A Very Short Introduction To… Intelligence
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Welcome to Cheltenham Science Festival@Home. My name's Ian Deary. I'm Professor of differential Psychology at the University of Edinburgh and I look after the Lothian Birth cohorts there. I and my team are interested in how and why people differ in intelligence. And our principal research is focused on the causes of people's differences in brain and cognitive aging, in simpler terms, why some people stay smarter than others as they grow old. Over the last couple of years, I've been working on an update to my book with Oxford University Press 'Intelligence a Very Short Introduction'. In fact, the previous edition was almost 20 years old and I've been updating it since then. So today, I want to walk you through that book. The style of the book is unusual for one of the very short introductions, insofar as in each chapter, I actually try and use a big data set to make the points as clearly as I can. I think it's important that readers know where people's conclusions are coming from and I'm interested in actually introducing people to the data behind some of the conclusions. I think that's especially important for the topic of intelligence, because it's something people are interested in. We value our thinking skills, a lot of people show differences and people should know where the data comes from for that. Also, it's full of more complicated areas and so some of the messages can sometimes be a bit blurred if we are further away from the data. So here's what I'm going to do. The book's got 10 chapters, I'm going to talk for about half an hour or so I can't cover all of them. But what I'm going to do is walk you through the book. And I'll be stopping at about four of the chapters to tell you some of the things that are in them. So I'll be introducing you to four datasets and some of the conclusions from them. So here we go with a very short introduction to intelligence, the even shorter version in half an hour.

So the first question I asked in my book, by the way, it's got 10 chapters, each of them tackles a big topic and intelligence. And the first of those chapters is this question. How many types of intelligence are there? Now, right now, I'm tempted to go on to my very first slide and show you the data. The problem with doing that is you cannot stop people looking at the diagram once you put it up. So I want to tell you something about it first of all. In answering the question, how many types of intelligence are there? I am going to deal with one large data set. It's the norming data set for the Wechsler adult Intelligence Scale number four United Kingdom version. Now, the reason I'm doing that is it's one of the most widely used tests of intelligence in the world. And also it shows pretty much the same results as any other battery of intelligence tests. So a few facts First of all, Wechsler when they were validating and norming this battery of intelligence tests, took 15 of the tests. What they do is they apply 15 different tests of thinking skills to a large number of people, in this case, it was about 2000 people of different ages. Now, the thing I'd like to concentrate on here is this, the 15 tests actually examine very different types of thinking skill. So for example, they've got different types of memory tests. They have tests of reasoning, some of which involve shapes, some of which involve other things, but it's largely abstract reasoning. They have several tests of speed of thinking, where people are doing pretty simple, repetitive tasks at speed. And they have some tasks and things like general knowledge and understanding words and understanding concepts. The point I'm making here is that those 15 tests, very few of which involve data and paper and pencil. Those 15 tests assess very different types of thinking skill. Now, when you looked at the 2000 people, I want you to ask yourself this question. Is it the case that being good at some of these tests was unrelated to being good at others? Or do you think that people who tend to do well one of them do well at all of the others? Well, I can tell you the straightforward answer is this, even with very, very different tests of thinking, people

who do well on one test tend it's not perfect, but tend to do well at all of the others. In other words, there is such a thing as general intelligence. Some people are just high on general intelligence and tend to do well on a whole variety of different thinking skills. Let's actually look at these thinking skills now. So this diagram, along the bottom, you see the 15 tests of the Wechsler adult Intelligence Scale number four, United Kingdom. And the important thing here is along the bottom is that, as I said, some people do well, on all the tests. However, what we also see is that some of the tests relate to each other more strongly than they do to other things. In other words, it's not just a case of people being generally intelligent. Some people have got relatively good strengths. Some people are relatively good at verbal ability, some reasoning with perceptual materials, some memory and some processing speed. But the capabilities in each of those four areas that you see here tends to be what we call correlated, the people who tend to be good. One of these also tend to be good at the other. And because they're all correlated, we psychologists extract something called general intelligence or general cognitive ability, sometimes it's just called g for general intelligence. So once again, 15 tests along the bottom, they all correlate some of them correlate more strongly than others. You get these four what we call domains of thinking. And they all correlate, and we get general intelligence. So just to finish this off, if you think to yourself, why is it that somebody is good at any one of these tests? It's for three possible reasons. One is they're just generally clever. The second is, they just happened to be good at those types of tests that you see in the four ovals below. And the third reason is that good at that specific test. So when I asked at the beginning, how many types of intelligence are there? Well, the answer is, there's one, and there's several. There's general intelligence, but there are other skills, too. So that's an important message to be clear about that. It's not just about general intelligence. Neither is it just about one skill being unrelated to another. So that's the first issue I address. What else is in that chapter, I also look at what the world literature says about whether there's a general intelligence or know what the answer is there is almost every data set has ever been looked at finds a general intelligence. That was chapter one.

Chapter Two is about age. And again, that's something that concerns us all is that what happens to our thinking skills as we grow older? Well, in this next one, I am going to look at a dataset from Virginia in United States. The data are from Professor Timothy Salthouse's lab, and what he did was this. He tested people from early adulthood until relatively older age, and he gave them a large variety of thinking skills tests, and he asked a question are younger or older people better or worse at these tests, he collected together several of his own studies between two and a bit on four and a bit thousand people. Big collection of data. And what he asked was, with regard to the sorts of skills that we see at the middle level here that I just talked about, how do these do as people grow older? So the next thing I'm going to do is in chapter two, look at what happens to some of these domains of thinking as we grow older. Now, as I always say, once you put a grandfather, it's hard not to look at it, but if I can direct you to where to look, and I'm going to look at the same time look along the bottom. Here, it's age, okay, there were people tested who are of different ages, and the age goes from about 20 to 80. Something just make sure you can see that age 20 at the lower end, and age 80 something at the front end. Okay, so up the side is what's called the Zed score. Never mind that it's just the score and the zero is average. It's better as you grew up and worse as you go down. That's as simple as that we've aged along the bottom, and we've got how well people score up the left hand side, higher is better. Now let's start with a good news. So just identify the line that's connected with dots that have got black circles. It's vocabulary, knowledge, knowledge of words, the meanings of words, how words are used. Can you identify that the black circles? Now note that when does it peak? Well, if we trace it alone, it seems to peak about 60 something. And as we go from 60 to 80, it's still better than it was in youth. So that's

the good news. On average. There are exceptions but on average, as people grow older, they get better at this vocabulary knowledge. We also know from other work that we get better or at least stay relatively good on things like number of skills and on general knowledge, however, you probably also drifting away, even though because you've absorbed that and started to notice that some of these other lines don't show this pattern. They neither show a steadiness with age, or do they go up. In fact, they go down. So let's go for the worst news of all first. Identify the lane that is speed. And if you look at the key, it's the black triangles. And if you look amongst those other lines, the reason I have picked it out is probably fairly obvious. It's the one that it's at its best about 30. Can you see that the triangle at its best about 30 and relatively speaking, it's a straight downward path from 30 to 80. Now, once again, I want to stress this is the mean or the average of a large number of scores. Okay? There are exceptions to that, but on average speed of thinking skill goes down from 20 to about 80, something in a relatively straight line, just to give some sort of size of a chunkiness of that effect. It's a pretty big, it's a pretty big effect. It's probably worth about something like 15 to 20 IQ points. Right? Let's look at the other ones. We've got reasoning there. We've got spatial visualization. What does that mean? It means being able to work things out in two in three dimensions. And we've got some aspects of memory that is forming new material and holding on to it after a certain amount of time. Try and see there that there's a relatively gentle slide down from about 20/30 until about 50/60. To be honest, not huge amount happens. But can you see that then things speed up a bit, as we go from about 50/60 until about 80. So in other words, what Timothy Salthouse finds in these data, is that some skills stay relatively good with age here, vocabulary knowledge. We call these crystallized ability or crystallized intelligence, the other things that one holds on to the other things, things like reasoning, thinking in different dimensions, memory and speed. They are aspects of what we call crystallized fluid intelligence, just to repeat, they are aspects of fluid intelligence. They tend, on average to decline from 20/30, something down to about 80.

Now, other things in this chapter that I look out with respect to what age what happens with regard to age and intelligence, are this; We describe some of the studies that give people the same intelligence test in all ways that they took when they were young, and we ask whether there's a stability overall that time, there is, is quite a lot of stability. And then we asked the question, what are the things that contribute to people doing relatively well, an older age compared to youth? What are the sorts of lifestyle factors? What are the biological factors? What are some of the genetic factors, but what I've shown you here is the average in thinking skill changes as people grew older, let's just pop back a second. So, I'm not going to be able to stop here for a while, but the next few chapters cover the following. In chapter three of the book, I look at whether there are sex differences whether women or men are cleverer. I can give you a spoiler right now, they're just the same. There's no sex difference. In chapter four, I look at contributions from the environment and from genes, whether people's genetic differences contribute to intelligence differences. And the answer is, of course, that both environment and genetics contributes to intelligence differences. But what I do there is describe some of the traditional twin studies, and also some of the newer studies that look directly at DNA testing. In chapter five, I asked the question, are people who tend to be more generally intelligent in doing complex tasks, also better at simple speed things? Like for example, just pressing a button when a light comes on? And the answer is yes, people who are higher on complex intelligence tests also tend to be good or fast at relatively simple tasks, and I described them in more detail. In chapter six. I asked this question, what do more intelligent brains look like? Now for a long time, it's been a subject of argument as to whether one can measure something about the brain that's associated with being more or less intelligent, as is determined by a test on an intelligence test score. And it's only really with

the advent of magnetic resonance imaging, brain scans, MRI, magnetic resonance imaging brain scans, that would be gone to find out more solidly. So what I want to do next is describe a study that, in fact was done by some of my team. In fact, the people who led this were Dr. Stuart Ritchie and Dr. Simon Cox in my team, and what they did was this, they took about 670 of the group that I look after called the Lothian Birth Cohort, they were age 73. And they took a whole load of thinking skills tests, intelligence tests, and they also had their brain scan. And what I want to show you know, here the anonymize scans of one person and just get your eye in gear here what we're looking at are brain scans of four people just anonymously, but just to describe the phenomena. So let's go from top left. And if you just look at me for a minute, and what we're doing here, is cutting the head through from about the ears. And that gives us a measure of brain size. Now, the whole brain is measured, but I've just shown you one slice here. If you move to the top right, can you identify the gray on the outside of the brain, that's the brains cortex. And we measured the thickness of the cortex all over the brain. On the bottom left, what I want you to concentrate on there are the fari white lanes. These are the brains connections, the brains white matter, and they are the parts of the brain that connect the cortex. And just to give you an idea of the complexity of the white matter, If one takes all of the connections in the brains white matter of an average person, they would go around the equator of the earth four times. So there's a lot of connections. And what we can measure these days is how well those connections are working, how healthy the connections are. If they're not very healthy, it's a bit like having potholes in the road or cones in the road that block some of the characters. In other words, it's good to have open and working brain connections. And on the bottom right, the thing I want to sport there are the fight marks. Some of the older people in the study. Remember there were 670 of the Lothian Birth Cohort here. Some people have more or less of these white marks. What are they? Well, they're called this they're called

White matter hyper intensities. Sounds a bit complicated, but it's not really white matter. We already told you the white matter's, the connections in the brain. Hyper intensity just means they show up very intensely on a magnetic resonance imaging scan as this one does here, what are we there are like little scars in the connecting tissue or the white matter of the brain. It's not an illness. I've probably got some already, however, I'm going to tell me the results I better stop. I'm going to tell you the other results first. So let's jump back to the top left. What we found in the Lothian Birth cohort 1936 670 individuals was this, they took 13 tests of thinking skill. And from that we formed a general intelligence score. And what we found was that people top left, people with bigger brains, on average, scored higher on general intelligence. For those of you who like statistics and correlation, the correlation is just below about point three. On the top right, when the thickness of the cortex people with higher intelligence have thicker clothes cortex of the brain, they have more gray matter more of the thinking skills cells in the brain, or whatever else contributes to having thicker gray matter. On the bottom left, we found that people with better general intelligence scores tended to have healthier white matter, their connections in the brain looked better. Correlation there, as it was with the cortex was about point two. On the bottom right, what we found was that in the Lothian Birth Cohort at age 73, anyway, those people who had fewer of these white matter hyper intensities, these little scars, probably in the white matter of the brain tended to score better on general intelligence. Again, the correlation just below by point two. None of these correlations is large. But all of these correlations are highly significant. And we've seen that in this group, that a bigger brain thicker brain cortex, a healthier set of gray and white matter connections, and fewer little scars in the brains, white matter seemed to contribute towards being clever with regard to that being measured in intelligence test scores. What we also know and what I described in this chapter, which is chapter six, I described the other

research around the world, which finds about the same. In fact, just to finish this off, Dr. Simon Cox in my team also looked at thousands of people in the United Kingdom's UK Biobank sample. And he found that bigger brains there were also associated with being higher in general intelligence. And again, for those of you who like correlations, correlations around point two, seven. So there is something about the structure of the brain, the brain related to being better on general intelligence. It's not a strong association, but it is there. Also, I have to say we don't really understand what it is about the brains thickness or cortical thickness of white matter health right down below that associates with intelligence. We know the associations there, but we still got to explain it. Okay, that's enough of that.

Let's go back again. And so that was chapter six about brains and intelligence. Chapter Seven, which I'm not going to describe in detail is about whether intelligence test scores when people are children, predict whether on average, they will do better in educational qualifications and do better in the workplace. And yes, there are associations, intelligence, specially general intelligence is related to having higher educational qualifications, doing better at school, and doing a bit better in the workplace, and actually in being more socially mobile, moving up socioeconomic status from one's parents, not the only factors involved by any means. But there is some association there.

However, I'm going to take you on to chapter eight, I think chapter it's quite an exciting one, because it's about whether or not intelligence test scores taken in childhood and in youth are associated with later health, and even how long people live. And again to give away the answer straightaway is they are, and we've only known that since about the year 2000. This is a remarkable finding that test taken for say about 45 minutes when people are very young. It's associated with longevity, or mortality, and illness. But what I want to do is describe one remarkable study so you get the idea of this sort of research. And what I'm going to talk about here is one of our own studies, and this was laid in my group by Dr. Katherine Calvin. It was published in the British Medical Journal just a couple of years ago. And this is what she did. Katherine, in her analysis started with the Scottish mental survey 1947 entire dataset. Let me tell you what that is. You see, Scotland's a very unusual country, because it's the only country in the world ever to have tested the IQ of the entire nation. It did this. On the fourth of June 1947. It was a Wednesday. And then it tested 70,805 children on exactly the same test. On the same day, the Murray house test number 12 of general intelligence, again, administered to 70,000 odd children, about 95% of the children born in 1936. They were about 11 years old until he took this test. Now, these data were securely, confidentially stored away for decades and decades. And they were discovered by me and my friend Laurence Foley in the late 1990s. and subsequent to that, what we did was this, we obtained permission to link through his data to death records in Scotland. And we managed to trace about 90% of the people who took part in the Scottish mental survey of 1947. So what we could do was, we could link the scores taken at age 11. In 1947 of the people born in 1936. And 60 odd years later, we could find out whether they were still alive and if they weren't what they have died off. And in fact, what happened was by then, about 25 to 30,000 people had died. And what we found was this. Was that on average, a child aged 11 in 1947, who scored about 15 IQ points higher than another was about 20% more likely to be alive all that time later. Okay, about 60 odd years later, but what I want to do is show you that in a bit more detail by showing you one particular cause of death. Okay, so of the 25 to 30,000 people who died in the Scottish mental survey 1947 people born in 1936. As you can see there, over nine and a half thousand people had died of cardiovascular disease. And again, it's a graph I want to talk you through it. So if you look first along the bottom, what we find there is we split this intelligence test the marine house test into 10 groups. On the left, as a reference is the lowest scoring group, right?

Remember, these are groups of children, aged 11, who've been followed up many, many years later, until 60 odd years later. And so we've got the reference group at the left, and as we go on, just look along, you've got 23456789 and 10 is the highest scoring group. And on the left hand side, we've got something called a hazard ratio. But let me just explain. I'm going to say, look at the reference group, it says read and look up, it's set at one. So what we've done here is we've taken the IQ test score of our lowest scoring group, and we've said their risk of dying from cardiovascular disease, these 60 odd years later, after being aged 11 is set at one and this is what we find. We find that all those dots steadily going down, which means this as people got higher and higher in their intelligence test score, they were less likely to have died of cardiovascular disease at this age in the late 70s. So what we find great along to the right hand side, and can you see that the dot from the highest scoring group, group number 10, is at about 40%. In other words, they have about only 40% of the chance of having died of cardiovascular disease compared to the reference group. In other words, they're less than half as likely to have died of cardiovascular disease. And also you might be thinking if there is an association between intelligence in childhood, and how long people live, it may only occur at the lowest levels, but this shows you that that's not true. The risk of dying of cardiovascular disease by the late 70s declined steadily. People get higher and higher and higher in intelligence. Now, just to say I've only picked out cardiovascular disease, I could also have picked out other causes of disease. I could have picked things like smoking related cancers, digestive diseases, and other types of illness, even Alzheimer's disease or especially vascular type dementia, they show this kind of patterning too. Now, I want to emphasize most strongly that these are remarkable associations, but we don't yet understand fully why they occur. We're obviously looking at things like work through with education, whether it's people's health knowledge, whether it's to do with social status, as people grew up and get into different types of environment. But these are relatively new and somewhat remarkable findings. The rest of the chapter is in fact involved in looking at some of the World Literature people have got these results in other countries, or some of the studies are absolutely remarkable. They sometimes run to millions of subjects in some of these studies. So that's health, and death and intelligence. That was chapter eight of my 10 chapter group.

Chapter nine is on something called the Flynn effect. This is absolutely remarkable effect on intelligence test scores that over the 20th century anyway, subsequent generations seemed to be scoring better than previous ones. We don't understand why that has been found. But I describe the phenomenon and some of the descriptions that have been attempted to date.

In the last chapter, chapter 10. I own up to the fact that intelligence can sometimes be a controversial topic, and I asked the question, if you get a disparate group of psychologists together, and not four heads together, can they actually agree Some of the solid science and solid findings about human intelligence differences? And the answer is yes. And I described a remarkable taskforce that was set up by the American Psychological Association, in the wake of the controversy of a book called The bell curve, when the American Psychological Association got various experts who took very different points of view. But they managed to come up with a really useful article on what we know, and what we don't know about human intelligence differences. And I described that and subsequent findings, and it is really good to find out that in fact, the American Psychological associations Task Force on intelligence has got pretty much the same sort of results that I described in the book, although I describe it at some greater length. And of course, at the end of the book, I described futher reading because it is a very short introduction, and I take people through some of the historical work on intelligence.

So that's my very short introduction to intelligence my second edition with updated and more recent and bigger and better studies underpinning the point I'm trying to make. And if people are interested in intelligence, and if they have particular questions would like to know more about the Lothian Birth cohorts, they're welcome to visit our London birth cohorts website, or that's my email address there. And again, thanks for attending Cheltenham Science Festival at home. And I hope if you do go and have a look at it, you'll find my intelligence a very short introduction, Second Edition with Oxford University Press interesting and find my 10 chapters on interesting questions about intelligence, at least a decent introduction, if only to inspire you to go and read a bit more. Okay, that's it. Thank you very much.