent tone of it, that it is all this big game…

BH: Yeah.

HF: And it really isn't.

[gentle violin music]

[clip from BBC Pandemic playing, various speakers and background music]: With the help of thousand of volunteers we are about to simulate the outbreak of a fatale contagion throughout the UK. [street noise] That might seem like a funny thing to want to do, but if I can succeed, this will save lives when not if, a real pandemic hits. [clip switches speaker] The UK government puts pandemic flu at the top of this risk register, the reason for that is it will happen. There will be another pandemic.

[clip ends]
[gentle violin music]

BH: When you were like… reading some of those script lines or delivering some of those script lines like… did you seriously think it was a serious as what you were saying? 'Cause it's almost like… you know… like you said like two years later it's all happening for real.

HF: Yeah. I think the big surprise about this one, is not like these haven't happened before, you know, this… when we filmed it two years ago, SARS and MERS were in recent memory, Swine Flu of course as well, very recent…

BH: Hmm.

HF: You know Ebola too. It's not like there weren't recent examples of this, this exact thing happening. I think the thing that's been surprising about this one isn't so much that the virus jumped from… you know… jumped from a different species into humans. That step was… is almost, you know, it's inevitable really, it's a random act of nature but it will happen… it will happen again, this is not the last time it's gonna happen. I think what's been surprising about this one is that it sort of somewhere in the middle. So SARS and MERS were very very

deadly. But they also were… everyone who got sick got symptoms, and so actually it was comparatively quite easy to contain, you could spot where people were sick, you could isolate them, you could do contact tracing…

BH: Hmm.

HF: You could draw a ring around it, essentially, and lock it down. And then at the other end of the spectrum you have something like flu, which is, you know, I mean you can't really stop flu at all. I think the thing about this virus is that… in a lot of ways it's just on that cusp of being able to stop of it, you're… you're… [stutters] it just about has about enough, you know, symptomatic cases that you can feel like you can stop it, but I think, you know, actually it's proving to really slip… I think you cannot treat this in the same way as you can with sort of SARS, MERS and Ebola. I think it's just… yeah… it's frustratingly in the middle, really where it feels like you can just about contain it but perhaps it's always gonna slip through your fingers.

BH: Do you think that's why one thing that's seems to be kind of missing from your 2018 film is the incredible importance that seems to have arisen now of testing to get the data? 'Cause you said like, with those other ones you almost didn't need to test. If the person was really really sick, you knew they had it, and if they weren't sick, well they probably didn't.

HF: Hmm.

BH: Whereas because we're in this gray area with the coronavirus, testing has become this thing that everybody wants. And you never really talked about testing in the 2018 special, like it was sort of…

HF: No, we didn't, you're right. We didn't. I think yeah, there is this pressure on testing at the moment. I mean I kind of think I'm sort of… I want to be very optimistic because a lot of people are looking at testing as this sort of green

shoots of hope for all of this, for how to get us out of lockdown.

BH: Hmm.

HF: But if you can have tests across the country, wherever can test themselves on a regular basis, can work out whether they have immunity or, you know, have had the virus or are currently sick with the virus and then you can allow people who are okay to go out and so on and so on and so on. I think you know, that's one of the things that people are really looking forward to. I'm just a bit concerned… about that as an approach. Not only for the biological reasons and the practical reasons of getting those tests manufactured and out, you know, as quickly as you can. Much more for a mathematical reason. Which is that… [sighs] this is really where false negatives become a massive problem, right?

BH: Right.

HF: So one of the tests that I've been looking at recently for another program with the BBC is a home test that's ninety percent accurate. And that sounds like it's really positive. That sounds pretty positive. Ninety percent accurate sounds amazing.

BH: Hmm.

HF: Problem with that, it's like the classic story about picking up on… on breast cancer diagnosis which is that if you have a test that's ninety percent accurate and the test says that you do not have the virus… the chances that you do not have the virus are not ninety percent. Like that's the wrong way to interpret those numbers. We did this actually… Matt Parker and I did this during the Christmas Lectures…

BH: Mhm.

HF: Just to illustrate this really counter-intuitive nature of false positives and false negatives, when all you have to go on is accuracy rates and just it all depends on how common it is in the population, just the numbers… the numbers don't make good intuitive sense. But the thing is, is that if you are missing… if you… there's this strange asymmetry with this virus, right?

BH: Hmm.

HF: Which is that if you even have one person in your… in the country who is wandering around with the virus and doesn't know that they have it, we effectively have to treat everyone in the country as though they are infected.

BH: Right.

HF: And so unless you have a test that is one hundred percent accurate you will still have this virus that's circulating.

BH: And everyone's taking the test. [laughs]

HF: And everyone's taking the test.

BH: Yeah, yeah.

HF: I mean also, not being funny, right, this test, the one that's ninety percent accurate, requires a nasal swab, right? I don't know if you've ever had a nasal swab.

BH: Hmm.

HF: It is not a pleasant experience.

BH: I read about it, it looks like you gotta stick the thing right back into your

brain.

HF: Yep, like… I mean pretty much, right. And with… there is some instances in hospitals where nurses, you know, perfectly well trained nurses are taking nasal swabs and their getting forty percent false negatives because they're not just managing to get enough the correct… molecules and particles and whatever, that you need for these tests.

BH: Yeah?

HF: And then you're expecting people to do this to themselves at home? I mean… there's no way that you're not gonna get cases slip through the net.

BH: Yeah.

HF: And I think that that's okay. I mean I still think that there's value in all of this stuff, in slowing down the spread. I just right now, I can't see that we can… we can crush this thing. I think we can slow it down certainly but I think that unless we get very good at something or unless a vaccine comes along very very quickly… I think that all of the really positive things on the horizon will only take us so far in slowing it down.

BH: Hannah another thing about the 2018 special, I'm not gonna sit here and pick holes in it…

HF: [chuckles]

BH: …because as I said it was amazingly predictive.

HF: [laughs]

BH: But…

HF: You can, Brady, it's okay, you can.

BH: [chuckles] Throughout the special one of the things that is portrayed as that possible silver bullet is vaccines. There's almost a very hopeful tone about vaccines. It is tempered by the timeframes involved but you're always talking about if we vaccinate these people everything'll be alright or if we develop this vaccine in four months, this'll be alright. But it seems like now that the reality has happened, vaccine seems a long way off and seems not a big part of the discussion at the moment.

HF: [sighs] Yeah. I mean I think that it's… some people have latched onto this idea of a twelve month time scale. I just… I don't know. Ebola took five years, right? [sighs] [laughs] I don't know. I just don't… I just don't know. Maybe I'm just being… [laughs] maybe you've caught me on a particularly [laughs] depressive day.

BH: Yeah.

HF: But I… just don't know if… I… don't know if it's likely for us to think that it's gonna come in and save us.

BH: Even with like all the world's sort of resources?

HF: Yeah I mean… and that's a really good point. That is a really good point. It's not just like you've got one research lab in, you know, in somewhere in Britain looking into this, you have… a huge monumental effort from all of the world's scientists and I think that actually… the pace of scientific change that we've seen in even the last two months is something that… I mean I've never… I've never witnessed it before. You know people publishing preprint papers on archives, you know, online, and then getting comments from all people all around the world and then incorporating those comments into their papers, you

know, before it even goes through this… normally snail's pace peer review process, I think has been really really exciting. So okay, maybe I'm… maybe I'm being a bit too pessimistic. I think it's also worth adding though that, you know, Western countries don't get to jump the queue in this and even if a vaccine pops up in an extremely optimistic way, even if a vaccine pops up, you still got to manufacture enough of it, I mean there are… what seven billion in the world? And I don't think that we get to just jump the queue.

BH: In a very morbid way, this feels like a little… golden era for mathematicians?

HF: [laughs]

BH: Like, it's strange isn't it? Suddenly like mathematicians are like in a practical way being treated really important and being… being listened to.

HF: [laughs] Yeah.

BH: Is that a fair comment? [laughs]

HF: It's true, well no I think it is. Having mathematicians on the front page of the newspapers regularly is pretty extraordinary, isn't it?

BH: Yeah.

HF: I did think that actually. Like… the Today program asked me to go on a couple of weeks ago. I was… I dunno, the Today program could be bit of a stressful thing…

BH: Yeah.

HF: …for various reasons it can be quite a stressful thing and I was like

tempted to say no, and then I was talking to my husband about it and he was like, you spend your entire life going on how important maths is and how fundamental it is to the way that we make decisions and our understanding of the world and here is the number one example of all time ever of how important maths is, if you don't go on and talk about it then like, you can't really, you know, it sort of goes against everything you stand for which I think is true. Which I think is true. So I went on, anyway.

BH: Alright. How did it go? Alright?

HF: It was very stressful. [laughs]

BH: [laughs] So we hear about this SIR model and seems to have these three things as I understand it. I've made a couple of videos about it already.

HF: Mhm, yeah I've seen them, they're amazing.

BH: Who's got it, who hasn't got it…

HF: Mhm.

BH: …and who's already had it.

HF: Mhm.

BH: Obviously there's a lot more subtlety to these models and complications and watching your special I see them putting some fancy equations on the screen as eye candy that I don't really understand.

HF: Mhm.

BH: Can you somehow give me an idea… as to what levers and buttons are

going into these models that aren't talked about when we do these basic things like who's got it, who hasn't got it, can we get this R zero number down? What's some of the more, for lack of a better word to use a favorite word of yours, what's some of the more delicious mathematics that's going into it?

HF: [laughs]

BH: Like what are these things I'm not seeing? Can you give me just like a taste of that?

HF: Yeah, totally. Okay so, on the standard SIR model, you're assuming that the population is well mixed.

BH: Hmm.

HF: And then there are other versions, like the Washington Post had a really nice example of where you essentially have, it's like particles in a box bumping into each other.

BH: Yes, yes.

HF: Which is also really nice, but in reality people don't… people are not uniformly mixed… you know, it's… and we're not particles in a box bumping around into each other. So…

BH: Yeah.

HF: So one of the things that goes into these models is this… is social mixing. So it's how we're coming into contact with other people and you can go into a lot of detail about that, you can take age categories and what age groups are mixing with what age groups and then there's, you know, geographical… population densities and so on. All of that stuff can come into it.

BH: Hmm.

HF: But I think for me the key thing, especially at the point we're at right now, Adam Kucharski's got this really nice way of summarizing it, and he calls it the DOTS. It all comes down to these are the levels that you have to change the trajectory of a disease, of an outbreak, so D is the duration, so that is essentially how long you are infectious for. So, O is opportunity, so that's how many people you come into contact with. T is the transmission probability, so when you're in contact with somebody what are the chances if you are infected that you pass it on. And then S is the susceptibility, so how susceptible the population is. So the big ones at the moment, you can't change duration, you can't change how long people are infectious for, and there's very little to do with, you know, without a vaccine there's very little we can do apart from, you know, just letting everyone get it, which is, I think, not an ideal solution. I mean you can't do anything about the susceptible… how susceptible the population is.

BH: Hmm.

HF: But opportunity and transmission probability are the two things that you can change. These are things that you could… that are then quantified and can be put into the models [voice in the background]. But… so opportunity really is how many people you come into contact with.

BH: Hmm.

HF: That's essentially why we're in lockdown. And then the transmission probability, that's where things like staying two meters away from someone…

BH: Hmm.

HF: Washing down your shopping as it comes in and… you know wearing

masks, all of that kind of stuff comes in. But these things are then translated into a mathematical description and put into these models.

BH: So when the mathematicians play with these models and simulate things and come up with what they think's going on, how much subtlety can they then use in the… the tools that they give to government, like it seems very blunt instrument at the moment? It seems like, alright, now everyone's locked away, now everyone can come out. Or now we're closing the schools, or now we can't, or this is how many hospital beds we need. Is there anymore subtle advice that they can give to the government to sort of slightly tweak things or is it always this sort of black or white? Okay, lock everyone up.

HF: Yeah.

BH: Okay, now they can come out in June or July or whatever.

HF: Yeah, I mean I think you've hit the nail on the head really which is that this all comes down to the R naught, which Ben Sparks did a brilliant explanation of in your Numberphile video. But essentially the number of people one person goes on to infect. If it's above one, the outbreak is growing and if it's below one, it's declining.

BH: Yeah.

HF: And exactly as you said, if we were full lockdown, so the moment the current situation with the UK, the best estimate that I've seen for the current R naught is naught point six two, which means that the outbreak is declining. We're not seeing that in the data yet, because, there's an inevitable lag in the numbers, and if you don't do anything. If you don't have any social distancing, if you don't do anything at all, it looks like the R naught of coronavirus is around two point five. So…

BH: Hmm.

HF: But between naught point six two, lockdown, no one's allowed out of their houses apart from once a day, and two point five, there's quite a lot of room in terms of the numbers. And what you really want to do is you want to find something which allows people to have some sense of normality but without letting this thing go out of control, really. I think there is still some people who want to stay in lockdown long enough until the disease goes away and personally I think that that is… just… going to be difficult. [laughs]

BH: Right.

HF: I think it's gonna be difficult in terms of, I don't think you can make this thing go away, even on lockdown there are enough people out, you know, key workers and people flouting the rules too, let's be honest, where I don't think you're gonna get it to go away completely for a very very long time.

BH: Yeah.

HF: And I think secondly there are two ways that people can die here, I think people can die from the virus, and I also think that people die from the lockdown, you know? There are cancer patients who've had their chemotherapy postponed. There was… during Ebola, in Sierra Leone, there was a massive spike in the number of maternal deaths, just because women were not accessing hospitals in the same way. And for every maternal death, there are numerous infant deaths that just won't be recorded in the same way. And I think that we… if we try and stamp this thing out completely completely completely, then I think that, you know, you can end up causing deaths in another way unintentionally. Lockdown itself is sort of deeply problematic. But I think the ideal, what you want to do… [sighs] is you want to slowly, you know, release the lockdown bit by bit by bit, so you are never going up to that R naught of two point five but you're hopefully finding a kind of… a middle ground. And that's essentially

what they're trying to do in Sweden, right? So Sweden and Norway, I don't know if you've been following this story but, you know, two countries right next to each other, they've got very different approaches. Norway's going for the shut it down, suppress it as much as you possibly can, and Sweden's going much for the, let's definitely take steps, they've closed universities, they've banned gatherings of over fifty people, so it's not like they're not doing anything…

BH: Hmm.

HF: But they are trying to maintain as much of a sense of normality as they can while keeping the virus under… you know without letting it have completely uncontrolled spread.

BH: Does that mean they're going down this herd immunity route or is it more just they don't want people going out of their minds?

HF: You know, I just have a slightly have a problem with the herd immunity as though that characterization as though that's the objective.

BH: Hmm.

HF: I think that it's a consequence rather than the… hmm… the objective. Oh… gosh. [laughs]

BH: I'll come back to herd immunity in a moment.

HF: Okay, okay.

BH: 'Cause… I have got… I do wanna ask you about that. A question just popped into my head actually. You were talking about these kind of this other problem, these other deaths that can happen. These other consequences…

HF: Hmm.

BH: …as a result of lockdown. Are mathematicians modeling that too?

HF: I think that people are starting to look into, yeah, the consequences of lockdown.

BH: Yeah?

HF: It's really hard to do though because…

BH: Yeah.

HF: …a death from coronavirus, well actually there is uncertainty around the deaths too, but you are more able to point at a death from coronavirus and say, that the virus is what caused this death.

BH: Yeah.

HF: Whereas the consequences of lockdown, you know, I think Austerity for example, there's lots and lots of evidence that says that Austerity was the direct cause… or indirect I suppose, cause of a huge number of deaths within the UK and…

BH: Yeah.

HF: But you can't really… it's really hard to point at something and say, poverty is the reason why this person died. Despite the fact that poverty actually is a cause of huge number of deaths worldwide every single year, you know, if there's someone who right now has got, you know, a lump perhaps, that they're a bit… they've noticed but they're like, oh I'll just wait until after the lockdown.

BH: Yeah.

HF: Before going to see the doctor, because it's going to be very difficult to get a doctor's appointment, I don't really wanna go and, you know, visit a hospital et cetera at the moment.

BH: Yeah.

HF: And if they put that off, by the time they get it seen to actually it's too late, you know that's definitely a consequence of lockdown, but it's really hard to point at it later down the line and say that's what caused it.

BH: Yeah.

HF: Do you see what I mean?

BH: Yeah.

HF: So these things are really difficult to quantify, but I think that there are really serious consequences of this and think that's even in a country like Britain who is very wealthy, comparatively to certain parts of the world, very well able to handle this stuff. I think when you think about places like South Africa, you know, locking down in South Africa where it's just… there's really very… I mean so they've actually canceled the vaccination program of measles, rubella, I think they've started canceling polio as well, in certain parts of Africa, in response to try and to lockdown for this virus.

BH: Hmm.

HF: And it's just like there are consequences to this stuff, it's not, you know this isn't just a… this isn't a choice of, as some people are characterizing it, lives versus money, it's really not like that, it's lives versus lives.

[gentle violin music]

BH: So Hannah has now retired inside, she's left the home office because of heat and battery issues so, wish us luck. So I feel like, like a lot of people at the moment have some degree of fear. People are a bit scared, which is completely understandable.

HF: Mhm

BH: Do you feel like, mathematicians, people who understand this at a different level, are more scared or less scared? Do you think you're more or less scared than…

HF: Ooh.

BH: …someone who has no real mathematical comprehension of how pandemics work?

HF: I think I was definitely more scared earlier.

BH: Hmm.

HF: I think that the, yeah, I think that the mathematical modelers and the immunologists and the virologists, I think that they had that period of like, oh holy hell…

BH: Hmm.

HF: …in like, January, February. But I also think that actually, broadly speaking I think it's a bit easier to rationalize it and to be honest I certainly think for myself, I'm not concerned. I'm not really that concerned. David Spiegelhalter

did a really brilliant piece of analysis where he looked at your risk of dying from the coronavirus…

BH: Hmm.

HF: …and essentially calculated that it was equivalent to your risk of dying over the next year. So it's like you have one year's worth of risk in one go.

BH: Right.

HF: In a couple of weeks, or, you know, across the course of two or three weeks. So that means if you're very young, you know, if you would not be concerned about dying over the course of the next year then you don't particularly need to be concerned about dying over the course of… of the virus if you get it.

BH: Hmm.

HF: Of course inevitably as you go older that that risk increases, but I think that even not even there the numbers are actually… are perhaps less frightening I think than sometimes they come across in the media, because, you know, for instance, if you're over eighty and therefore the highest risk group of this particular virus, your chances of survival are still eighty-five percent.

BH: Hmm.

HF: Which actually, I mean, it's not great, I mean you wouldn't choose it but eighty-five percent is still good solid odds.

BH: Yeah.

HF: You know, at sort of beating it.

BH: Yeah.

HF: So I think that… I mean that doesn't… it'd probably be a horrible experience and I'm sure that for every person who very sadly dies from this thing there are numerous other people who have a very very horrible time of it.

BH: Yeah.

HF: But… I think that having those sort of mathematical skills enables you to put those numbers into slightly more context.

BH: Well you lead nicely into my next question then. Because…

HF: You're welcome.

BH: [laughs]

HF: [laughs]

BH: I often hear mathematicians bemoan the lack of mathematical literacy in society.

HF: Hmm.

BH: And even during this pandemic you've heard it, oh if only people understood exponentials better and things like that they'd really how serious this is and what not and I wonder whether or not you think if society was more mathematically literal that would necessarily be a really good thing at the moment? Because, I wonder if they could gauge the risks and understood the numbers better they might be a bit more cavalier with their social distancing and their lockdowns and their quarantines because they would see things differently,

it would be a more considered risk. Whereas at the moment…

HF: Yeah.

BH: …if you're living in this like irrational fear, at least you're gonna stay inside and help the cause.

HF: Yeah, I mean that's true in some ways… the fear is useful in that it makes people pay attention to the rules, but then I also think that actually that fear has a real downside as well. I don't know if you've been following this sort of 5G stuff.

BH: Oh yeah.

HF: So, there's someone who I know very well and very close to who… has bought into the 5G stuff.

BH: Right.

HF: To my endless frustration.

BH: For people who don't know, this is this weird conspiracy theory that…

HF: Yeah.

BH: 5G networks are somehow contributing to… the problem or causing the problem or…

HF: Yeah. It's like a government conspiracy. I mean I don't totally understand all of it.

BH: Yeah.

HF: But I think it's something to do with fascism and something to do with David Icke… not sure.

BH: Right. [laughs]

HF: [laughs] Bit sick of him.

BH: Yeah.

HF: But I think, gosh, I just think in a way, I think I understand why people are turning to that in so… in such numbers because I think that the real truth of this is really scary, right? This is a random act of nature that no one can do anything about and I think to think in a conspiracy theory gives you someone to blame. It gives you a person that you can point to and it lets you believe that humans are still in charge. That we're not just part of this, you know, this natural world and the consequences of which we have to sort of… stomach at some point or another. And I think… so in a way I think that, although I take your point about if people had more mathematical literacy maybe they would be so scared but then I think if people weren't so scared they wouldn't also believe…

BH: Yeah.

HF: …in this really dangerous stuff. That actually has the same consequence, right? That people are breaking the lockdown as a result of it to go and burn 5G towers. So, I dunno. I've also actually I've gotta be honest with you, I've been super impressed with the public. I mean on Twitter, and Instagram and stuff, everyday you've got people arguing about the difference between linear and log graphs… like log axes.

BH: Oh.

HF: I just think that's… I really like that.

BH: Don't start me on that.

HF: [laughs]

BH: By the way, just for the sake of clarity as the maker of Numberphile, I'm not advocating like… mathematical ignorance in society as a useful tool. I just…

HF: No. [laughs]

BH: [laughs] I…

HF: You've sort of done more…

BH: [laughs]

HF: …to go against mathematical ignorance in society than pretty much anyone on earth, Brady. So I think it would be a strange position for you to take. [laughs]

BH: Alright, seeing you brought it up. I think these graphs with log scales on the Y axis are bad.

HF: Oh! Okay. Go on.

BH: I think they lull people into a false sense of security when they see a nice gentle slope not realizing what they're actually looking at is this god awful exponential curve that's shooting up into the sky like the red arrows.

HF: Oh that's interesting.

BH: Mhm.

HF: So you… oh okay… that's interesting. But the… okay… the thing is, is that you can't really tell what's going on, on a linear…

BH: I know!

HF: …graph, right?

BH: I know! And I know that's why you do it.

HF: I mean you can't really tell what's going on.

BH: And I know that's why you do it and I know that's a useful tool for mathematicians and people who can look at that and in a second, you know transfer it in their head.

HF: Get it.

BH: But I think when you're printing them in newspapers and websites and people seeing Italy and America and the UK and they've all got these very similar just slightly differing diagonal slopes people are thinking, oh it's all the same everywhere and it's all quite gentle when in fact what they're looking at is something that should be scaring the bejesus out of them.

HF: But they're still seeing the numbers, though.

BH: Yeah.

HF: I think if somebody…

BH: Yeah.

HF: …if somebody struggled to read a graph or let me rephrase that. I think if somebody took a gentle slope on a log axis as though it was like, oh it's nice and gentle, surely they would also see the number a thousand a day, which is where we are, you know…

BH: Yeah.

HF: …right now recording this. I'm sure it'll be a different number by the time anyone listens to this, but surely they'll see that number and realize that, oh no this is really is like very scary.

BH: Yeah? Okay.

HF: I dunno. I guess that's… well you know what we need to do? We need to do a study.

BH: [laughs]

HF: We need to ask people. [laughs]

BH: I think there are higher priorities right now than a… but… but…

HF: [laughs]

BH: Let's save that one for later. Let me ask you about something else that I know you have some interest in. Data and privacy. My…

HF: Hmm.

BH: My sister lives in Singapore and she was telling me about what happens there…

HF: Mhm.

BH: …when someone, when they have problems. And what they can do there quite easily is if someone tests positive they can look at what taxis they've caught, who was sitting in that same taxi in the last two or three hours…

HF: [chuckles]

BH: …they can contact those people and warn them and isolate those people and having access to all this data lets them put out the fires very quickly. Obviously…

HF: Hmm.

BH: …this rings massive alarm bells in everyone's heads, including mine, who are used to sort of this…

HF: Mhm.

BH: …you know, data privacy issues. But it does seem like having more access data does let you deal with pandemics better. You're 2018 film demonstrated that brilliantly although you anonymized everything and made a big point of saying you had.

HF: Hmm.

BH: It did show that if you have this information you can do all sorts of things. You can figure who's spreading what, you can vaccinate those people, control those people, you have a lot more weaponry to save lives. Where do you come down on this? What do you feel about this?

HF: You do have a lot more weaponry. I think you just have to decide what

kind of society you wanna live in, really. Because I mean you're absolutely right that China, and… South Korea and Singapore, in terms of the way that they've managed to deal with this virus, let me just put a little asterisk by deal with and come back to that in a moment.

BH: [laughs]

HF: But it's completely different to what's happened in Europe, right? Like the, you know, the particular Singapore and South Korea have managed to slow the rate of infection much quicker than we have within Europe.

BH: Yeah.

HF: And all of the sort of technological reasons that you mention are a really important part of that. I just think that we have to be careful when you make decisions that you are not making them in a quick response to an emergency… a decision that you will later regret.

BH: Hmm.

HF: In this particular culture, I mean I'm not one way or the other, right? Like, I can definitely definitely see the real benefit of a centralized system right now where you know where people are and you know who's sick and those pieces of information are joined up. And the way that things are in Britain at the moment is that it's very difficult to connect those dots, because no one really wants the government to tell a company like, you know, Google or Facebook or whoever, who's sick. No one is really like up for that data be passed in that direction. And simultaneously all the companies who have the data of where we are, I don't think people particularly want the government where we are all are at any point in time, either.

BH: Yeah.

HF: So it's like in both directions no one really wants that flow of information. Which is why the apps that are being explored now work on bluetooth rather than on GPS. They work on your proximity to other devices, rather than necessarily exactly where you are, just to try and help get around a few of those privacy issues.

BH: Yeah.

HF: But the thing is, is that… I think in this urgency to try and save people's lives, because that's ultimately what we're talking about here, I can just see that slight knee-jerk reactions which we come to regret later and I think that we just need to be careful about that. I mean I think we've seen that in Hungary a bit actually, in a more political way, of people using the situation to make sensible decision for the situation but actually we'll be difficult to be reversed later. But I also actually wanna go back to that sort of the fact that Singapore and South Korea have been able to deal with this virus.

BH: Hmm?

HF: You know Singapore have lockdown again, right? So…

BH: Yeah.

HF: Ultimately what all of this technology has enabled them to do is to elongate the gap between their lockdowns. It hasn't got rid of the virus all together, and they've done all kinds of incredible things, you know, including quarantining anyone who comes into the country for two weeks, you know, mass testing, all sorts of stuff, all sorts of really clever stuff, and they still haven't been able to fight the tide of this thing coming in. And I think that that really is a… there's a difficult lesson in there

BH: Hannah talking to you about your research, you know, a few times over the years, 'cause even your normal research often deals with taking humans and groups and society and attaching numbers and graphs to thing…

HF: Mhm.

BH: …and then analyzing it and obviously we've seen a lot of that happening over the last few weeks with the pandemic.

HF: Mhm.

BH: I always wonder how dehumanizing people and turning them into numbers and graphs, is that really good way to be making decision because it takes like… it makes your decisions more rational and less emotional, or is that a really bad way to make decisions because it takes away that constant thought that these are humans with lives and loved ones and families? We saw this obviously when the whole herd immunity thing came up.

HF: Mhm.

BH: You know just treating people like, okay, if we let this percentage of people get it this could be good. Forgetting that you're kind of give… [chuckles] people will be sick and dying as a result of it.

HF: Yeah that's peoples mums and dads and daughters and brothers and sisters that are dying. Yeah, yeah I agree.

BH: How do you reconcile this? Because part of you has to make decision for the good of the many and treat it mathematical but part of you has to be like you know a compassionate human.

HF: [sighs] You know I mean in a way you are… [laughs] you're like

describing one of the sort deep philosophical arguments, right? There's sort of like Bentham's, like, utilitarianism and all of that, that's essentially what you're describing in a way. I mean I think that actually… I think it's not one or the other, it can be both a good thing and a bad thing to think of people as numbers on a page. I think that you in some ways actually being able to be removed in a kind of and look at things statistically, I think that does allow you to see the… to see the rationale of different decisions in a clearer light. I think that's one thing. I think if you, yeah being in that, being unemotional I think allows you to compare different interventions in a better way, or in a clearer way. But I also think that if you totally and completely rely on the numbers, then you're forgetting that we are human, which, you know, has been one of my big arguments for the last… sort of that's, you know, my last book was essentially all about that. Like you cannot throw away the fact that we are human when you think of us in a mathematical way.

BH: Hmm.

HF: But I also think that it what it does do, is it puts too much faith in the mathematical models because these things they're not crystal balls, right? They're not… they're not telling us what the future is going to look like, there is all kinds of uncertainty wrapped around them, and I think that you have to be careful when you are creating mathematical models, not dismiss them as junk, but also not to think that they are these magical things that allow you to peer into the future. You have to… they have to be part of a suite of evidence that allows you to get you… towards the best decision possible.

BH: Hannah throughout your contagion special on BBC back in 2018 there was this number emblazoned on the screen several times. It was like this magic number, of the number of people that would die in the UK, if we had a really bad pandemic.

HF: Mhm. Hmm.

BH: This was two years ago.

HF: Yeah.

BH: It was based on the modeling you'd all done, it was 886,877.

HF: [sighs]

BH: I wrote it down 'cause it was on the screen so many times.

HF: Hmm.

BH: What do you think about that number now?

HF: I really… don't know. I mean I think that the number is gonna be smaller, right? It will definitely be smaller than that.

BH: Right.

HF: So this, I think is a perfect illustration of what I mean about the uncertainty around the numbers.

BH: Yeah.

HF: Around like the mathematical… what the maths say. Because… the estimates for the fatality rate of this virus, they vary wildly.

BH: Yeah.

HF: And it depends on the situation which you look at. So if you look at the cruise ship for example, where I think the fatality rate there was about one

percent or so.

BH: Yeah.

HF: You could take that as though it was a fact and in many ways actually the numbers that have been thrown around in the paper… the papers are sort of based on around that idea, that a certain percentage of the British population will get it and around one percent of those will die, so if we did… if we did nothing, five hundred thousand is the number that has been…

BH: Hmm.

HF: …that has been calculated and quoted widely.

BH: Yeah.

HF: But the thing is, is that the cruise ship actually had a population that skewed much older and we already know that older people tend to be more at risk than others. There's also you know… so evidence from other places are that perhaps this number can be a bit lower but until we have the testing, until we know what the real denominator is, until we know how many people have this virus and aren't symptomatic, how many people have had this virus and didn't even know they had the virus, we really don't know what that real number is. We really don't know what the real fatality rate is. Which is why testing is so incredibly important. But I think that… [sighs] I don't know… I mean that I think that I really really hope that we get better at something, slow this down enough that a vaccine comes along or that something else comes in and yeah helps us to minimize the number of deaths as far as possible.

BH: I know you've just recently recorded sort of another… another thing with the BBC. I dunno if it's a sequel or a follow up.

HF: Mhm.

BH: Making this… sequel… about two years later, almost exactly two years later actually now that I think about it.

HF: Yeah. Yeah it is.

BH: Just over. What's different? What did you learn or how is your thinking change from when you were doing it as a, this is gonna happen one day, slightly jolly special to kind of making something in the middle of it? Like what's different, beyond the obvious?

HF: Yeah. [laughs]

BH: Yeah.

HF: Well okay when I filmed that first one, I became certainly for a period of time… I became very cautious about germs. [chuckles]

BH: Right?

HF: So there was one occasion where my mum and dad had flu and I had a big project coming up and I really did not want to get sick and I also had a baby in the house, so I… yeah my mum and dad wanted to come to my house. They were like driving past and they wanted to come to my house and drop off something.

BH: Hmm.

HF: And I made them [laughs]… I made them post it through the letter box and I wouldn't let them in my house. [chuckles]

BH: And this was two years ago?

HF: This is two years ago form the upstairs window, like I opened the upstairs window and was like, Hi! Like… [laughs]

BH: [laughs] Yeah, yeah.

HF: Thanks for dropping off the letter! Go away now! [laughs]

BH: I mean that's just standard procedure now.

HF: Exactly, that is standard procedure now. That is standard procedure.

BH: Yeah, yeah.

HF: So in a lot of ways I think that like I… not that much has changed. So yeah I think that the first program had a similar effect on me.

BH: Yeah?

HF: But I just… yeah perhaps didn't realize it would come this quickly.

BH: From talking to you, you know obviously this is all anyone talks about, I've spoken to you today and spoke to you the other day just on the phone. I get this feeling that you have this… respect and awe for this virus and for pandemics that not everyone quite has. You feel like… despite the fact it's all pervading, and it's changed the world so much, you feel like people still aren't quite getting it. They don't get it.

HF: Hmm. [sighs] [laughs] I don't wanna depress any one. [laughs]

BH: [laughs] Okay.

HF: I don't wanna depress any one, but I think that for a while now I have thought that this virus will become just another one of the coronaviruses that regular circulates, the seasonal virus, you know like…

BH: Right?

HF: …the cold and flu.

BH: Yeah.

HF: Which essentially means that everyone will get it at some point and I haven't changed my mind on that. But that means that this is not something that's going away in the next three weeks.

BH: Yeah.

HF: Or four weeks. Or two months.

BH: Will there be a mathematical legacy to all of this?

HF: I don't know. Maybe we'll just fade back into obscurity. [laughs]

BH: [laughs]

HF: But I think, you know, a lot of ways actually I think that mathematicians are probably gonna come into a lot of blame for all of this. I think we're sort of in a position where we can't really win because I think that it's the mathematical models that are driving the decision as to when we lockdown and when we don't lockdown.

BH: Hmm.

HF: And if everything goes well, if the lockdowns go well and we save a lot of lives then I think that people will start to wonder whether the mathematical models were right and whether we needed to lockdown in the first place.

BH: Yeah.

HF: And then if the lockdowns don't work [laughs] then I think people will accuse the mathematical models of being wrong and that we needed to do more.

BH: [laughs]

HF: And I don't know if at the end of this anyone's going to step back and say, wow, thank goodness we had those mathematical models, even though I really really am grateful we've got those mathematical models.

[gentle music fades in slowly]

BH: I will. I'll thank you.

HF: You will? Thank you, Brady.

[music fades up]

BH: Our thanks to Hannah for joining us today. I'm gonna include links to her stuff and some of what she was talking about in the notes for this podcast. [music continues] Also thanks to the Mathematical Sciences Research Institute for its support of Numberphile. And finally, thanks to our patrons, you make it possible for us to keep making as many videos and podcasts as we do. [music continues] You can find a list of current patrons on the Numberphile website. You can even join them yourself by contributing at patreon.com/numberphile. I'm Brady Haran, and we'll catch you again soon.