

Numberphile Podcast Transcript

Episode: An Educated Adult - with Tadashi Tokieda

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Tadashi Tokieda is a Professor of Mathematics at Stanford University - and a popular contributor to videos on our Numberphile video channel. But his path to mathematics was unusual.

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[Gentle piano music]

Brady Haran [BH]: Today's guest is someone many of you have been hoping for. It's Professor Tadashi Tokieda. Tadashi's known to Numberphile viewers for his whimsical videos involving what he calls toys. These are everyday household items like rubber bands or paperclips which he uses to explain deep fundamental concepts. But he's not just a mathematician, today you're gonna learn Tadashi's a true polymath, an expert on languages whose world travels have given him a unique insight on the world. These days, he's based at Stanford University and I join Tadashi at sunset by the swimming pool in his backyard.

[Gentle piano music]

BH: Cheers, I've never done this over a glass of wine before.

Tadashi Tokieda [TT]: And that's very good too, yes.

BH: We're in your backyard in California.

TT: That's right.

BH: It's lovely. It's been a beautiful day as well, so let's hope...

TT: It's been a beautiful day.

[audio cuts out]

BH: Alright then. Let's start at the very beginning. Where were you born? I can guess but you tell me [chuckles]

TT: Well according to my parents, my memory's a little hazy at that time. In Tokyo, in Japan. I may add that the... traditional, you know, Japanese saying, you are not really from Tokyo... Edo-ko is the actual expression, Edo used to be the name of Tokyo before the Meiji Restoration. You are not really through dyed in the wool Tokyo-ite unless you can claim to be the fifth generation. And among my genealogy there is one sort of strand that I can follow that makes me the fifth generation. You know, born and bred in Tokyo. Unfortunately my son was born in Cambridge UK so the tradition breaks at my generation.

BH: Did you also grow up in Tokyo, or how long were you there for?

TT: Yes, mostly. So I grew up in Tokyo until six and then I moved to the area between Kyoto and Osaka, and so that's in the west of Japan. The older part of, if you like, of Japan. And by the way, "Kyo" of Tokyo and Kyoto is the same word, it means capital and Kyoto means capital city and confusingly "To" of Tokyo is east, so eastern capital. Because at the time of Meiji Restoration the Emperor was moved from Kyoto to Tokyo, after a thousand years Kyoto. That's why it's called it. Anyway, so I lived in the west of Japan and to this day I can do the western dialect as well.

BH: Oh, are they very different?

TT: They are quite distinct. Yeah, very very noticeably different. I mean they are mutually understandable. But if you hear one person from one region you immediately know which region. Anyway so I lived there for three years and then went back to Tokyo. Back then, speaking of breaks, a huge break occurred in my mid-teenage, I went to France by myself. So I stopped living in Tokyo at that time. Later I went back and lived there a little bit.

BH: Before we get to France then, as a boy what were you like? What, you know, were

you... would I have guessed you were gonna turn out to be the man you are today, if I met you as a boy?

TT: I guess not. In nursery, and there are many stories about me, so first I was a very kind of spaced out and very gentle, very slow boy. So much so when I was leaving nursery to go to primary school and remember Britain is extremely peculiar in the world that they send children to school at an early age of five or something, but in Japan it's from six or seven onwards, so I was not really so small anymore. But the nurses at the school apparently cried because they are worried that, you know, little Tadashi would not be able to cross the street and what if he doesn't know which classroom to go to and so on. So I was that kind of boy. But at the same time, a bit unusually at that time in Japan, my mother was working, at the patent office in the center of Tokyo. So she would come to pick me up very late, very late meaning just after five o'clock, so after everyone had left nursery at four o'clock, so bless them, some of the teachers had to stay behind to look after me and they took turns apparently and I'm ever so grateful. But in order to entertain them the following thing happened, so at home we had a collection of comic stories called Rakugo, this again is part of the Japanese tradition, some performer comes and sits in front of the audience and tells a funny story, and it goes to this day, so it's a great art and then, you know, some transcripts that were edited were made into books, so all the classical stories for the years gone past, so they were read to me every day, and apparently at the nursery the following evening I would recount these stories to nurses. I had fairly good memory. And so they would just listen to Tadashi telling those comic stories [laughs] and then you know, that's how I entertained them.

BH: So you were like a raconteur even at a very early age?

TT: Well, I don't know, but I did like those stories and I just told them. But I was a very shy and not very fast boy.

BH: As you got a little bit older and started, you know, going to school and things, what were your interests? What were the things that consumed you?

TT: So a little earlier, one of the things that really... well I don't know if it interested me because you know, I'm not sure children, or even, you know, a little later people get really interested in things rather than, you know, they find something in which they're comfortable and then they sort of keep doing this more and more because that comes naturally to them, you know? It's a little different from interest in the adult sense, isn't it? But anyway, so very early on I started drawing and I was made to take lessons, a very nice teacher, and in fact she was the daughter of the principal of the nursery school

that I attended. And so I would go there to her house on every week and take painting lessons and drawing lessons. And so I became kind of very advanced, so I started drawing extensively.

BH: What were you drawing?

TT: Oh, all sorts of things. So the first thing that I was made to draw was, of course, still life. So you know, I would have some fish or the flower and so on to just sketch and I learned sketching and then, you know, I would also draw from memory I would draw something abstract, for example the feeling of elation or sadness or whatever, you know, all sorts of things, and different media as well. So the Western oil painting, which I didn't like so much because it's really a pain to prepare and then wash-up afterwards. Or, watercolor which was much easier. Or, Japanese brush, Japanese or rather Eastern Asian brush painting and so on. So all sorts of genre. And you know there is something very strange about this interest. It's been noticed that mathematics and music are very special among all human activities in that they accommodate the phenomenon of child prodigy. Right? If you think about it child prodigy exists in mathematics and it certainly exists in music, in fact it's made a big deal out of, but almost nowhere else in human activity is there a child prodigy. I mean, you would be ridiculous to think of a child prodigy in history, right? I mean a historian. Well, okay, some people gymnastics but that's different because child prodigy surely means a child being able to perform what an adult does, you know, as well as an adult. But in the case of gymnastics, adults don't perform gymnastics, you know, above a certain age that's finished, so it's a really child proper activity. That's different. But if so you think about it, mathematics and music only, so that's something these two fields have in common, I don't know what it is. And in particular we very seldom hear of child prodigies in painting or drawing. Visual arts, but I was kind of one and then so I had some exhibit in jointly with my teacher at the major gallery in Tokyo at age five and so on, so on.

BH: So as a five year old would someone look at your paintings and not know they were done by a five year old?

TT: So that's different, so you see, the difference, I think they would have known that it was done by a five year but they thought it was charming and so there are of course other kinds of child prodigies that very rare child prodigies in painting and they come up in the media every once and a while whose work is indistinguishable from an adults but that's quite different. But anyway I did a very wide variety of genres. In fact, you know, a bit like a circus monkey who was trained to do anything and so I didn't have my own artistic voice, far from it, obviously, it came naturally to me. I did more and more of it and took pleasure and it was a nice Sunday activity, to take lessons, so I did a

lot of that, yeah.

BH: And were you then sort of, because you were so good at this at a young age, were you then pushed in that direction?

TT: No no, I was not pushed at all. So nobody ever pushed me and in fact my family's attitude was very orthogonal to pushing. For example I think like many children in Japan I was... I started on piano lessons, because you know Japan is very unusually. Yamaha, this company, which makes both motorcycles and pianos, what a combination, by the way there is another company called Fazer in Finland that makes motorcycles and chocolates. Another interesting combination. But anyway Yamaha decided, I think, more or less consciously after the Second World War to put the piano in every household. Of course an upright. They succeeded, so, an amazing promotion of households in Japan, even small apartments in which we lived, had an upright piano. So I started taking piano lessons, but apparently after a few lessons I said to my mother, unless you carry me all the way to the lesson on your back I'm not going and then she said okay in that case you are not going. And so that kind of... so no I was by no means pushed, and far from it. And in fact I was never pushed in my life, as far as I can tell. But it came naturally, as I say. And in fact it was kind of assumed by everyone around me and therefore perhaps by me that I would become a painter.

BH: So, you were good at this, what did you enjoy? Is that what you enjoyed, like... did you enjoy playing sports, did you enjoy mathematics? We will come to mathematics later. Did you enjoy playing with your friends? What were your passions?

TT: I didn't really have passions, again, I was a very slow and mild child, and you wouldn't believe it to look at this curmudgeon that he turned out to be. So I didn't have a real passion but of course I enjoyed doing things. I enjoyed sitting in the warm sun. I enjoyed kind of being with my parents. We lived in an apartment which was as some unkind Americans said right after Second World War, was a rabbit shed, and really really small. I don't know how to describe it just verbally like this but now we live in a house on Stanford campus and our garage is about double the size of the apartment in which I grew up. And yet in it, I enjoyed playing baseball with my father [laughs].

BH: Baseball?

TT: Yeah, that's right. When I was three or four, and so on.

BH: If I went back in a time machine and spoke in Japanese to the young Tadashi and said, what do you want to be when you grow up? What do you think you're gonna be

when you're an adult? What would he have said to me?

TT: So as I mentioned before because all the adults around me, you know, liked my drawing and I assumed I would be a painter of some sort, so as they did.

BH: But... I guess painting... I don't know if this is the case in Japan though, I guess the cliché is that becoming an artist doesn't lead to fame or certainly doesn't lead to fortune...

TT: No, no!

BH: Would your parents...

TT: No, no, of course...

BH: So...

TT: You would die destitute and then of course you start becoming famous after your death, right?

BH: So did your parents push you in that direction?

TT: No, no.

BH: Or were they saying, no be a doctor or...

TT: No, no, no, they didn't. Jumping ahead there's one thing that my father said which I remember apropos of nothing. So he attended the department of mathematics at the University of Tokyo and kind of didn't do well at all. He wasn't cut out to be a mathematician but he was good at mathematics in high school and good enough to get into the kind of most competitive program in mathematics in Japan. But anyway, so he was fond of mathematics in an unprofessional sort of way and he became an actuary so, you know, that doesn't... that's not... you know miles away from applied mathematics. But in my youth, I'll come back to that, I was extremely sort of fond of Chinese classics. Classical Chinese, I would read, you know just as in Europe, Latin and Greek used to be taught, a while ago, in Japan still Classical Chinese is compulsory for all secondary schools but I started and I was way way ahead of the program. And in fact I probably became very quickly better than the teacher and I was reading professional stuff. To this day I read... I'm an avid reader and passable scholar of Classical Chinese. But watching me read Classical Chinese my father said, well that's an area where there is no progress,

and I got very very upset by this, and sort of started arguing against my father. I remember this. I think his intention was that I should study more science but anyhow, no I was not pushed. I was not guided in any direction. But I was, you know, just as most future mathematicians are, I wouldn't be shy to say that I was a clever boy, so you know, I had no difficulty with school work. And so that means that I had freedom, so I didn't have to sort of make an effort, I didn't to so much because things came naturally to me. That became a huge handicap later on because I didn't learn how to work until very late in my life and that's of course another story. So I had no particular passion. I liked comfortable and friendly and sort of warm sort of family and friends in Tokyo, and you know, and in this tiny tiny apartment which I thought was a great universe. And I liked reading, I suppose, a lot. I liked looking at the pictures as well as the text.

[Gentle piano stinger]

BH: One of the things you're known for now, we might come to it later on, is your enjoyment of toys and using toys to demonstrate things and that you're very associated with toys now. What was your relationship like with toys and playful things when you were at that age where toys are a common thing?

TT: Yeah. So curiously that came very late. In fact I didn't get interested in what I now call toys. So as you know and some people know, if you can buy something from a toy store, it's not a toy in my sense. My toy has a very very special meaning. It's an object of daily life that you make interesting. Which looks innocuous and which doesn't look interesting but which if played with in imaginative fashion would reveal a surprising, that's the key word, surprising phenomenon. Hopefully amusing phenomenon, which has seasoned scientists scratching their heads for a long long time and which... has some potentialities inside. But in that sense I was not terribly observant I would say about natural phenomena or things that happened around me. I was very relaxed and I didn't get interested in that kind of toy until after my graduate school really. So it's a very very late interest in life. Indeed I was not interested in physical phenomena for a long long time. The world of imagination, yes. As I said I liked reading, and it was almost all sort of fiction. Yeah, so children's stories, of course, but then later on in the classic novels and so on. And also drawing, but quite quickly, you know, I still drew, of course, lots and lots of, you know, sketch and realistical drawings, but also I drew out of imagination as well. So that's... and I also liked reading some book and then translating what I read into drawings. So that's my childhood. So I would have made a good illustrator. And, you know, the drawing you may think is a side interest compared with what I'm doing now but not so because I draw abundantly in my lectures, for example, when I give public talks and so on to illustrate what I'm doing. And in a way, although I wouldn't say that in public like this, one of the reasons I do

mathematics is because it affords me an excuse to draw. You know, otherwise, why would I draw? I mean it's a bit embarrassing and I'm still a shy person despite this public mask, you know, drawing something and showing it to the public and saying, geez this is my drawing, is a bit embarrassing but if I have an excuse of a mathematical article that I'm writing and explaining something and illustrating what I'm doing, then of course it's a good cause. But I really like drawing much much more than languages and language is much much more than mathematics I would say.

BH: So take me on the next step of the journey, you said that you left Japan?

TT: Yes.

BH: How does this come about?

TT: So that's a very complicated story. So I'm going to tell the details that I've never told anybody in the West. So I went to a boarding school at age about twelve. And you know, nowadays with perhaps the image from Dickens and so on, boarding school has a perhaps a bad reputation among some people. And it was tough, right? But I have a fairly good sort of memory of this. Anyway, the important thing is that in Japan, foreign languages are very badly taught. I have to say in the defense of Japan that well badly taught because Japanese is an isolated language and it's not like... if I may say so, rather boldly, an Englishman trying to learn French because these are basically dialects of each other. I mean they share seventy percent of the vocabulary, because of the history. So, you know, constitution, constitution, yeah? Restaurant, restaurant. Of course it's the same word. Okay, for Japanese there is no such salvation and so may I remind you that if you notice a Japanese struggling to speak English, well please take pity on us because, you know, for a Japanese, English is as difficult as Japanese is to an English person, English speaker, yeah? It's that symmetry. Okay, so, in Japan languages are very poorly taught although they make a lot of effort and the only language that is available in secondary school is English, but there are two exceptions. There's a school in Tokyo which offers French and another school in Tokyo also which offers German. So I happened have attended the former one. So my first and for a while the main foreign language was French. By the way I had learned Classical Chinese before so if you count that as foreign language that was really my first foreign language, but anyway, among living languages French was the first one. So I really liked French, because, you know, I liked languages already, and at the same time, you know, I began to think that well, I'm finding school too easy and it's not quite... I'm not saying it quite right, but I kind of began to feel that my life was a bit too much of a routine and I wasn't getting anywhere exciting. So I argued that well, if I could do the same thing but in a foreign language I would at least benefit from picking up a language and that would sort of broaden my

personality and my universe and...

BH: So you wanted to make life harder for yourself?

TT: So my...

BH: Sort of tying an arm behind your back?

TT: My parents must have been... I must have been a very cogent kid. Maybe it was my real reason, maybe it was not my real reason... actually come to think of it my real reason is that, you know, in French, speaking of French, there's an expression, "folie de loins," so the craziness for faraway. When you're young, of course, you might be romantic and you dream of going very very faraway and sort of see things that are undreamt of indeed, and so on. So I was like that too, so France was suitably exotic and why France? Because, you know, French, as I explained was my foreign language, so I persuaded my family and myself and every authority involved including the French Embassy who thought that I was too young to be let go by myself at that age but eventually they gave me a visa and so I went to France.

BH: How old are you?

TT: Fourteen.

BH: That's seems...

TT: When the decision...

BH: That's extraordinary, isn't it?

TT: But then... by the way I didn't go to Paris, rather I went to Bordeaux for another rather lucky reason that, you know, even at that age I thought well in Paris given a large and active Japanese community I would be coddled and wouldn't have enough contact with the natives, shall I say. So there was another possibility in Bordeaux so I went there and I have to say this was in the mid-Eighties. As far as eyes could reach there was not a shadow of another Asian. It was really wonderful. I was like a UFO that landed in their midst. And I must say, that, you know, Bordeaux became my second home. I still regard it as really as my hometown, besides Tokyo. Bordelaise have a reputation for being a bit chauvinistic, I have to say, and if I had been from Alsace, for example, they would have been very mean to me, but because I was so exotic and alien, they didn't know what to do with me and I would like the opportunity to record my [clears throat] my kind of

deep gratitude and fondness for the French, in that throughout my time there, I spent two years plus, you know, I was in some basic boarding facility during the week, but all the other children who were in the boarding facility, you know, they had very very basic stuff for children who came out from outside of town, but most of the, you know, the vast majority of children there were, of course, day children and so on, and those children who were in the boarding facility would go home over the weekend. So I would have been alone but weekend after weekend I was flooded by invitations from all manners of families and they were not always the same families. Really wide variety. And at that time I was convinced that this was orchestrated by the school. But no, I stayed very good friends and close contact with these teachers of the period and especially the principal of the period, but no it was apparently all spontaneous. So they invited me and I would spend... and I had to turn down most of the invitations because there were so many of them. And so Bordeaux have a reputation but my experience was very different and it was really I have a warm feeling for what the French people can do.

BH: I'm struggling to conceptualize the two images you've painted of yourself as a young boy though because on one hand I'm picturing this quiet shy mild mannered... sort of character but on the other hand you've got this kind of courage and bravery to say, I wanna leave the comfort of my parents and my family and my school and things I know and go the other side of the world on my own and then say I don't even wanna go to Paris where there'll be other Japanese people. I wanna really throw myself in the deep end. The two seem at odds, those two kind of characters.

TT: Yes, yes on the surface I know what you mean. But I think there are two things you can think of which would make the conundrum a little clearer. One of them is that, you know, people who tend to... who seem brash and who are very extroverts and who are kind of loud and so on... are so within a certain context and within a certain environment, right? And if they're put in a completely alien place where they are lost, they may not exhibit the same features, right? So in other words, all that extrovert nature and so on is in tandem with in what the environment they live in. And so like mathematician I'm tempted to say it's a function of your environment. These people who are in evolutionary terms, another sort of mixed metaphor, they're over adapted to their environment, and don't travel so easily to another environment, yeah? Just as you know a creature which is extremely sort of successful in a certain environment and well adapted and who is dominant in that environment, the top of the chain and so forth, when the environment changes, might go extinct very quickly, where as you know little creatures that are struggling in the mud at the bottom and who are not so well adapted because they are kind of hedging their bets all over the place when the environment changes they might actually have some fighting chance. Similarly for a human psyche, I

think, people who are not over-adapted might have a better chance and might have even better courage because nothing is holding them back and so on, to go of course somewhere else. So that's one thing. Another point is that this... well... I don't want to talk about transition but in some sense a transition was completely conscious. In other words, you know, I used to be a very shy person and so on and in some sense I still am but at some point in my early teenage I realized that well, you know to do justice to myself and then to frankly take advantage of what the world has to offer, I'm gonna change my personality.

BH: Right.

TT: So, I decided to train myself. Completely consciously.

BH: Like reinvent yourself?

TT: Invent myself. So there have been cases of this and so recently and I used to know John Conway very well, he was a great mathematician of English origin who spent the latter half of his career in Princeton. So that's where I got to know him very well. But Conway apparently was fairly shy but mathematical gee whiz kid from Liverpool but he got a scholarship to go to Cambridge. And then on the train from Liverpool to Cambridge he thought to himself, oh yes, I was being bullied and I was kind of a shy person, but in Cambridge nobody knows who I am so, so I'm going to be a different person. And when he stepped off onto the platform at Cambridge station he was a different person and that was the persona that he wore all his life. Sometimes I have to say, you could detect something else under that mask, but anyway. So it's not as dramatic as this, but I'll give you two examples. So in Japan we have many many different forms of humor. For example, Rakugo, that I mentioned, is a story, is one. But this Western, or... maybe a little Jewish tradition of joke, in the sense of a short story that has a surprising twist at the end that makes people laugh, is not one of them. So that doesn't exist.

BH: Right...

TT: So our humor tends to be kind of... it is a bit a like if you know that author P. G. Woodhouse, situation. So you put lots and lots of situations and sort of build more and more a structure which is obviously unstable and the end everything collapses and that's the kind of humor that we... anyway so jokes in the traditional European or Jewish sense doesn't exist, so when I arrived in France, of course, all the French children of my age in the outside, inside, class were swapping jokes and I had no idea what was going on. So I had to learn this. And especially from the Jewish tradition, so now I sort

of know more stories than probably is healthy for a brain to accommodate. So that's one thing I really trained myself, and another thing is the concept and practice of swear words. So in Japan... so you should if you are of linguistically and culturally of European origin, you should be aware that swearing is actually by no means universal among human cultures. Yeah? So you think that well this is very fundamental [chuckles] to you but no it's not. So in Japan, there is no swearing. By swearing I mean a register, that's the technical term in linguistics, of words or phrases that whose immediate meaning have nothing to do with what they're so to convey and which are reserved, you know, partly taboo, partly maybe, you know, sexual, maybe coprolalic and so forth which you say when you're frustrated, or angry or whatever, or when you're trying to sound cool. That kind of thing does not exist. So when I went to France of course, the first hour, you know I heard my friends, you know, swearing. And judiciously, I was, you know, sort of studiously I was looking up in my pocket dictionary and found words that have nothing to do with the context, right? So why are they invoking an excrement? I have no idea. But that's something else that I had to learn.

BH: Do you swear now?

TT: I... so you know that I seldom swear.

BH: I've never heard you swear.

TT: You've never hear me... I don't think you've... I can't think of anybody who heard me swear. But if you drop something very heavy on my foot, what comes out is French.

BH: Right [laughs].

TT: Right. And so maybe in private sort of moments I sometimes swear but...

BH: But only in French. [laughs]

TT: And that's natural. That's another of course anthropology of swearing. In what language do you feel comfortable swearing and what language is it effective. So in some sense the most effective language that I happen to have come across is Russian. In Russian swearing is amazing. You know you go into all the details of your mother and grandmother and all the ancestries and so on and so on.

BH: [laugh]

TT: But somehow it's not... it doesn't do it for me, I have to say. Anyway I don't swear often and partly perhaps because it came to me quite late.

[gentle music box stinger]

BH: So, how do we move this journey on from France? What happens? You're there for two years, in Bordeaux?

TT: Yes, and so I rushed through lycée or the high school program, and then I went back to Japan for a number of reasons. Again because I feel very relaxed with Brady Haran, the great Brady, I'll tell somethings that are not directly relevant to the main stream of the story. My parents insisted that whatever I do I should get a degree from a Japanese university before doing anything else. And that struck as reasonable.

BH: Why did that strike you as reasonable?

TT: Well, you know, from my parent's point of view it's of course the obvious thing and but from me... maybe because, you know, I was still inebriated, shall I say with discovering foreign cultures. I should have said early on that when I arrived in France and one of the things in the back of my mind was, of course, you know there's a stereotype of a young and promising painter who goes to France and who lives in an attic and dies in poverty or almost and so on and then becomes famous afterwards, right? So of course I had that in mind and I have to say France is really remarkable in that respect but when I arrived in France I discovered, it was really epiphany, I was struck by a lighting of discovering languages. In Japan, which is as you know, an archipelago island nation, of course, you know, we learn foreign languages and we are aware of foreign languages but it's all a bit too remote. You see, you watch people speaking, for example, English on television and okay, so they pretend to speak English, but can you really, you know live speaking only in English? I mean can you fall in and out of love, get angry and get really sad and lose a loved one and mourn in English? Can you actually the joy of your life in English and can you suffer in English? Surely not, right? I mean this is the kind of language that you learn in school and you make believe that it's normal but when push comes to shove of course you switch to Japanese which is language has all the emotional load that is necessary for a human being. So that was more or less my unconscious take on this. But in Europe of course, you know, you go two hundred kilometers in that direction, three hundred kilometers in this direction and then there are people who actually fall in and out of love in that language. You know? So that was a tremendous shock to me. And I became fascinated, some people might say obsessed, with languages, and nothing else mattered. And so I started learning one language after another. By the way the way I learn language, despite my

previous sentence, is not really one language after another, but anyway. Really that became for the first time I discovered the passion. And it was clear to everyone around me that language was my thing. To the extent for example that, you know, I still remember that evening when I was in France the first year, some actress from Spain came and held an evening sort of function of reading poems from Garcia Lorca, so a Spanish poet, a poet from Andalusia. And Romancero gitano one of the most romantic works that he wrote was the text, and so she read it one after another and I didn't know Spanish at all and I went to listened and I was completely captivated by Spanish so I decided to teach it myself. So this the extent of obsession, instead of taking classes or something what I did was to... I was already reading French, I went a bought the largest grammar of Spanish... for professionals really and the largest Spanish-French, French-Spanish dictionary. And then by consulting this grammar book, which had many examples of various grammatical points and looking up things in the dictionary I wrote a text book for myself.

BH: [laughs]

TT: Graded textbook. So lesson one, lesson two, lesson three. With suitable sort of vocabulary that I thought I should be learning in sequence. And then you know, grammatical points that I sort of arranged for myself in a graded manner to learn without too much psychological resistance and you know and so on, and then having compiled this textbook, which I still have somewhere, and I proceed to study that textbook and taught myself Spanish.

BH: But you went French-Spanish, not Japanese-Spanish.

TT: No Japanese-Spanish and that was so much easier because, as I say, slightly blasphemously, Spanish and French are dialects of each other, right?

BH: [laughs]

TT: And then I became fairly fluent. Of course eventually I had to speak with a real Spaniard and then, you know, read Spanish books and newspapers and so on, which I did, but then next thing, in order to keep myself on my toes, you know, I was taking of course in lycée all sorts of lessons in various subjects, right? So the French literature, history, and geography and what have you, not much sciences, but anyway. I decided to take notes in all those subjects in Spanish.

BH: [laughs] Was this just to give yourself a challenge?

TT: So, simultaneous translation, no it's just more practice.

BH: Yeah.

TT: And simultaneous translation, and I was managing, so I very quickly became fluent in Spanish and then...

BH: Why did you want to be able to speak these languages though? Was it just curiosity or did you think it would give you some...

TT: So, so again, thank you very much for bringing this up. So some people, you know, learn one language after another, just because, you know they... they're driven and so on, and in the Guinness Book of Records there are people who are known to have two hundred languages, that's all of course fraudulent. Okay, fraudulent is a bit too strong because they mean well, but that's misleading, because you see if you mean by the ability by knowing language the ability to say hello and how are you and have some kind of practical conversation about finding out where the next, you know, football game is or the nearest coffee shop is and so on, yes you can two hundred languages. But that's not what I mean by knowing a language. Knowing a language for me, it's very much like getting to know a friend.

BH: Hmm.

TT: So, first of all, everyone has some. And some people have more, some people have less, in numerical value, but it's not quite true that the more you have the better. Right, it really has to do with what kind of friends you have and what kind of history you have shared, what kind of sort of destiny you are going to share and so on. And also, you know, with like friends, you might be extremely close during a certain period of your life and then grow apart.

BH: Hmm.

TT: And not be in touch for years and years and then come together and sometimes you sort of [claps] start again. Or sometimes you don't. And with languages it's very much the same. So...

BH: So you wanted them as friends?

TT: So with languages, it's very much like friends. And just like friends there's always some kind of accidental looking, but in retrospect some kind of fateful sort of encounter.

So for me Spanish was Garcia Lorca and Romancero gitano, one of my best... favorite anthologies of poems and it's still today. And, you know, with French it was something else, with English it was another thing and then with Hebrew and so on and so on, it's something else. There's always a very very sort of accidental looking but fateful encounter which motivates me. So I never learned language just for the sake of learning a language. Okay, later on when I became a professional philologist, that's the term that I use in preference to linguist. Of course, you know, you have to have some kind of breadth and the sort of common sense knowledge about various languages so of course I picked up some things but that's not my basic attitude to languages. For me a language is like getting to know a friend. Making a friend.

[gentle piano stinger]

BH: Let's get back to Japan. You move back to Japan, your parents think you should get a degree at a Japanese university. What do you do?

TT: So I went back and then there was a problem, because in Japan in those days, this has been abolished since, there was a rule that said you are not allowed to graduate from high school before you turn eighteen, and you are not allowed to enter university before eighteen. But when I went back to... you see in Japan the school year starts in April and ends in March, which is very nice because, you know, it starts and ends when the cherry blossom is in full glory, but the in France it was September to August. So when I went to France I was moved up half a year up and when I came back I was moved up half a year up so I skipped one year, so there was a problem, because no university would allow me to sit an entrance exam, except one private university called Jochi University in Tokyo, which is of Jesuit foundation by the way, decided to close its eyes and they allowed to sit the exam. So that's where I went.

BH: To study what?

TT: Study classical languages.

BH: Right.

TT: Classical languages in the European sense. Study Greek and Latin, and a little bit of Hebrew. And I was very fortunate to meet a very good supervisor from year one actually, year one of undergraduate studies. Somebody called Jason Roussos, [ed. note, pronounced Yason] I mention his name in memoriam. He died quite young and he was a Greek diplomat and also a former pianist who lost a thumb in a terrible accident and so he couldn't be a pianist anymore so he went to Oxford and did D.Phil or a doctorate

in philosophy and then started traveling as a diplomat, Greek diplomat, and ended up in Tokyo and was teaching not quite part-time but not quite full-time at the university. So I became his student and he was wonderful as a teacher of Greek. So I had already known... learned Greek in France and as such I had a huge advance ahead of the other students. Anyway Greek is not... Greek and Latin also, not so popular in Japan, so I remember in most classes we were maybe three or four students and by the end of the year, the number dropped down often to one, that is me. So when I graduated clearly I was the one, so I was given a job so I could teach and I could be comfortable, and in the meantime it was really a fascinating thing. It's the, what is called the field of classical philology.

BH: Philology?

TT: Philology. So philology means, etymologically of course, love of languages. But this is the word that, old fashioned, which used to be current in the 19th century. This is the glory days of the European scholarship, which discovered and reconstructed the Indo-European languages. So, you know, where do those languages that are so diverse now, come from? And what is the historical revolution and can you decipher for example, decipher the scripts and all that kind of thing. That's philology. And this is the study that of course extremely systematic and if a mathematician can say so, is extremely rigorous. I mean there's no nonsense about it. But at the same time, very much, interested in quirks and peculiarities of actual languages. Where as, yes I study modern linguistics, especially after Chomsky, but you know, they are talking about the universal grammar and you know, patterns innate in humans and so on. I'm not really interested. I mean, again, this is probably, I should better not had better not broadcast but sometimes it feels like it's kind of done by wannabe mathematicians who are not doing it properly, right? I mean, and in fact it's very striking that many of those modern linguistics actually don't know many languages, and in fact, many PhD programs in linguistics have dropped language requirements altogether, which is very peculiar to me. I mean, you know, I'm in languages because I like languages, not because I like some theory about some pattern about some theology about languages. I actually like the real languages, yeah, okay. So again it comes from my attitude that it's like making friends. I mean who cares about the general or sort of philosophy of humanity. I actually like these people, that's why I'm friends with them.

BH: So at this point you think you're gonna have this career teaching about language, studying language?

TT: That's right, so Greek and Latin and...

BH: Yeah.

TT: And I also worked a lot in Classical Chinese, which goes back quite a way. So I really liked those things and in fact, to this days I'm no longer a professional of course, and I don't devote much time but... I like this. Yeah.

BH: So where is mathematics at this point?

TT: So mathematics comes in purely by accident. And it's really another instance of making a friend and this turned out to be a lifelong love. Right? And in fact I married mathematics later on. So, what happened, and this is story that has been told elsewhere but each time, you know, I have several versions of the story and each time I tell a different version.

BH: [laughs]

TT: So, I might as well. I was already a junior junior lecturer in Classics and Classical Philology, but I was still writing my thesis. You see it was not... the competition was very low to be honest so, you know, I could get a job before PhD. And in the course of this I needed a certain reference from the library, so I went to the library, at the university. But I couldn't find it. It had been checked out, but next to it... very close to where it should have been was a biography in Japanese translation, obviously, of a Russian physicist called Lev Davidovich Landau. And to those people who have studied physics, Landau is a household name and he's one of the greatest theorists of the 20th century and he's especially famous for being the kind of senior author, together with Lifshitz of Landau-Lifshitz Course of Theoretical Physics. And this is kind of the bible in ten volumes of all sort of aspects of theoretical physics. And if you walk into any physicists office in any country anywhere in the world you'll see some volumes of Landau-Lifshitz, it's really fundamental to this day. I certainly consult no other book more often than Landau-Lifshitz. Anyway, so but Landau's biography...

BH: Mhm?

TT: Written by his niece called Maria Bessarab. This was a non-scientific biography in the sense that, you know, it tells anecdotes and fairly purple prose and so on so on. I had never heard of Landau for the simple reason that I had never any interest in hard sciences. Nothing at all.

[Audio cuts out]

TT: No, I had never heard of Landau and so but I was also going on a train journey so I wanted to have something to read so I took this book out of the library. And it was a curious book. As I said, you know, it doesn't have much scientific content but the biography of Landau and one thing that you should be aware of is that the Landau was, you know, created in Moscow, a very powerful school of theoretical physics and also wrote this really bible of theoretical physics together with Lifshitz. But also when he was now... what's that... fifty... four if I'm not mistaken. He was in a terrible car accident on the way to Dubna and which really in which he was declared clinically dead several times over and some people like Penfield, the great neurosurgeon from Montreal flew in to Moscow to operate on him and so on and he was eventually saved but he could never go back to science, so had this terrible car accident. So the biography came to this scene of the car accident and then what happened and so on. But then narrates a remarkable scene when Landau's son, Igor, who was an apprentice physicist came to visit the academy hospital to check up on his father and his father had been in a coma for maybe a month and a half, right? But that morning he woke up, finally, and this is the scene. So, Landau doesn't say anything like, oh where am I, or Igor, my son, or I'm happy to be alive. He was always in the habit of teasing people around him so he said, according to biographer, oh Igor, you are here, what's the indefinite integral of $\frac{DX}{\sin X}$?

BH: [laughs]

TT: Now indefinite integral of $\frac{DX}{\sin X}$, this is the kind of thing that you learn in elementary calculus, study advanced calculus and so on. Anyway, Igor, nothing doing, so he takes out the slip of paper and starts, you know, doing all the tricks and substitution and change of variable and integration by parts but somehow he doesn't succeed. The answer turns out to be $\log \left| \frac{\tan X}{2} \right| + C$. But anyway, so he can't do it and then Landau looked at Igor and teasingly said, Igor you regard yourself as an educated adult and yet you are incapable of performing such a simple task. When I read this I took it as a personal insult, because I had been sort of held as a very good student and in fact more, and I regarded certainly myself as an educated adult, after all in the European tradition, you know, and a Asian who learned Greek and Latin and a little bit of Hebrew and all that kind of thing but I had never heard of integral and in fact I had the vaguest idea of what $\sin X$ could mean. I had never learned this stuff. So as kind of a revenge on Landau and to show him, that I [chuckles] am an educated adult, I decided to teach myself this strange subject called mathematics, up to the point where I can solve this problem of indefinite integral of $\frac{DX}{\sin X}$.

BH: This is crazy. This must tell me something about your personality though, this is...

TT: Yes.

BH: Most people would just read that as a joke and move on.

TT: That's right, but it happened only once in my life. Right? So I don't know if it's part of my... okay so without any trace of this personality, of course it couldn't have happened so it's part of my personality. At the same time I think it's significant that this manifested... this personality manifested itself only once in my life as far as I know.

BH: Hmm.

TT: And this was the crucial moment of my life because it led me to my vocation.

BH: Hmm.

TT: I don't hesitate calling mathematics my calling. In the sense that, you know, for many people a job is a job, right? I mean you do it in order to do something else, yeah? But, you know, if I were to be exiled to South Pole and while struggling to survive I would still not be able to... yeah, I can't help thinking mathematics, part of the day.

BH: How old are you at this point when you read the book on the train?

TT: I was well into my twenties. So it was very very late for a mathematician, because most mathematicians actually wake up to some kind of mathematics in their mid teenage.

BH: Mhm.

TT: And many people take part in Math Olympiads and all that kind of thing and hone their skills and by the time they go to university, they have already learned a lot of the university material and all that kind of thing. So, but I had never never heard of calculus at this stage. But at the same time, I wasn't out of the woods yet because the, you know, I had nobody to turn to all the people that I knew were in Classics and Humanities and so the only source of advice that I could think of was Landau himself in the book and elsewhere in the book Landau was quoted as saying, well you know, that was his attitude as a physicist. In order to do physics and serious science you need mathematics backwards and forwards, you have to know it really like the back of your hand. But that means practical ability to solve problems. Yeah, and to be very flexible in using your tools. Nevermind proofs that the mathematicians go on about and don't worry too much about definitions, what you have to do in order to learn mathematics is

go to a library and check out the biggest book of problems with solutions that you can find and just do all of them. That's how you learn mathematics. So I had no other authority to turn to so I listened to Landau. I went back to the university library and looked among the shelves and the book that had the largest number of solved problems was in Russian. Not surprisingly because the Russian tradition has an art... really a wonderful art of producing those collections of problems from which you can, you know, teach and train yourself in mathematics and to a certain extent physics. It's a really great tradition. So I checked it out because that's what Landau said and this book was by... it's not famous by the way, by three authors called Danko and Popov, Kozhevnikova and it was called [Russia title]... Higher Mathematics through Problems and Exercises. This started with high school material of manipulating polynomials and you know, two and three dimensional analytical geometry and what have you through very thorough calculus to basically engineering syllabus at a university of solving differential... partial differential equations by Fourier methods or some probability calculations and so on so on.

BH: Did you already speak Russian at this point?

TT: Complex analysis... no I didn't. But anyway Landau said...

BH: [laughs]

TT: ...the largest number of problems so I took the largest number... now a linguist or a philologist is not afraid to pick up another language. So, because that's what Landau said, I started working through this book...

BH: [laughs]

TT: And the Russians are very good at compiling such books. It was very self contained so I didn't need any other reference that winter. Now this was very slow in the beginning for two reasons. Number one, I knew no mathematics at all. Number two, I knew no Russian. So I was learning Russian at the same time, but having two obstacles means that you are removing them at the same time, so the progress was shall I say quadratic, so I went faster and faster and faster as my Russian got better and better and my mathematics got better and better so, after about three months, this set in two volumes contained three thousand five hundred or so exercises, I was nearing the end of three thousand five... I must have worked maybe eight hours a day and it's again very strange in retrospective how much energy I could muster for what seems like a very [laughs] you know, almost no reason. But anyway and so...

BH: Did your colleagues know you were doing this like in your department. Would they say, what are you Tadashi, and you'd say oh I'm just learning Russian and mathematics? [chuckles]

TT: No, no, they didn't. They didn't because I was so far ahead of everyone else that, you know, they kind of let me alone, left me alone and...

BH: Okay.

TT: Yeah. And after about three months I was nearing the end. And by the way, halfway I came to the point where I could do the indefinite integral [chuckles] $\int \frac{dx}{\sin x}$ [laughs]

BH: [laughs]

TT: But I had momentum, I couldn't stop.

BH: Okay. [laughs]

TT: And so I just kept going.

BH: [laughs]

TT: And as I said it's tangent of...

BH: You over...

TT: Log of tangent of X over two.

BH: You over took Igor. [laughs]

TT: Yeah that's right, Igor. And then so I kept going and towards the end I realized two things, number one, I was fairly good at this kind of silly manipulative exercise, yeah. Number two, maybe this is not what mathematics is all about. So, I looked around. I got a bit interested, and in those days of course this was before the internet, so [clears throat] I wanted to study mathematics for two years, and to see what it was like. I went to various places, libraries and embassies indeed, and then I found that in England, Oxford allowed you to rush through the undergraduate program in two years if you're crazy enough to take all the exams in two years. Especially for people who already have a degree from another university in another subject, so I applied and I got a small

amount of money from the British Consul and I went to study mathematics for two years in Oxford but this had another problem in fact. I knew no English. That is, I could read English in order to consult the professional literature in philology because a lot of it is, of course, written in English, as well as German and French and of course, a lot of it Latin also, but anyway... so I knew no... but I had no active knowledge of English, but you know, a philologist is not afraid to pick up another language [laughs] so...

BH: Yeah.

TT: I taught my... so this very makeshift and rapid way of learning... teaching myself English has consequences later on. For example, I noticed at some point that there was the word jail. J A I L. But then there's another word that I encountered every once in a while, spelled J, excuse me, G A O L. And I thought it was pronounced gaul. And I kept pronouncing it gaul. So eventually I went to Oxford and in conversation I sometimes jail, I sometimes said gaul, I thought, you know, they are two common synonyms for jail in English. One was prison and the other one was gaul. And nobody ever corrected me.

BH: [chuckles] No?

TT: And it was only after I went to do a PhD in Princeton that I think maybe I was in my third year or something, my good friend, Lebanese, Kamal Khuri-Makdisi said, Tadashi, I heard you say gaul many times, I think I know what's going on. [laughs]

BH: Okay.

TT: Taught me that this was actually jail. Anyway so, you know there are things like this.

BH: So were you going to Oxford just to do like an undergraduate degree in mathematics?

TT: That's right, so as a mature student.

BH: Yeah.

TT: And... but it was undergraduate so I skipped the first year and I sort of rushed rushed through the other two years and so on.

BH: Yeah?

TT: And... but I really liked it. I was a bad student. I didn't know what it meant to study mathematics, so it was... really... tough but I liked it so towards the end I thought well I would really like to do this. So I was on a leave of absence from my position in Tokyo, but I resigned and then I went to Princeton to do a PhD.

BH: I mean... I assume you're being very modest then. Getting to do a PhD in Princeton means you're obviously doing very well at mathematics...

TT: Ah! But but wait wait... this had lots of accidents also. So, first...

BH: Were you disappointed when you went to Princeton that there wasn't a new language for you to learn? [laughs]

TT: No, no, but you see...

BH: [still laughing]

TT: Going to Princeton was an accident and I really was lucky. What happened is that, I don't know if you're aware of this but there is an American Standardized test called GRE. Graduate Records Examination, which you take if you want to go to graduate school, almost anywhere in America, right? And there are of course practice kits that you can buy, some of them published by Barron's and so on. And there is the general test and there's a subject test. There's a subject in mathematics. So I bought these from Blackwell's, the local bookstore in Oxford and I studied through them and all that. I wasn't particularly good at them, and I payed the fees and then I went to the test center in London, so there was... this was administered outside the U.S. as well on a certain chilly... November morning. But then, I went there the night before, by the way, and stayed in a hotel and so forth because the train connection from Oxford to London was not so good. Anyway that morning I showed up on the misty morning and then the building was completely locked on all sides. And furthermore I saw maybe a dozen other people who clearly came to the same test center and who are milling around completely lost. So it was closed. What do we do? Well, this was before the internet, right? And so we started calling various phone numbers that we had. America was not yet awake, and besides it was Saturday. Eventually we tracked down the number in Holland, I think, which was in charge of administering those tests in Europe, and they said, Oh! The test center... London test in GRE, we forgot, or something like this.

BH: Mhm?

TT: So that didn't happen, and this was the last and only one that I could take before the application deadline to America, so I was... I applied to Berkeley and Princeton, so I went back to Oxford rather... depressed and thought well there goes my chance of going to graduate school in America but then once I arrived in Oxford my tutor said, what you should do is to take up a phone and call those places, Berkeley and Princeton, explain what happened.

BH: Mhm.

TT: That hadn't never occurred to me, okay, so I called Berkeley. Of course this was already Saturday so I had to wait until Monday to call them. But anyway, Berkeley said, oh so what happened? So I couldn't take the test and of course I'll be very happy to take the next test which is going to be in January but please understand that my test score will not arrive in time, so I hope you will not prejudiced my application and they say of course it will prejudice... it will affect your application, yeah?

BH: Hmm.

TT: And so I was very sad about this. And then I called Princeton and Princeton said, what? G... G what? GRE? What's that? Oh it's a test, and we require this? Really? Okay. And you want us to take... no you don't want us to take... you didn't take it? Why didn't you take it? Oh you didn't take it because... oh okay. Oh, nevermind because we will have already sent you an admissions letter yesterday.

BH: Okay, [chuckles] nice.

TT: So that's why I went to Princeton.

BH: Lots of worry over nothing.

[Gentle music box stinger]

BH: So what happened during that period where you were reading the book and then when you went and did your undergraduate at Oxford? That seduced you away from languages to mathematics?

TT: Well... many many things. I will start with the more facetious one. The way I studied mathematics even in Oxford was very peculiar. So I had no idea that you were supposed to go to lectures and read textbooks and study the syllabus and then, you know, practice on past examination papers. I had no idea about this because I had too

easy a time in Classical Languages and elsewhere before. I could just mind my own business and have my own program just as wrote my own textbook in Spanish.

BH: Hmm.

TT: Many years ago. And so I just went to the library and then looked at some old books because I had the worship of old things and then there is this book called A Course of Modern Analysis by Whittaker and Watson, whose first edition goes back to the beginning and really around the turn of the 20th century. So this was already a hundred years old, almost a hundred years old by then. And then, you know, you had wonderful sort of classical material in the most sort of unforgiving [laughs] manner and the worst of the tradition of the mathematical tribes of Cambridge at the time. And I was in Oxford, I'd like to remind you, and they spelt for example the word show, the verb show, as S H E U, shoe and so on.

BH: Hmm.

TT: So I was night after night sort of looking through without really doing anything, pages of Whittaker and Watson, that's how I quote unquote studied mathematics. [laughs] Really not much to it. But another thing that seduced me to mathematics were two things. One of them was not really a seduction, again a culture shock. So I went... this was already in Tokyo, actually. Before I arrived in Oxford, but my experience in Oxford confirmed what I had seen in Tokyo. So I went just to see what it was like to a mathematics lecture at the university. So, the professor was writing something on the blackboard and explaining. And in the middle of which a student from the audience interrupted the professor and said, excuse me I think that's wrong. And the professor looked at the board, thought for a few seconds and looked at the students and said, ah that's right, you are right and I am wrong. Corrected the mistake and went on. [chuckles]

BH: Yeah.

TT: I had never... seen that happen in the humanities. A student saying to a professor... that's wrong and the professor just casually saying, you are right, I am wrong and going on. Because the stakes are higher, they are worried about something else. It's true, I'm not saying that humanities... for example Classical Languages, that's really the hardest technical subject among humanities, if there was one.

BH: Hmm.

TT: So there is right and wrong, but you know, you would not say... you are wrong and the professor will not say, you are wrong... you know, you are right, I am wrong. It will be cast in some much more diplomatic language, right? But in mathematics... somehow, on the one hand they didn't know any course of courtesy but at the same time I felt that the, you know... they are all worried about something else.

BH: What was that thing?

TT: Well... mathematics. That's kind of a sort of circular statement but, you know, somehow they were worried about the mathematics and the stakes were so higher that they didn't really mind too much how you expressed yourself, provided it was clear. Yeah?

BH: Yeah.

TT: And that was amazing. I mean I had never seen that happen. And, yes so that's... that's one thing. Another thing which... began as a belief but turned into a conviction is that, okay, so I was doing something even to me of that time seemed slightly reckless because... well reckless I had my job in Tokyo, so which I was planning to go back to, so it wasn't reckless it was just...

BH: Hmm.

TT: A fun experiment. But mathematics clearly was a difficult subject, I knew this. But I also believed from the beginning, before I knew any mathematics that it must be a very learnable subject, because here it is. It's supposed to be the most rational of subjects and very very logical, and generations upon... two thousand years of the clever people. Some people might say cleverest people, worked very hard to make it the systematic and streamlined and logical and you know, clean and all that kind of thing. And reorganized and reorganized and so forth. So it must be a very learnable subject. Whereas... other subjects for which I have the, you know, great fondness and so on, are not so learnable in the same way. For example if you take history, well if you are born outside the tradition that describes that history, well, you know there are so many sort of things that you are missing, right? I mean, you know, you don't understand English history unless you have lived in England, really. And unless you have lived at least a life of experience the life of an English person, and you have some sympathy for the, you know, all the cultural sort of hints and the signals that you consciously or unconsciously collect at all times. Process all the times. So it's very much culture dependent, very much background dependent. But mathematics is a much more learnable subject. I'm not just saying that mathematics is a universal language and that

kind of trite sort of hackneyed sentence but at the same time because mathematicians are so much... work so hard at making the subject clean... yeah?

BH: Mhm. Mhm.

TT: That it must be a... and these are clever people. They are no fools so it must be a learnable subject. And it turned out to be a very learnable subject. It's a very very hard subject but if I worked correctly, what's correct that's a big question but reasonably and kept going at it and with a little bit luck, I must be able to make progress. And I did.

BH: If mathematics and you are such a good match, you say you're now married and you have an aptitude for it, you have a love for it, did something go wrong that made you come to it so late.

TT: No, I don't think so. I think if I come to mathematics much earlier the way that most of my colleagues who later became mathematicians did, I may not have stuck to mathematics. I think I was too immature for mathematics, much earlier. I was precocious for other things but not for mathematics and I wasn't ready for mathematics until that moment in time. I think mysteriously it all worked out. And just the same thing, if you married a certain person and if you found the love of your life, well, why didn't you sort of... what if you found that person from early age for example, from your childhood, well it may not have worked out, right? It's exactly the same thing. And so... and by the way you said I have aptitude for mathematics. I don't think I have any particular aptitude for mathematics. I like mathematics.

BH: Hm.

TT: And probably more than an ordinary person likes mathematics. That's certainly true. But I don't think I have a particular aptitude. But I really like it.

BH: I know you have a funny relationship with the word if, but if that book hadn't been on the shelf that day you were in the library do you think you'd be a mathematician?

TT: No, I would have stayed a classicist. That's for sure. I'm absolutely certain. Yeah.

[string music stinger]

BH: So, you went to Princeton and then like tell me about the sort of mathematician you've become. I mean you now know lots of mathematicians so you can probably compare yourself with other ones. What sort of mathematician are you?

TT: I suffer from my background in a way. So for example, I don't have much stamina, unfortunately, and that's because I came to mathematics quite late.

BH: You're doing well with this podcast, then.

TT: Yeah, that's right, that's right.

BH: [laughs]

TT: And it's already dark and we'll wrap up.

BH: We're now in... Tadashi and I are now in pitch black in his backyard, it was sunny when we started. [chuckles]

TT: That's right. So I don't have much stamina...

BH: Right.

TT: So I can't keep going at a difficult problem for a long time. And I have a... a curious rapport with mathematics and it's activities. Perhaps which I'd like to explain. So I don't like difficult problems. And in fact to me I'm not saying anything about other people, right? But to me it's almost a sin to work on a difficult problem, because if a problem is difficult for me that means that I'm not... that's not right.

BH: Right...

TT: I'd rather work on an easy problem, because that means that it's natural, I'm ready for it and the problem is for me. So, in a way you know, there are many many criteria by which you can judge... attach a value to an activity. It can be difficult or easy. It can lucrative [laughs] or not money making.

BH: Mhm.

TT: Or it can be, you know, noble or not and so on. But the criterion that is really must important to me and that has to do with my background is natural or not natural.

BH: Hmm.

TT: So I like to do natural things, and not... avoid unnatural things. So, if a problem is

too difficult for me, I don't mind giving up, because I'd rather work on an easy problem. Actually it's to me at this point in time easy, and if it's difficult I might wait for ten years and come back to it and man... sometimes it becomes really easy at that time.

BH: Hm.

TT: Or there might be problems that are tremendously difficult for me now, which could have been very easy ten years but I missed the opportunity. That's fine too. Yeah? So that's one strange thing that I have. Another thing which comes from the humanities background is that there is a very very strange effect. If I'm having a difficult time learning... reading, deciphering somebody's work, it helps tremendously if I meet that person. [chuckles]

BH: Right?

TT: So, meeting that person, and I don't even have to speak about that work, you know, many mathematicians especially brazen ones like me go to the author of a paper and say, well, I can't be bothered to... read your paper, explain it to me over coffee now and [laughs] then they will oblige you and that's very helpful by the way.

BH: Yeah.

TT: But I don't even do this. I just might talk about the weather, I talk about something else. But somehow all those mysterious signals about the human being that I haven't had before allow me to... anyway, it makes reading so much easier. It's unbelievable.

BH: Hmm.

TT: And if I were being nasty I would say that sometimes meeting the person makes me realize that I don't have to read this.

BH: Right. [laughs]

TT: But that's one thing. So meeting somebody, the author of... so mathematics for me is a very personal activity. In the sense that almost all the mathematics that I understand are very very well, shall I say, there isn't much of it, either was involved in it myself or I know the authors quite well.

BH: Yeah.

TT: And if I have no personal connection with a piece of mathematics then I find it very difficult. Now when I say personal connection sometimes it can be through a book as well. For example I feel that I know Landau quite well.

BH: Hmm.

TT: But, you know, you have to... interpret broadly. So that's another very peculiar thing that I have with respect to mathematics.

BH: Professor one thing that you're often praised for is your lecturing and teaching and you've done Numberphile videos with me and your popular talks and lectures, people quite enjoy your way of communicating mathematics. Do you think that has been informed by your interest in language or something else? Like what attitudes do you take into a lecture or teaching that you think might be different from other people?

TT: Well, first I'd like to kind of soften that statement as well. You know, I have a belief, another strange belief of mine about mathematics that in fact not only in mathematics but about human understanding in general. That I believe that you never understand a piece of mathematics the first time you meet it.

BH: Hm?

TT: I don't believe it.

[long pause]

TT: It's always the second time. Now, it's true you sometimes meet people who seem to be very quick on the uptake and who understand something as soon as it's explained to them and so on but I think they had met it before. If only kind of half consciously and, you know, or they had been prepared in some other ways, so and that's very natural because, you know, if something is as hard as mathematics and as substantial as mathematics, you don't understand it the first time, if it's genuinely new, and if you understand it the first time, it wasn't new to you. It's almost a tautology for me. So in a way, the trick then is if you are for example worried about taking an exam or something or having to understand something on the spot because you're meeting some very important person in a conference or something, well let it be the second time. Just prepare yourself... just give yourself a first time elsewhere. So that you have already muddled through something and had the experience not making head or tail about this but the second time you'll understand, yeah? So I think many people come to me, bless them, after some public lecture and so on, or after just simple teaching period that, oh

yes, why didn't my previous teacher explain it this way, now I understand completely. Well, thank you very much, because I'm here at the right moment. I'm here for you the second time. I think that's all there is.

BH: Okay.

TT: Really, maybe that's not all there is but that's the bulk of what there is, yeah?

BH: Okay.

TT: Another thing is that I have tremendous sympathy for people who don't understand mathematics because it's... it's so recent for me at least in my psychological history. Okay, I'm now an old man and I got my PhD when dinosaurs roamed the earth, but at least because my trajectory, I still remember very vividly the days when I knew no mathematics at all, and I was functioning as a human being. [laughs] Or maybe, some of my friends will say I was not functioning as a human being.

BH: [chuckles]

TT: But anyway I remember this very well, whereas most of mathematicians, you know, barely remember the time when they didn't know mathematics, right? When they were not doing mathematics, so it's possible to become... I think I... really believe that it's possible to be very intelligent, very hard working, very sensitive and very human while being stupid at mathematics, that's perfectly possible.

BH: Hmm.

TT: Yeah? And I have one more story. Maybe we should wrap it up?

BH: Will you give me one more story and then you give me one more question and then we'll stop.

TT: Okay. So, I was teaching many years ago, I found myself teaching a remedial mathematics in New York, an evening class. And I was teaching, you know, arithmetic, really, to grown-ups who came to evening classes in an attempt to catch up and I have to say, well, unfortunately it was too late for them. But anyway so I was teaching students who were much older than I was, you know, in their forties and fifties sometimes and for example I was teaching how to add fractions, yeah? And obviously, you expect it don't you, that some of them started adding numerators and denominators separately, and this is... such a common mistake that in elementary

teaching that I was prepared for this. I had what I thought was a water tight defense. First I said, in no uncertain terms that what they did was wrong, so be... be absolutely clear that this is wrong, and second I gave them some intuitive daily examples that show that what their rule gave complete wrong results, for example you know one half plus one half, if you have one and one and two and two you would still be two over four which is still one half. Really? Half plus one half is still one half? I mean that surely be the whole, right? So that kind of thing. Then third, I gave them in writing on the blackboard and orally, the correct rule, and I told them that this is the correct rule. What they had believed until now is incorrect and whatever the reason this is the correct rule and please be careful to use this at all times from now. And then the fourth, I applied the correct rule to those intuitive examples from step two and I showed them that they gave elementary reasonable answers that they could accept intuitively, so yes there's evidence that this is a correct rule. So that sounds water tight, right? But then and speaking of my previous point, I learned something that day, because one of the students looked very very unhappy about this and said, well but look, you know, on this special example that you chose, my rule didn't work, but how can you say that my rule doesn't work in general? Right? So that's a shock for most mathematicians, yeah? But, when a normal person says general versus general, this person doesn't mean with no exception ever. I mean mathematicians are the only people who are crazy enough to let one single counter example destroy their entire edifice that they built.

BH: Mhm [chuckles].

TT: Yeah? What people mean by general is generic. That is most of the time, in most important and typical examples. Okay there might be exceptions but we'll deal with the exceptions case by case, that's what... so what this person was asking is, well maybe my rule of adding numerators and denominators work most of the cases but, you know, you very sneakily came up with a very very special example to sort of invalidate it, but maybe not. So yeah, that taught me something on that day. And this is something... this is a sensitivity or rather the kind of realization that I keep at all times because I came to mathematics so late and I still am kind of struggling with mathematics and then I still sort of feel tremendous sympathy or camaraderie shall I say, with people who are perfectly intelligent but who know no mathematics. And it comes I think from the maybe deep... into the deep past from the fact that, you know, if you live in a single culture, a single language, you end up thinking, for example, that well, English, if somebody doesn't speak English all that well and struggles and is very inarticulate, well that's the end of it, I mean, you know, you don't think highly of this person. But who knows, maybe this person might be the greatest, you know, poet that the Russian language has produced in the last fifty years, or the, you know, best so is finest thinker in Japanese or who knows? But you don't see that until you step into the other person's

shoes and then start speaking their language. Yeah?

BH: As a mathematician what do you want to accomplish? Have you got like an ambition or a burning desire? Do you want your name on some really really famous theorem or proof or like what drives you now everyday when you work?

TT: As a mathematician, I want to be remembered for being somebody who worked with Brady Haran on Numberphile. That's all.

BH: [laughs]

TT: But yeah... [laughs]

BH: But are you ambitious or are you competitive or what like why do you go to work everyday?

TT: I'm very very ambitious in the sense that I have things that I want to do but they... these things that I want to do are none of your business. In the sense that they don't belong to a program. They don't carry names or conjectures. They are certainly not by anybody else, but these are programs by me. And I'm... I'm interested in this, I'm sometimes fascinated by them or sometimes I find them so natural that I think somebody, in particular me, should try to look into it, and those are the... and so I have long long lists and very intricate programs which keeps evolving by the way, as I live, you know? From year to year. But... and you know even trivial things like books to read and people to talk to and things to learn and so on and you know, and the projects to do and so on, I have quite a lot of these, but they are all mine, and nobody knows about them and I would be hard pressed to articulate them but they are very very clear because I keep thinking about them all the time.

BH: Are they written down?

TT: They are not written down but every once in a while some... some little hints of them kind of sneak out and these are called publications. But, yeah, and sometimes, you know, I'd share some of these with... I'm sure by watching videos on Numberphile you have no idea what I'm up to. But I am up to something and they keep evolving. Just as I say, you know, if you have a very good friend, why do you go see this person? What's your ambition? Do you want money out of this person? Do you want to, I don't know, have sex with this person? Do you want to what? Well... you want to go to this person, you want to spend time with this person but maybe you don't have any of the aforementioned agendas. Nonetheless, [string music slowly fades in] you want to go see

this person. You want that person to be part of your life. And that's your ambition.

[music continues]

BH: For more from Tadashi Tokieda check out the notes for today's episode. [music continues] I'm gonna include links to his numerous Numberphile videos. I'm Brady Haran, and you've been listening to the Numberphile podcast. [music fades out]