

Numberphile Podcast Transcript

Episode: The Offensive Lineman - with John

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John Urschel is studying for a PhD in mathematics - and played three seasons of professional football in the NFL.

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Brady Haran [BH]: To be honest I'm like a massive sports fan.

John Urschel [JU]: Mhm.

BH: So when I sit here and think about oh all the things I'd love to talk about there's loads and loads of football stuff but I have to remember this is for my Numberphile audience and most of them aren't sports fans. [laughs]

JU: [laughs]

BH: So I gotta like reign it in.

JU: Right you gotta control yourself.

[gentle intro music]

BH: Today's guest is a mathematician currently completing his PhD at MIT. But call up John Urschel's CV and there are a few lines that... well, might catch your eye. That's because he played three seasons as a professional footballer in the NFL. Lining up in forty games for the Baltimore Ravens. And before that he was star college footballer at Penn State. But throughout his athletic career John's continued with mathematical study and research [music continues] and after retiring from the NFL at the ripe old age of twenty-six he's now focused full-time on mathematics.

[music fades out]

BH: If I went back in time and met you as a kid...

JU: Yes?

BH: What are you like?

JU: Let's see, I love puzzles.

BH: Yeah.

JU: I love horror movies. I know this is pretty random but...

BH: Yeah?

JU: Yeah these are the two things I really enjoy. You wouldn't think I was an athlete.

BH: No?

JU: You wouldn't think I was, you know, a social butterfly let's say but I was just really into, especially puzzles, man. That was my thing. Board games.

BH: So you weren't a big guy? Because obviously you're a big guy now anyone who looks at you would think oh well that's guy's obviously a footballer.

JU: Well I was a big guy but I was also pretty overweight when I was little.

BH: Okay.

JU: So I didn't really look the athlete part.

BH: So if I had met you I would be more likely to think that you're a future mathematician than a future footballer?

JU: Oh, absolutely. I want you to know that like from elementary school all the way through like middle school, if you had met me you would have been like future mathematician but I don't know about the football.

BH: What happened, what changed?

JU: I got in shape. I lost a lot of weight, I started exercising. I started looking at what all the other kids were doing and I thought, wow I should really try this whole conformity thing out and so I just started playing sports. I started doing things that other kids were doing because well I was sort of quiet. I was soft spoken. I didn't really sort of naturally get along with other kids so I thought let me just fit in and do what the other kids are doing. And the other kids were playing sports.

BH: So John I think it's bit of a cliché or bit of a trope that if a kid is really

smart but you know all kids want to be sport stars, don't they, that's like a dream. And they have some aspiration to play professional sport they'll often get like a guiding hand from a teacher saying you know it's really important that you use your talents academically because sport is such a gamble and you wanna have a good job when you grow. Were you getting that, as you got more into football but were clearly a pretty good student were your teacher's saying hey John, I don't think football's the way to go. You're so good at puzzle and maths maybe this is the way to go?

JU: No... you know I didn't really get any sort of guiding hand, I would say from teachers. My teachers, especially in the sciences, they very much let me be with some small exceptions. You know they saw I was very very strong, I would get, you know ninety-nines and one hundreds.

BH: Hmm.

JU: And I was just someone they wouldn't have to worry about. I would say my mother... I'm not sure guiding hand is the right word. More like forcefully sort of keeping me in line. She was always making sure I was staying on top of my academics.

BH: So as you went through college and obviously you were like a really good college footballer. Were you staying on top of your academics because you loved it or because this was like your insurance policy if you, you know, broke your leg or something?

JU: Oh by the time, let's say, I was done with my first year at university...

BH: Yeah?

JU: I was fully in love with mathematics. And at this point I only care about like... learning more math. I started doing math research and yeah... this was all

that concerned me. I wasn't too concerned about grades, I wasn't concerned about, you know, getting a good job or any of these things. I just wanted to learn more about math.

BH: Was it hard to have the head space for both? To keep on top of football at the level you wanted to be and... be like, you know, doing research and learning all this new stuff in the world of math?

JU: They both took up a lot of time, I mean, man, when you're an American football player in the States and you're sort of going to university at the same time, like playing college football is really a full-time job.

BH: Yeah.

JU: And so fitting in the classes and fitting in the study, it's tough but... I mean this is what I did for fun, so like you know, I would get done with practice, you know, eat dinner... I would just go home and hang out and I'd read a math book, like this is what I did to decompress.

BH: What about like your teammates and stuff like that?

JU: Yeah I'm gonna level with you, like, none of my other teammates were, you know, reading math books to decompress but you know, some guys liked to read books at the end of the day. Most guys like, you know, playing video games or watching TV. These are the more typical things you do after practice.

BH: So was the math something you would wear like on your sleeve and be proud of and like hey I'm the football math guy and like that makes me a novelty and interesting or was it something you kind of kept a bit quiet?

JU: I would say neither. I mean it's not something I ever hid. It's not something... I mean I was... ever since sort of like college I've always been

proud of my mathematics but at the same time you know I'm just one of the guys, so it's not something I'm championing, but... it's also not something that I'm hiding.

BH: This might be a stupid question but did you ever feel like your kind of mathy puzzley brain ever brought anything to your football?

JU: You know, a little bit. I feel like I pick up the playbook pretty quickly.

BH: Yeah.

JU: Like I learn the plays decently quickly and I feel like it helps me sort of like think through my decision making on the football field in a sort of more rigorous way.

BH: Did football ever bring anything to your math?

JU: It definitely brings a little bit of competitive drive and...

BH: Yeah.

JU: I think more than anything American Football it really taught me how to be resilient. How to work hard. I mean these sort of stereotypical characteristics that show you how to be successful at something. Football was the thing that really gave me that.

BH: So at college do you ever feel like you came to a crossroads? Like as it became clear that the NFL was possible and you could take football to the next level. Did it ever feel like a choice? Oh I'm gonna have to give up the math to take football to the next level, or did you always think you could keep both balls in the air at once?

JU: I knew I was going to have to put one on the back burner for sure. I mean in college I managed to do both and you know... certainly math took away some time that I could have spent sort of doing more training for football and football definitely took away time that I could have spent learning more math and sort of doing new things. When it became time for me to play in the NFL... for sort of at least the first season I played in the league, I did put math sort of on the backseat because it was just you know... professional football just took up so much time.

BH: Have you ever felt like, you know, you didn't quite reach the level you could have in football because of math or you aren't quite where you could be as a mathematician because of football? Like is there any regret there or anything?

JU: [pause] No, I think I went just about as high in football as I could go, I mean, I'll tell you sort of any day of the week, I definitely have way more talent in math than I did in football.

BH: Yeah.

JU: And, you know, I had to work really really hard in football to sort of get to where I was and I think I really peaked out right around, you know, about as good as I could do and then math I mean... I think it's a little too early to tell. I definitely haven't sort of had the time to put in sort of as much time into math as I would like. I mean I think I'm still doing decently well for myself but... football took away a lot of time and now as soon as I retire I have a child.

BH: [laughs]

JU: And she's taking up a lot of time as well.

BH: So I'm imagining a lot of people listening won't be particular familiar with American Football.

JU: Mhm.

BH: You were an offensive lineman.

JU: Yes.

BH: Which as I understand it, from the bit I watch, is kind of part battering ram, part kind of blocker, obstacle sort of thing. It doesn't strike me as like... the position on the field you were first to go to look for the intellectual, the mathematician... is that unfair?

JU: Yeah! That's actually incredibly unfair because well... if you use for instance standardized testing of intelligence that's perhaps used in the NFL...

BH: Yeah?

JU: When you're entering... it turns out that the smartest... I believe the two smartest positions on the field, once we remove kickers and such, this is another discussion, but once we remove the kickers, it's the quarterbacks and it's the interior offensive lineman.

BH: Okay.

JU: Are the two smartest positions, and... it makes sense because as an offensive lineman, although your description of our sort of functions is correct, one thing that offensive linemen have to do is we have to make a lot of cerebral decisions. We have to do a lot of decision making, in the same way that a quarterback has to make a lot of decisions.

BH: What kind of decision are you making as an offensive lineman?

JU: So deciding how we're going to block a play. Deciding like what are plays

going to look like, how we're gonna scheme it out, who blocks who, and what sort of blocking scheme we should use. And this is highly dependent on once we get to the line... what we see in front of us.

BH: So it's not just prescribed from on high and you're just...

JU: No.

BH: Following orders... there's a lot of fast decision making?

JU: Yes, there's a lot of fast paced decision making that sort of falls on us because it's really hard for the coaches to tell you exactly what to do in like every situation. You have to make a lot of decision on your own and you have to be adept at recognizing what the defense is doing.

BH: Can I ask you another sporty question, then?

JU: Yeah! Absolutely.

BH: I've watched a lot of American Football on TV, or a reasonable amount for a guy in England. What's playing in the game and being out there on the line like compared to watching it on TV? If you wanted to help me understand what the difference is between being an actual player and being just like some chump watching it on TV... how would you do it?

JU: Yeah I would tell you, one, everyone's a lot bigger than they look on TV. This is the one thing everyone says to me when they watch, you know, people on TV and then they see them in person. Everyone's bigger than when you see them on TV. And on TV I think you don't quite realize like... how loud and how hard the hits are.

BH: Right.

JU: Yeah because on TV this doesn't really get conveyed to you. Whereas if you see it in person, you get a very different sort of feeling. I mean you hear it. You see it and you hear it.

BH: That brings us to probably something I know you get asked about a lot, when we talk about the hits and the violence of football.

JU: Mhm.

BH: And you're this smart guy, with this brain that's this incredible asset to you. There's been all this publicity about head injury and the violence of football.

JU: Mhm.

BH: What was your thinking about that? As this becomes a bigger and bigger issue and you're a mathematician and you're thinking, you know, maybe my future down the line's gonna be using my brain and there's all this publicity about how these hits might be doing some damage to my brain. What's going on here? Is this playing a role in your retirement? Or is there pressure coming on you or...?

JU: It's not something that now that I'm retired that I'm particularly concerned about. I mean I've retired pretty healthy. I had very few head injuries. I think it's sort of common sense that sort of okay playing American Football, it can't help your brain.

BH: Yeah.

JU: You know, it can only hurt it. But I mean this is the case in sort of a number of sports although American Football's to a great degree than let's say European Football, or let's say wrestling or other sports. But this is definitely

something that I think football's been trying to address recently. I mean the NFL has been trying to do a lot of rule changes to deal with this and also look into sort of better technology for helmets but [sighs] yeah it's a tough question and it's something that I think everyone who sort of, you know, plays football or wants to play football just wants to be aware of.

BH: John I feel like you're a special case though. I mean you're almost like a super talented pianist risking their fingers, you're not just like another player you're a guy who has like this brain which could play and hopefully will play a big part in your future. Are you getting any extra pressure? Are any mathematicians you're working with saying to you, hey John I think you got a bit of talent here, you sure you want to be banging your head every weekend? Or was that never a discussion?

JU: Oh! Yeah, yeah, no. Of course I've gotten extra pressure like through college all the way through the pros from family, from friends. Yeah, from fellow academics. Even some football players always ask me, like, are you sure you wanna be out here? [laughs]

BH: Yeah?

JU: No I mean I love playing football. It was something I really enjoyed doing especially at the college level. I dunno it felt like time to retire, I started enjoying my time at MIT more and more and you start thinking more and more about longevity.

BH: Yeah.

JU: You know, I wanna be able to do math into my sixties and seventies. Like you go around these math departments like MIT and you see these older professors and they're just still chugging along very happy to be, you know, involved with math and... I wanna be, you know, functioning, hang out with my

daughter, hang out with my grandkids, still be able to walk around, you know my knees still work, my hip still works, my shoulders are okay. I was blessed to sort of retire and be more or less, I mean, compared to most NFL retirees, very healthy.

BH: I don't know how much trash talk there is between players in the NFL. I would have imagined there's quite a lot, like trying to get in each other's head during a game.

JU: Uh, yeah there's some but not as much as you would think, I would imagine.

BH: I was wondering whether or not your opponents like got in you head about mathematic stuff. Did they like research you enough to know that this could be an Achilles' heel or was that not something you ever heard out on the field?

JU: I've only heard this out on the field like on select occasions and it's only when I'm like playing against like friends of mine.

BH: Right.

JU: It's happened that like, you know, I'm playing a friend of mine and before the ball snaps someone asks me what two times two is.

BH: You didn't have like big like [chuckles] defensive guys saying look out for that pretty little math brain of yours, you're about to take a hit.

JU: No, no such thing.

BH: Ahh. They missed an opportunity there I reckon.

JU: They missed their chance.

BH: [laughs]

JU: Yeah, now I know what you have done.

BH: [laughs] For sure I would have been right into that, although to be fair I don't think you would have been too riled if you had me on the other side of the line. [laughs]

JU: Yeah I'm sure how well that strategy would have turned out.

BH: John I notice you wear number sixty-four, are you gonna give me anything mathy here or is that nothing?

JU: I wish I could. It was a complete coincidence. It was the number I was given when I first got to uni.

BH: And let me ask you this then, I'm gonna give you a choice here.

JU: Okay.

BH: Fields Medal, or Super Bowl winner's ring?

JU: Fields Medal.

BH: What if sweeten deal and say Field's Medal, or Super Bowl Ring with first ever offensive lineman to win MVP in the game?

JU: Field's Medal, man! Fields Medal.

BH: Wow. I'd thought you think about that more. [laughs]

JU: No, no. Fields Medal. I mean Fields Medal says I've really contributed something, whereas I really enjoyed football and, you know, I loved it but you know... I'm not making anything.

BH: But what about this whole thing about the camaraderie and the team and all that matters is working as a team towards winning something and like you've dedicated lots of your years to football.

JU: Mhm.

BH: And to reach the pinnacle of that would be something?

JU: No it would definitely be something. I mean... okay if you sort of gave me other choices like if it was... Super Bowl Champion versus lesser things than you know. There are many instances where I'd choose Super Bowl Champion but...

BH: Alright, yeah...

JU: Yeah, you throw out a Fields Medal. I mean, you know, c'mon man, you're hitting me something heavy here.

BH: I gave you too good an option, I should have... I couldn't think of a lesser award that would have been a fair contest so, I'll know for next time.

[violin music]

BH: What's it been like going from being this guy who's on TV and in stadiums and people are screaming and like, you know, you're the big guy in the room when you walk in 'cause you're a football star and people want your autograph and stuff to being... a PhD student? Which like, you know, is considered [chuckles] the lower ranks of life in the university?

JU: Oh it's been amazing. I'm someone who really enjoys peace and quiet. I really enjoy keeping to myself. I mean I always have even when I was very very little and that hasn't changed. I enjoy not being bothered.

BH: Do you think you're having an authentic PhD experience? Because you're always gonna be that guy who, oh see that guy over there, the really big one? He played in the NFL, like he's bit of a big deal. You're never just gonna be the normal mathematician, are you? You're always gonna have that novelty about you.

JU: Yeah I've come to sort of just accept the fact that I'm never going to be a normal PhD student. I'm never going to be like just a normal math professor and I recognize this and this is something I'm comfortable with. The hope is let's say the reasons why I'm never going to be a normal PhD student is, you know, largely related to these football things but even, you know, being a regular professor or mathematician... I hope there will be reasons for this perhaps not football, though.

BH: Do you think... you're gonna have to work that bit harder to get legitimacy amongst your peers when you move up to that professor level? 'Cause mathematics is like any field of endeavor there's like jealousy and politics and that. Can you imagine that a lot of other mathematicians may think oh yeah okay he's Mr. Football, as you really got it where it counts mathematically? Like do you feel that you're gonna have to go a little bit harder to... prove yourself because of that?

JU: Yeah, I definitely feel that pressure and that's something that's real and that's something I think about and I always try to think about where my priorities are because... okay I'm retired from football and now I have extra time and I think about how much of my extra time do I put fully back into math? How much do I put into my daughter, which is being a good father and being a

present father is extremely important to me. And how much of it do I put into math outreach, which is something that is becoming incredibly important to me. And I think just an important thing in general. It's a tough question.

BH: Why is math outreach important to you?

JU: The reason why it's important to me, first of all, math education is not sort of equal in all places and okay... I mean... education's never going to be equal, equal everywhere but... [sighs] the amount of inequality we see at least I'd say in the States between sort of... people who have a great access to education and high quality teachers and great resources... versus people who are born into a household in some community where perhaps... he or she doesn't have the same resources, doesn't have the same quality of teachers and also doesn't have the same social culture around them that encourages education, that encourages studying and academics as a way to improve your sort of lot in life. We see that... your ability to say, you know, become something isn't just about how smart you are, how talented you are, how are you're willing to work. It turns out it has a good amount to do with where you're born. That's something that's quite sad to me. If you look at all the top American born mathematicians, very few of them are African American and it's not because like mathematics doesn't like African Americans or that somehow all the sort of genius... brilliant math minds in the United States being born are being born white and in good households. It's that there's a lot of smart, intelligent minds being born to the United States that are being lost for some reason or another. And I think that this is just an important problem, and it's something that's important to me because I've noticed that when I meet mathematicians who don't come from what I would consider a standard mathematical background, it's always this repeating story of a student studying something and they have one professor or one mentor who takes an interest in them and this is the reason they go into mathematics. And while these are beautiful stories... what you should really take away every time you hear a story like that is that... without that one professor, without that one person, this story would never happen. And it's sort of very conditional on, you know,

someone going above and beyond and that's not the normal story. Normally these people sort of... fall through the cracks, I would say.

BH: It's not scalable to have these occasional saviors come and pluck someone from their...

JU: Exactly and so I'm a case of... you know... strong mathematician, seeing me in a random class he taught and really deciding this kid has real talent, he is going to be a mathematician and I am going to show him, first of all what a mathematician does and how beautiful it is.

BH: So you did have one of those people, John? I was imagining like football was your savior and the opportunities that football gave you took you there. But you also still had that one off mentor, did you?

JU: Yes! So, it's not like a savior in a traditional sense. I mean okay, I'm at university, my life is going to be fine. I was, you know, majoring in engineering, I didn't really know what I wanted to do with my life and okay I eventually switched even to a math major but I had no clue what I was gonna do with my math major. I thought [sighs] you know I like math classes, I'll take a few of them, maybe I'll get a Masters in engineering or a Masters in economics or finance and then, you know, I'll go get a job. But, you know, I took this course in analysis from this professor and he could have just, you know, taught the class, given the exams, graded it and then just moved on with his life, 'cause you know he has important research to do.

BH: Hmm.

JU: But, instead you know, he saw me in this class and he thought, wow, this kid has a real potential to be a good mathematician and he saw that in me and he decided to take it upon himself. It's not like I went to this guy and said hey, are there any extra things I could do, are there any sort of things you could have for

me. He sought me out after class and told me to come visit him in his office. And he gave me a math book to read and he walked me through things that I could read and then he proposed that, you know, I try to do math research. And he thought that I would be quite good at it. And he mentored me through the entire process and before I met this guy, Vadim Kaloshin, before I interacted with him, I had no clue what the profession of mathematician even was.

BH: Hmm.

JU: I'm gonna level with you. I was taking some college math classes and I think I'm not the exception. There's tons and tons of even college students who take math classes and have no clue what it is their math professors do. And have no clue what a mathematician even is.

BH: That whole research culture's quite hidden from the students, isn't it? They just see them as someone who's teaching them.

JU: Yeah. I didn't even know what the word mathematician was. It's very dependent on your upbringing I think.

BH: Do you think you've got something to contribute there then in letting people know what mathematicians are?

JU: Yes, I think it's an important thing. Am I the best person for the job? Certainly not, but for right or wrong I'm in a sphere of influence because I played American Football. This sphere of influence is especially prevalent in the United States where sports are extremely popular and American Football is the most popular sport and I have a responsibility to sort of use my platform to show people first of all, what is a mathematician. Second of all, why is math important to you as a person. Why is it important to you, if you want to go into a scientific field? Why is it important to you if you wanna even just be a writer? And third, I need to sort of be a role model because I recognize that like I was saying before

there are so many brilliant minds that are sort of just being lost and falling through the cracks. I have a responsibility to sort of be a visible African American mathematician because it's hard for someone to want to grow up to be something when one, they don't know that something is and you know even lesser so but two, if you see that profession and you don't see anyone in that profession that let's say even looks like you. For a young person that can really be a discouraging thing.

BH: It's an incredibly complicated issue, though, I wouldn't even know where to start talking about. But do you think the problem for talented young African American mathematicians is... mainly coming from on high or is it like a culture problem amongst themselves where it's just not an aspiration yet?

JU: Both.

BH: Right.

JU: Both certainly play a part because so often in... and I shouldn't just say African American but in sort of poorer socio-economic areas, often sports are put on some pedestal as a way out. As a way to sort of better your life, or better yourself when in reality okay... this might just be my opinion. I think the greatest gift you can give someone is education. This is the most powerful tool to help someone improve their situation or lot in life but it isn't necessarily viewed like that in all places.

BH: Do you ever wonder about your role as that messenger because obviously as you say you've been given this megaphone because of your athletic ability. You've been given the opportunity to speak to these people but at the same time it kind of undermines your argument because people can say well it's easy for you to say John, you're like athletically talented and huge and you got to play for the Baltimore Ravens and who are you to tell me to go and learn in school when you're like living some impossible dream.

JU: Yeah, no I mean that's completely... it's completely reasonable. I have this sort of...

BH: I'm not blaming you for being lucky. [laughs]

JU: No [chuckles] it's true I have this podium. I was extremely lucky, not all people are as lucky as me, I'll say. Also I have plenty of teammates that I've played with who [sighs] finished playing and all of sudden their bank accounts start running out. They don't have a college degree. They have injuries or issues from playing and it's tough. And these are the people who made it to the NFL.

BH: Yeah.

JU: Let alone the people who didn't even get there. So I'm saying... okay your dream is the NFL. You get there. You play in the NFL for let's say a year or two, the median career length in the NFL is three years, and now all of sudden you're out and you don't have any education to fall back on, in general this is recipe for disaster.

[gentle piano music]

BH: So let me ask you perhaps one of the most difficult questions you could be asked, can you explain to us what your area of research is in an accessible way?

JU: Oh... this, this I can do. So first of all, know that I get this question all the time, and now I'm getting this question to a math audience, so this... this is gravy. Okay, so my research in a nutshell is as follows. I do research in graph theory, which is effectively looking at properties of discrete networks in some sense.

BH: Yeah.

JU: I do research in numerical analysis, which is looking at performing some sort of computations on a computer, that can't be performed let's say by hand with a piece of paper.

BH: Yep.

JU: And you know trying to find approximate solutions to things that can't be solved analytically, often. And then third I do a lot of work in sort of more classical machine learning. Like I do work related to unsupervised learning and clustering problems.

BH: So in your field, we were talking about the Fields Medal earlier, if you're gonna win the Fields Medal and I think you've only got 13 years or so left. What's the holy grail? What's the thing that someone like you could crack that would make you big man on campus?

JU: That's a good question. First of all, I'm not winning a Fields Medal.

BH: No? [laughs] Alright.

JU: Not winning a Fields Medal.

BH: [laughs] okay.

JU: But there's a lot of interesting problems in all those fields. I'll just name a few...

BH: Yeah.

JU: Just to give the audience to things that they can look into. Like in Graph

Theory one of the biggest open problems is this so-called Graph Reconstruction Conjecture. Which simply asks, okay given that you have some graph and now you get to see the sub-graph induced by sort of like all the vertices but one...

BH: Hmm.

JU: For every single subset of that order, can you reconstruct the original graph back. So that's a big sort of open problem that should be easy but is not. In Numerical Analysis, at least in sort of the area I work in, one of the most interesting open questions is can you solve the equation $AX = B$. The linear equation $AX = B$ where A is let's say like a symmetric diagonally dominate matrix. Can you solve this in linear time?

BH: Okay.

JU: This is an important open question. In sort of unsupervised machine learning it's much harder to sort of define very important open questions but I also do a lot of work in quantization and so an open problem that's sort of quite related to sphere packing is something call Gershell-Shin* Conjecture which comes from information theory and this is a big open problem. So... I named a few I suppose.

*[Ed. Note: Best guess, could not find any exact matches after reviewing relevant literature, but there are papers which mention Scholze-Shin Conjecture]

BH: When you look forward in your career, like ten, twenty years or so and you think about what's ahead, what excites you the most? Like is it the papers you'll publish? Is it the possible PhD students you'll supervise? What's the thing you look forward to that just makes you think, oh I can't wait, I can't wait to get there?

JU: Just spending day after day, month after month, year after year, working

on some really hard problems.

BH: [laughs]

JU: And just loving it. Just loving the struggle.

BH: [laughs] it's such a different life to a footballer, isn't it?

JU: Yeah, yeah. I mean failure is just viewed so differently in football and math, I'd say.

BH: I heard you talking about that at a talk you gave, last weekend. I thought that was really interesting. Like failure is just not an option in football and yet it's a really positive thing in mathematics.

JU: Yeah, of course. I mean listen if you're a mathematician and you're trying to solve problems and you very rarely fail to solve something... you are really not pushing yourself that hard in my opinion.

BH: And what about failure in football?

JU: Yeah if you're failing a lot in football then you have some problems. It's quite the opposite.

BH: Let me quickly ask you about chess. 'Cause anyone who reads about you knows you're into chess. You gave a talk about it recently at the National Math Festival.

JU: Yeah, yeah. I welcome chess questions.

BH: I have no specific questions, just where you got into that from when you were young? Did you get into that later, or...?

JU: Yeah that's a great question. I didn't really get into chess until like I was a junior in college I would say. I was pretty late to the game and even then I was sort of very casually into it. I didn't start taking chess seriously until maybe like... three or four or five years ago. You know it's a hobby of mine. I very rarely play chess.

BH: Right.

JU: It's a hobby I quite enjoy. I hope to enjoy doing it for quite a while.

BH: You have no aspirations though, like your competitive side hasn't infiltrated chess, you're happy just doing it for fun? You don't wanna be like a certain level or a certain ranking or number or something?

JU: Oh well... now that you mention it.

BH: [laughs]

JU: Okay, I have a hobby, I enjoy it. I don't wanna be awful at it, you know what I mean? I've really toned my competitiveness down but I can only tone it down so much so like, yeah with respect to chess, like I'll probably become something called a National Master.

BH: Yeah?

JU: It's a title of Master sort of... on the sort of ladder of Master titles.

BH: Well that sounds pretty cool being able to call yourself and kind of Master, sounds pretty cool.

JU: Yeah, yeah. That would be like just something for myself so that I can tell

myself, well John you're not that awful at chess.

BH: So you've written a book?

JU: Yeah I wrote a book. That's true.

BH: I have not read it yet. I haven't managed to get my hands on a copy, 'cause as we record it's not even released yet but by the time people are listening to this it will be released and something they can get their hands on. Mind and Matter, is that the title?

JU: Yes, that's correct. A Life in Math and Football.

BH: Why is it called Mind and Matter?

JU: The Mind and Matter, it's a reference to Schrodinger, you know if you look at sort of the works of Schrodinger he wrote something called Mind and Matter.

BH: Oh so you've just stolen the name then, basically?

JU: [chuckles] Yeah, I've pretty much just stolen it. Although I have to admit that I'm not the only person who's stolen it because a friend of mine actually stole the Instagram handle Mindandmatter.

BH: [laughs]

JU: so like, there's a lot of theft to go around. I want you to know.

BH: I see you've cowritten the book. You have a coauthor.

JU: Yeah. That's my partner.

BH: It is. Louisa Thomas and she's a writer?

JU: It's a family affair, she's quite a good writer. She's written a number of books.

BH: Yeah?

JU: Mostly historical non-fiction.

BH: Yeah. So how does the writing process work when you write a book with your partner? What does that look like?

JU: The way it looks like is she makes all of the narrative sound really really good, way better than I sounded in the first place and I take care of all the math.

BH: You're handling the math and you're just splat everything on a page and then she just has pulled it into like... a narrative shape or?

JU: She makes me sound more eloquent than I originally was.

BH: [laughs] You sound pretty eloquent. Do you ever disagree? What happens when you disagree, like?

JU: Thing is we don't disagree because I know she knows what sounds best.

BH: Yeah.

JU: And she knows I know how to convey math.

BH: Cool. Alright.

JU: Yeah and so we both agreed we know when the other person is the expert.

BH: Okay. How would you describe the book for people who are gonna read it? Are they gonna get lots of math? Are they gonna get lots of football? I have no idea what to expect.

JU: Yeah, they're gonna get about half math, half football. It's a memoir, it's about sort of my life. For math fans first of all, the chapters even tell you what is in which chapter. So if you are not an American Football fan, let me tell you, you can just skip the football chapters. It's very clear sort of...

BH: [laughs] yeah.

JU: What the topic of each chapter is and I'll focus on the math part because of the audience. I would say it's just my journey with mathematics from being like a little kid all the way through sort of my PhD at MIT and while you know I'm doing any serious math, I'm teaching you calculus, I'm introducing you to a lot of mathematical ideas that I believe are quite interesting and that I personally interacted with as I grew up. And you'll see them and you'll interact with as I did.

BH: So someone reading this, I mean obviously you want them to come away with multiple things but are you wanting them to come away having learned math, or just like to be inspired or just learn a bit more about who you are? What would you describe the main purpose of this book? Why are you putting it out there in the world?

JU: I would like you as the reader, okay perhaps you already like math in which case I want you to enjoy the book, but for a broader audience I want reader's to come away with an appreciation of math that perhaps they didn't have before, especially given sort of their experiences in school or their current experiences in school. I want them to walk away with a new found appreciation for math that perhaps a lot of the readers got because they were coming for some

football.

BH: Nice. Just sneaking a bit of a medicine in the dog food.

JU: Yeah, except, yeah you try to sneak it in and all of a sudden the dog food is just like completely covered by medicine.

BH: [laughs] And the medicine starts tasting pretty good.

JU: Yeah, exactly.

[gentle music]

JU: People often talk about the wonder of the things I've done, like the wonder of doing American Football and math but sometimes I like to try to stress that there's really no secret for just hard work.

BH: Hmm.

JU: Like there's really no substitute. There's no like secret formula. It's just I hope that you really love the things that you do and you work really hard at them and that's like for someone who wants to be, you know, successful at something or successful at multiple things, that's really all the advice I can give you. There's no secret.

BH: Can I get you on the record with one last deal as well?

JU: Yeah.

BH: If I make my way over to MIT sometime and bring over some brown paper you think you'll talk me through a bit of mathematics for a couple of videos as well?

JU: Absolutely I would love to.

BH: Alright then. Well, seeing you've agreed to that I will for one more time tell people that they must check out *Mind and Matter*, by John Urschel and Louisa Thomas, it's gonna be worth a read. I will include links like in all the usual places and stuff like that for people who want to check it out but I wanna say... thanks so much for your time, John and it's been really interesting.

JU: Yeah, thanks for having me.

[gentle music fades in]

BH: For more about John's work at MIT and a bit more about his football career too, I'll include some links in the show notes and of course I'll also link to his book, *Mind and Matter: A Life in Math and Football*. It's got a really great cover. There's a big burly John pictured on the front but he's covered in chalk and standing in front of a blackboard. [music continues] The Numberphile podcast is made possible by the Mathematical Sciences Research Institute, that's in Berkeley, California. And this episode was supported by the audio engineering company Meyer Sound, who are also based in Berkeley. You can find out more about both MSRI and Meyer Sound via links also in the show notes. My name's Brady Haran, I'll be back again soon with another podcast and our next guest is someone who's been requested by our listeners very often, so stay tuned for that one. In the meantime you can watch all our Numberphile videos, support us on Patreon, maybe check out merchandise like t-shirts and mugs and posters and stuff by going to our webpage, that's Numberphile.com. Thanks so much for your time and hope to catch you again soon.

[music fades out]

