Paleo Solution - 249

[0:00:00]

Robb: Morning. This is Robb Wolf with The Paleo Solution Podcast. I'm incredibly excited today. We're doing a little departure from our usual schedule of protein, carbs, fat, exercise, sleep, rinse, lather, repeat. Actually get to talk the somebody who's been essentially a hero of mine for a long time, Professor Barbara Oakley, professor of engineering at Oakland University. Doc, how are you doing?

Barbara: Hey, I'm doing just great Robb. Actually I want to return the compliments because I found your work to be just marvelously helpful for me because I have autoimmune disorder. I've got rheumatoid arthritis and so I think your approaches have been incredibly helpful for me.

Robb: Oh wow. I had no idea. Thank you. I was going to say hopefully you liking my material doesn't undermine your credibility. But thank you. That's a huge honor, that is the most gratifying part of the work that I do is if I found out that somebody has been positively influenced by all these.

My wife's mother died due to R.A. complications about three months before I met my wife. Gosh. We have probably 3,000 or 4,000 emails now of people sending in medical documentation like my antinuclear antibodies were this before eating autoimmune paleo and now they're basically in the normal range afterwards, not largely asymptomatic if I take care of myself.

So it's something that just drives me forward because there are so many people out there that you know the crazy used car salesman pitch, give it a shot for 30 days, see what happens. And I guess you've tinkered with it and clearly found some success with this.

Barbara: I've really found success. And here's the funny thing, I know that in reading your book, one of the things you talked about was how difficult it is to get people to understand that there are problems in some of the approaches that have been promoted by well meaning individuals in the government and by well meaning scientists and so forth.

And it’s hard to say hey no, look they're really is good scientific research that backs up what I'm saying. It’s just kind of sometimes lost in the morass of all sorts of other things. But it’s actually similar. My area of expertise is education. As far as I'm a professor of engineering which is a kind of funny thing because I grew up hating Math and Science. But that’s kind of another story but I got out of the military at age 26 and sort of decided to diligently see if I could retrain my brain to go from sort of this touchy-feely language kind of person to a Math person. And I was able to do that.

But really what I wanted to kind of bring back into this is you might be surprised to realize that in the education literature, it’s the same sort of morass of very different, wildly divergent claims where people often really put forth claims that are not substantiated very well yet everybody jumps on board because they sound very good. And a recent incredibly important study was just published. They found that 0.13%, at 0.13% of all education literature is actually replicated. So that means pretty much people go out, they publish and nobody ever checks them.

So that’s why there's this wild sort of phantasmagoria of competing educational approaches and things that people say hey, this sounds good and they jump on the bandwagon. So I think education is in some sense a lot like nutrition as far as they're being a kind of a wild west of research.

Robb: Doc, help me with this because so you're a professor of engineering. I started of going into engineering and when I worked harder than I ever had in my life in my first engineering graphics class and my handwriting is appalling. And the guy looked at me and he’s like yeah man, you should go with something else. So I ended up going into Chemistry instead.

I mean there's contentious elements in Physics, in Chemistry, in Engineering to a degree but I feel like that there is not the contention that exists say within particularly nutritional science which I would argue when you start getting into biological systems, you have much more complexity.

[0:05:06]

But I have this sneaky feeling also that because engineering is so steep in the foundations of Physics, it’s basically Applied Physics and Mathematics, we have a pretty tight grasp on Newtonian Physics, on

Quantum Mechanics, on Statics and what not. I don't see this thing degree of contention that exists whereas in nutrition particularly this whole evolution via natural selection, evolutionary biology should be kind of the starting point where we have conversations but it's not.

It's this study versus that study, Mediterranean diet versus south American diet. I mean do you agree with that? Do you have any kind of an opinion in that regard?

Barbara: Well, I think you're making a very astute observation about hard science, Physics based sorts of disciplines like engineering. In engineering, if you get a theory wrong, your plane goes down and everybody dies. It's apparent pretty quickly that there's something wrong. But in Biology especially in Nutritional Sciences, I think you get a little bit a step back, I mean it's not so glaringly obvious when you get something wrong.

So if you say for example hey, it's obvious fat makes you fat right. Even though that's incorrect either by a lot of research findings, it just sounds so good that people buy into it. It's easy to make research approve whatever you wanted to prove and whenever something begins to involve something that people think is good for other people, then all the sudden it gets away from a science and it gets more into something where you're proving something you just think is good for other people.

And so it's not science really so much anymore. And I think nutrition's like that, education's like that but engineering isn't quite like that because you can immediately see or see much more quickly when you're doing something that's off target. And besides, it's not so touchy-feely, it's really pragmatic stuff.

So there's less of a tendency to say oh this is really good for people and so I'm going to make it have this kind of finding instead it's just sort of hey, this circuit does this and if we tweak it a little bit we can make it faster. Does that make sense?

Robb: Yeah. I mean from an experimental stand point, you can set up a lot of experiments testing you know an i beam bridge versus a suspension bridge and what not and test them under load and say well, this one seems to work better given the amount you know which one holds more load with the amount of material in there. And you can start testing and fiddling with that whereas in biological systems, it takes a long time for

effects to become apparent. They are adaptive and so like you said we could even be doing something reasonably harmful to a biological system but it will find ways to cope and adapt over the course of time.

So we may not know that that's really an issue immediately. So it's still is one of these interesting things for me though. There's still even within interestingly the evolutionary biology scene, there are some folks there that really – I feel like the fact that I do what I'm doing is actually indicative of a failure on the system that this hasn't already been woven into the story. This idea of discordance, sleep, food, exercise, gut biome, community relative to some sort of ancestral norm.

And not that that is necessitating some sort of reenactment story. But just here's a starting point so we can start having discussions about how human health is influenced by the biophysics and the biochemistry of the environment that we live in. You know that's kind of my crazy used car salesman pitch. And some people seem really comfortable with that and say yeah, that makes a lot of sense and let's start couching our question and answer sessions from there.

And then other folks were like no, no, no, we just need this random mice control trials with really no orientation towards an epistemology and then they're okay with that. And it's fascinating to me. And again two possibly, two different educational or mindset kind of orientations going on there.

[0:09:49]

Barbara: I think there really is. What's sad – one of my great heroes in learning was Santiago Ramon y Cajal. And he was this juvenile delinquent in the 1800's in Spain. And his father just gave up on him but in his 20's he decided to retool his brain and to try to start learning. And he won the Nobel Prize for his research on neuroscience. And he's called the father of Modern Neuroscience. He's just an incredible guy.

But one thing he said was he wasn't a genius. He didn't have these remarkable powers of memory. Also, some other things. He was very persistent and he said there's a place for people who are really persistent like me because what happens is these incredibly brilliant people who move far surpass him as far as they're natural IQ and so forth, what their tendency is is to jump to conclusions.

And I think that we see that a lot in the world of diet. People who are really smart, great researchers and what they can often do is because they're really smart, they're not used to other people sort of finding fault with how they think. So they're not used to being flexible in their thinking. You know taking feedback and readjusting and going in a different direction because the direction they're going is wrong.

But more than that they'll just make a simple basic fundamental jump of conclusions and aim towards that and you'll often see that in science very, very often. And especially if it's something that sounds intuitively obvious like it must be right like fat's bad for you that it would you make fat.

Even though it's not right, people kind of pile them aboard and everybody kind of makes studies that show that finding, even though it may not be the correct finding, just because well the brilliant people were already piled on with that and everybody's kind of following their lead and you get a big enough group of people. And then all of a sudden you're finding that journal editors are selecting people to review papers based on the fact that hey, you know I don't think that's a good idea so I'm going to get a reviewer that I know who's going to pan this thing.

And so the journal start shaping how the research unfolds. So it's a fascinating process. I'm working now with a friend on a new book. I did a book called unedited volume called Pathological Altruism. And indeed people for the proceedings of the National Academy of Sciences on Pathological Altruism and Altruism bias, well meaning intentions that actually misdirect how science and many other disciplines unfold. And I think that has a big impact in nutrition and in education.

Robb: Interesting. What do you see is being somewhat of a solution with regards to that? Just open access so that you have people from outside disciplines who maybe have a peripheral interest in the topic getting in and looking at the research, looking at the numbers in a very critical fashion? What do you feel is kind of a systematic process towards weeding some of that out?

And then before that I feel that intuitive leap is probably a bit of a double edged sword I would suspect. Like often times that is the moment you know like Kary Mullis sitting out on a surf board on LSD coming up with a

polymerase chain reaction. There's that leap of intuition that gives us some major breakthroughs occasionally.

But the other side of that is this leap of intuition may lead us down the polymerase path and then we end up defending that tooth and nail. But what are some ways that we can create systems to, how can we engineer some solutions to that process?

Barbara: Well, you're bringing up a lot of interesting points. I mean Kekule' who had that sort of vision of the benzene ring. He was sitting there looking at a fire and it sort of came to him the ring or burrows, that circle of snakes that gave him the pictorial intuition that the carbon ring was the way it was if I remember correctly. You know far more than I about that.

[0:14:49]

But what Kekule' and others often said was this intuitive leap is incredibly important but boy you better check it because a lot of intuitive leaps are actually wrong. And so we always celebrate this idea of yes, you get this intuitive insight. But actually a lot of intuitive insights are just dead wrong. And so it's always something we need to be aware of.

Now one thing that there was a brilliant historian of science Thomas Khun and he wrote Structures of Scientific Revolutions. And one of the things he found was that outsiders often go in and look at a discipline and they're the ones either very young people or outsiders are the ones who make breakthroughs, dramatic breakthroughs in disciplines because you're able to look with fresh eyes.

So I do think that having outsiders go in is one possible or it's one mechanism whereby people can start kind of making correctives when science goes astray. The problem with science going astray is when it's going astray, during that time people were always saying no. But this is science. And then afterwards when people got realize that hey, it's really wrong what these people were suggesting then they'll say but that wasn't science. That wasn't really science.

And of course it's sort of like you got this self-protective armor. Whenever it works for them they say it's science. And as soon as it doesn't they pass it off and say well it wasn't really science. But you can't really tell because at the time that these kinds of misdirected individuals

are going off track, they'll say it was science or it is science and so you can't really catch them.

I think they are – John Ioannidis at Stanford University is doing wonderful work. He found that most scientific studies, he published a very controversial paper showing that many scientific studies are dead wrong. They draw conclusions that they simply shouldn't be drawing particularly they do statistical analysis that prove out nothing. There's the research is based on fundamentally flawed initial assumptions. There's just all sorts of problems. And he started a new center in Stanford to study bad science.

Robb: Interesting. Which I'm sure makes him very, very popular.

Barbara: He's I think a very strong minded individual because you'd have to be. People love stones quite a bit as you know. Anyone who takes a different approach no matter how pragmatic, no matter how well founded, as they say you can always tell the leaders because those are the ones who get arrows in their back.

Robb: That's what that's feeling been, okay now I'm putting two and two together. Speaking of two and two, you didn't start off. You weren't hatch a Math prodigy like most people would assumed that professor of engineering would have just kind of leapt out of the womb and started doing differentials and integrals. And off into the sunset but that wasn't really your story. How did all that you know lack of Math and then re-steeping a Math, how did that all play out?

Barbara: It's a funny thing because one day one of my students found out that I was not a natural Math person growing up. In fact I flunked my way through elementary, middle and high school Math and Science. I was abysmal. I remember being called into the principal's office once because I was reading a book of literature when I was supposed to be doing Math.

And I just said there's no way on Earth you will ever get me to study Math. It has nothing to do with the world and I hate it. And so they just let me go and I went back and I read and they never bothered me again. By the time I got into the military and I've worked with a bunch of West Point engineers and I begin to realize I listed in the army to study Russian. And because I love learning languages and so I learned Russian and I did

end up working as a Russian translator in Soviet trollers up in the Bering sea. So I have great drinking stories.

[0:20:03]

Robb: And probably a pretty stout liver after doing that too.

Barbara: Yeah. For sure nowadays, my liver is not able to take as much as it used to when I was young. But the Russians, they can outclass anybody. But the thing is I began to realize that my career options were really very limited with a background in Slavik languages and literature. There's just not a lot of call. And it's the kinds of interesting jobs I was looking for, there just wasn't much opportunity for someone with my background. I was really…

I followed my passion the way they always tell you, follow your passion. And I ended up in a corner because I followed my passion, I had restricted myself so that I didn't have the kind of education that the world really kind of needs nowadays. The world is much more technologically oriented and much more Mathematically oriented.

So anyway, I decided well hey, why not broaden my passion instead of just following them? Why don't I see if I can – if I'm always interested in new perspectives which I always was, I love adventures, I went down into the South Pole station and worked as a radio operator that's where I met my husband. So I always say I have to go to the end of the Earth….

Robb: Literally.

Barbara: But if I was so interested in new perspectives, why didn't I try a completely alien new perspective that would be learning Math and Science? And so I got out of the military and I went back and I started at remedial algebra, high school level algebra. And at first and it was terribly, terribly difficult. If I had known then what I know now about how people learn, I could have made it so much easier on myself. And so at any rate, I did manage to completely shift my brain.

My student one day asked me how did you do it? And I thought you know I should write a book about that. And that's where the book A Mind for Numbers came from. And it essentially shows you what we know from

research about how you learn well. And a lot of that information, it's funny.

You would think that everybody in the world one of their early things that they would learn would be how their brain works so that they can learn more effectively. I mean not the kind of thing where hey, I'm going to learn all the details of your brain and so forth but sort of what kind of tools do you naturally have for learning and how can you pick them up and use them more easily?

And so that's what the book is about and I also did a massive open online course. We've had 325,000 students so far in the first two sessions. It's incredibly popular. The course is called Learning How to Learn, it's with Coursera. And it is free. So anyone who wants to learn more about how to learn, just go there, register and then you can add just preview lectures and you can start watching immediately.

And it has a lot of these ideas. For example, just one quickly here. Your brain has two different fundamentally different modes of thinking. One is when you focus and the other is a set of relaxed neuro resting states that I collectively called the diffuse mode. And when you're learning something new as it turns out, you actually need to go back and forth between those two modes.

And by doing that, so you need to focus and kind of get it in mind but then you need to relax and what that allows to happen is that involves a much broader set of neuro networks and that allows you to look at what you're learning from a much more big picture perspective.

So we often aren't taught that. We're taught hey focus, concentrate. If you stop concentrating and you give up, it's because you're weak somehow. And instead when you get stuck on a problem, you often have to stop. You have to walk away because that allows you to access these different neuro networks. And then of course there's a lot about exercise.

[0:25:06]

Robb: It reminds me of interval training versus steady state. And even if you were under a steady state say like trail running or something, there's going to be changes in the topography and you're going to be accessing

different metabolic pathways and avoiding that staleness is actually very good on a physical movement standpoint.

And it's funny, I guess somewhat intuitively I had always set a kitchen timer for 20 minutes like if I was really – when I was writing my book, I did this. When I was studying for my Chemistry undergrad, I did this – I set a kitchen timer for 20 minutes and I would really get in and I would set a goal if I can get as much of X done in that chunk of time.

And when the timer went off, I went outside, tried to do something else, stretch, run around, maybe even read a novel or something like that. Do that for about 15 or 20 minutes then go back in and it was kind of a flip flop back and forth between those two modalities.

And I found that it was so much more effective for me versus just well I've got four hours, I'm going to grind for four hours. And I saw some fellow classmates that would do that, grind and they didn't seem to get nearly as much out of it.

Barbara: You were so smart in how you approach your studies. That's exactly what researchers find out now. It almost seems like the change is as important as the initial focus. So in some sense the more changes you can get, that can also be helpful. What I'm really talking about is study briefly, take a break. Study briefly, take a break.

Well I get a lot of anecdotal data that says people benefit greatly from that far more greatly than if they just do the grind business. But also I think that relates to the idea that when you are focusing, you're not stepping back and integrating what you just learned. So every time you focus for a while and then you stop and you go off and you do something else, subconsciously learning is continuing to take place. You are integrating what you just learned.

And so the technique you used is very, very similar to what they called the Pomodoro technique. That is developed by an Italian, Francesco Cirillo in the 1980's. And he recommended a 25 minute timer. Yours was pretty close. And what he would do is – the Pomodoro stands it's Itallian for tomato and he had a tomato's shape timer and he'd set it for 25 minutes. The idea is you focus as hard as you can during those 25 minutes.

And then when you're done, you just relax. So sometimes when I'm doing it, I actually catch myself thinking oh but am I focusing as hard as I can be because I'm obviously thinking about focusing now instead of actually focusing. And then I gently push that thought aside and then I keep on working on whatever it is.

But what you're essentially doing is you are practicing focusing without any interruptions. And that's a key, a part of this is do not let yourself like turn off every little – cellphone, instant messaging, any kind of thing that could disrupt you. If there's lots of noise, put headphones on.

And then focus as intently as you can during that time and then when you're done, it's important to relax instead of saying well I should do another one as quickly as I can. I'll do another Pomodoro. No. Don't do that. Because what you want to do as you're switching your retention and relaxing, your brain is actually integrating what you've just learned during that focus session. And so both components are very important and that's exactly what you did in your own learning.

Robb: Wow, wow. As you were describing that, I had a really interesting opportunity to be kind of the food guy and strength and conditioning coach for a very well-known billionaire software engineer. A really amazing guy and he would disappear into his office and work, work, work.

But one day I walked into their home and there was a gal sitting at a piano and I asked one of the staff I'm like what's her name and they told me and I jumped on the internet, I'm like holy smokes this was one of the best pianists in the world and they just paid her to come by and play background music in their house that day. That's how wealthy these folks are.

[0:30:09]

But every once in a while, this software guy, he would come running out and he would have a clarinet and he would just jammed with her for 15, 20 minutes. And then run back to his office. And then an hour later, he come out and he had a guitar, he could play 20 instruments just flawlessly. But this gal was just playing background music and the next day they would have like a jazz band in there and stuff like that.

But he's kind of work break, his study breaks if you want to put it that way, were basically going out and jamming with some of these best musicians in the world and then go back and get his work done. And he's built I think four multi-billion dollar businesses and this is just kind of his work schedule. He'll work 16 or 18 hours a day. But he has this weird little things that he breaks the day up.

He'll have a really concerted focused period and then an absolute play period whether it's doing gymnastics or jumping in his pool and swimming laps, climbing trees. I mean it was kind of like watching, he's a big guy and it was like watching an enormous kid just play. He would just run out and play music you know. And he's like hey, don't you have a billion dollar business to run? And he's like I am and I'm building another one.

When he was focused and when he was really on to a task, if you interrupted him, there was a pretty good chance that you would end up with you know chopped up by some guy named Vinnie or Guido and then buried out into some back corner of New Jersey or something. But then when he was in his – he also, I sort of bring again just some different kind of board games and stuff like that, when he would come up for air, I would just start throwing stuff at him.

And he loved it and he would be playing guitar and then we would have these word association games or something like that. And he totally loved it and then we jammed back to his office. He clearly had figured out intuitively, instinctively or maybe did some reading on the topic but I suspect that he kind of intuitively figured some of these out.

Barbara: What a fascinating story. This actually brings to mind something that I think is incredibly important for people to know. And that is when – it turns out we always used to think that you were born with the number of neurons in your head and they gradually die as you mature and you were just out of luck. That was it. Your brain would just gradually diminish.

But now we understand that there are some areas of the brain where new neurons are born every day. And one of those areas is the hippocampus which is incredibly important for learning and for memory. And so those new neurons that are to be born are critical in allowing you to both learn and remember new things. And so it turns out there's two

ways that those neurons that their ability to survive and grow can be enhanced.

And those two ways are first one is to be exposed to new environments and new things that you're learning new things. So that's what this individual was doing. He was working away but he was also exposing himself as much as he could to new sorts of people, ways of doing things, ideas, even in his own home, he's still trying to bring these new things in that will keep his various interest alive and learning new things.

But the other way, so being exposed to new environments and learning new things is one way your hippocampus neurons can survive and grow. The other way is simply through exercise. Exercise as it turns out is one of the most powerful tools that we have. I mean if you could put that in a bottle and sell it to people, the effects of the exercise on learning and memory, you'd be a multi-billionaire. Within days, it makes an enormous difference in your ability to learn and remember.

And so people often separate that. They think their mind and their learning of new things are somehow separate from your physical body and actually they're part and parcel of one another. And so the more you sort of enhanced your neurons ability to grow and survive through exercise, the better your ability to learn.

[0:34:56]

Robb: So fascinating. You know I have to admit I do a little both of bow hunting like long bow, or recurve hunting. If I didn't have a family and I had some tiny trust fund where I could do that every day and live under a bridge, I would probably do it because it is so engaging and enjoyable. It's just a constant kind of a zen state for me because not only am I integrating my physical movements of drawing the bow and releasing and there's this hole. It's a very intuitive way of shooting that doesn't involve lining up sights and stuff like that. So there's that whole piece to it.

But then you're looking for game sign, you're looking at topography, you're trying to move quietly and what not. And it is just so engaging for me and it seems reminiscing to have this novelty. Like every time I go out even if I go through the same path, just because it's a different time of year there's going to be a completely different experience occurring with that. And it's one of the most enjoyable things that I've ever done and I

suspect it's some of that combination of both novelty and movement that is kind of tying into that.

Barbara: You know I never have realized before because the big thing I do is I try to go for a walk. My husband and I go for walks everyday and I do some weightlifting. But walking for me sometimes gets a little boring. I'll be looking around and then it's like the same path we were going on. And so what you're doing is you're allowing yourself to look at what you're seeing in a very different way. And I wonder if there's a way to bring some of that same insight if you're not walking around with a cross bow.

Robb: Right, right. That might get the neighbors looking at you as scant a little bit. It's funny even as my daughter is growing, so she's two and a half now. But my nephew is six years old and just simply playing a game of tag with him is so much fun. You're cutting left, cutting right, slipping, falling. We went to a trampoline park and we're playing dodge ball there and it was so much fun.

I literally I was like I might lift some weights once every two weeks now and just go to the trampoline park because I'm learning how to do flips again on the trampolines and do all these other movements and you can run up the wall and kind of flip off the wall and all that stuff. And it is just so much fun and then if you get a three or four, six to 13 year old kids trying to take your head off with a dodge ball these foam dodge balls, I was so smoked after that I had to lay down before I went out to the car.

I literally laid down in the lobby of this place. And I do Brazillian Jiu jitsu, I train reasonably hard but that was so much fun. And I pushed so hard that I literally was trying to remember I couldn't remember a time that I had played that hard. I had so much fun and I came home and took a quick nap. And then I jumped in and had an amazing work day after that and I was actually an enjoyable human being to be around and it was totally amazing.

I think games like that that are relatively simple and not a ton of rules you know there's always interruptions you know resetting and what not seems a potentially a good way of doing that. So maybe you and your husband can get some Nerf Dart guns or a couple of Nerf football or something and chase each other.

Barbara: That’s a great idea. That’s a great idea. It seems to me – you brought up so many different points but just thinking about how like you're physically you're able to do things physically. And I think learning new skills physically in a fairly straight forward manner. And I think sometimes, you can correct me if I'm wrong, but I think that's probably true of you where for me, I'm really clumsy.

But at the same time, when I'm learning something new I have to repeat it a lot of times. And for me, if I'm learning a sentence in a new language, I kind of turn it into a gymnastic exercise where I'm trying to mimic with my tongue the sounds that whoever that person is making and to get as close as I can to that. And make it sort of game.

[0:39:57]

And so by doing that, I can end up repeating something literally 500 times. And then somebody says hey, you know you have a really good accent. That naturally. It’s actually not naturally at all.

Robb: But there was nothing natural about it, it was crafted yeah.

Barbara: Right. I just spent a lot of time doing it. But it was often in a sort of a fun way. So I do love this idea of mastery learning. I think when you're learning anything, you need to slow, practice, practice, practice until it becomes very natural. And then slightly increase the level of what you're trying to do.

And then master that and then slightly increase. That’s so important when you're learning Mathematics. Oh yes, when are we going to talk about Mathematics and evolution?

Robb: Yeah, I had a question for you which we didn’t catch before we roll but where the heck does Math come from? What’s the evolutionary advantage of being – I guess maybe counting your digits or knowing that there's a couple of people in your family group or something like that. Is that an artifact? Is that something that helped make humans human? I know there were few other animals that maybe kind of sort of can do a little bit of counting but is that unique to humanity and what role did it play in our success?

Barbara: Well, this is such a fascinating question. And we've gotten possibly some insight from a recent study. And so all of what I'm saying here is got to be taken with a grain of salt because we don't know for sure this would have to be replicated and maybe it was just a fluke. But what it looks tantalizingly-like is that human intelligence, we know that humans are sort of basically homosapiens not in lineage but there was a little bit of Neanderthal that crept into our blood line later.

Of course early on, Neanderthals and humans were the same line and they diverged. But then Neanderthals started, there was a little bit of back interbreeding. So I don't know maybe 5% or something like that of the genes are actually from this later back breeding with Neanderthal. And they can actually go back and they can see when this interbreeding took place because that's when you have much, much larger chunks of Neanderthal chromosomes that haven't been sort of broken down and interwoven.

And anyway what they're finding is that our intelligence and our Math abilities actually seem to come from the Neanderthal line. Isn't that weird? And that kind of bred in but humans have actually selected against intelligence somewhat. And it's interesting to me because I look at some of the studies on why is the human brain gotten smaller over the last 10,000 years. And sometimes it's sort of well, people have gotten smaller.

And I look at that and I'll be like oh yeah why smaller. They won't talk about the agricultural revolution and that – they'll talk about anything else but that. But we do know that brain size in relation to body size, does correlate roughly with intelligence or some sort of measure there. And so anyway, I can't help but wonder whether human jealousy is actually a factor in any slight decrease in intelligence as it seems through the past 10,000 or more years something like that.

But this whole evolutionary business of intelligence that has intelligence diminish, where did intelligence come from? How does Math play a role in that? You know you can't help but wonder let's say well were the Neanderthals, did they have more of a sort of a systemizing a bit more autism-like oriented approach to where we are able to actually solve the problems but then can't socially interact as well? I mean is that possible?

[0:45:02]

Maybe it is possible because the homosapiens line is the line that has the social skills sort of aspects. So it's all very interesting and it's going to be great to watch research play out on this because I know they're going to be finding some very interesting things in the years to come.

Robb: Oh that's so fascinating. So Charlie is super smart and everybody decides that they don't like how smart Charlie is so he gives out on a hunting trip and conveniently disappears and Charlie gets weeded out of the gene pool and..

Barbara: Exactly right. Look at Caesar. I mean Caesar was freaking brilliant. I mean just absolutely amazing, amazing human being. And he wrote laws for the Roman Empire that just went on hundreds of years afterwards and he was able to kind of get people together. And actually working effectively in government because a lot of what was happening in the Roman Empire is similar towards to what's happening today.

Robb: Shocker.

Barbara: But you have two warring factions, neither of which wants the other side to have any kind of achievements. And so each side blocks the other side so you end up within ineffective government and that's what Caesar was facing except maybe even worse. I mean it was pretty bad. But people were incredibly jealous of his skills, his abilities, his successes. And so we they stabbed him. He was a goner.

If you look in the history of the Ottoman Empires, the same sort of thing you'd have oh really just a great offspring, great son and he's going to become the emperor or the sultan. And then the bad guy can off him because the bad guy is capable of doing these kind of bad things. So it sort of was a counter selection. The bad guys can find it easier to win because they may have the smarts but they're also willing to do almost anything.

Robb: Right, right to further the cause. So interesting. Wow. So Doc again, you have a fantastic online course via Coursera, loved your book. My wife actually swiped it from me and read the whole thing which I tease Nikki mercilessly because she has like this leaning tower of Pisa on her nightstand and there's note cards a third of the way through, halfway

through and I just tease her that it's the place the books go to die and they're never completed. But your book was actually completed.

You know she has in some ways not a dissimilar background. She had a really, really strong language predilection and then I actually figured put that she was pretty darn good at Mathematics, ended up doing Economics degree and was quite good at that. But where do folks jump in on this stuff?

If I – this sounds goofy but every once in a while I'm kind of like I wish I could just sit down and break out an Algebra book or a Calculus book or something and just do some Math problems. But let's say somebody never developed that background or they're wanting to go back and start again and get a steeping in Mathematics specifically.

Do they grab some old high school text books and just start on page one and start working their way through? How could folks tackle this and used the chunking techniques and the Pomodoro technique and what not? And say work their way through pre-Algebra, Algebra, get some Trigonometry and some Calculus under the belt within a year or two?

Barbara: We are living in a fantastic new era where you can get information from the web and it's just wonderful stuff. So you can watch people's the best lecture anybody's ever given in their life. You can pull that up and use that to learn whatever you want to learn. So if you're interested in learning Math, there's great lectures on Coursera that you can look at any kind of Math you want to look at.

I really love Salman Kahn of the Khan Academy videos. You can just pull them up and watch. And I remember about a decade ago I was kind of excited about online learning. And so I mentioned that to a faculty friend who was a preeminent professor and I was saying you know you could put these videos online and people can actually watch them and stop whenever they wanted. And he was aghast because he said people can't stop you and ask questions.

[0:50:12]

I still have to laugh because in real life you can always stop somebody and ask them questions so many times. And most people simply can't do that thing. They don't want to interrupt the class that you can't do that.

But if you're watching something on the video, you can play it again and again like if they speak too fast for you, you can stop it and you can go back. And many of these online programs, they have forums.

So if you didn't get something even after you replay it, you could go in and say hey look folks, can you explain where this came from. And it's incredible. You can get a more personalized learning experience from online videos than you can in a classroom. In a classroom, teacher's talking to what? 50, 100, 800 students. In the video, a well done one, that person is talking to you only to you. And you don't have all the distractions. You can actually learn so much more easily.

And if you couple it with the books, so you can mark up the book and then you are looking at the video. That video can bring things to life so it's like the best of all learning where…. In a learning revolution for self-directed learners, it's a wonderful thing.

Robb: Doc, wait. This gets a little bit into the futurism deal. But are we going to have universities in the future? What's the future of education? You know in the United States, we have this huge chunk of young folks who are crushed under student loan debt. Maybe you got a background in stuff that has absolutely no job potential, I think historically we've said that folks need a good general education although I think that we're starting to maybe question that story a little bit.

But it seems like people really do remarkably well when they study the stuff that they're passionate about. It's very easy to gamify like you were talking about when you learn a language, you really get in and try to perfectly enunciate a word or a phrase and so that it makes you excited and so it increases the dopamine in your brain and your memory acquisition is better, the learning is better.

What's going to happen with the future of education? I mean does it become highly decentralized in largely web-based and then you go find you know if you're going into medicine, you go do the hands on training almost in a journeyman type fashion of yesteryear? What's it all going to turn into?

Barbara: That's a great question. I think one thing to be aware of is that for every door to the future, there are 10,000 guardians of the past standing before it and make sure that door doesn't open too wide. And it's

definitely that case with education. There's a lot of vested interest and a lot of individuals who might lose their job. If you have say a great Calculus course and so everybody all over the country starts taking this online Calculus course. About what? 10,000 professors will suddenly lose their jobs and they are not going to be too happy about that idea.

So whatever is going to happen is going to be happening very slowly because there's going to be a lot of push back. For example we saw at San Jose State that university came up with a wonderful program. In California there's a lot of problem with community colleges and universities and that people cannot get the course they need or some courses that they need for graduation.

And some courses get big backups. People can't get into them for years sometimes. It was a wonderful episode of the show Community where there was a big paint ball competition and the prize was that people would get early registration for some courses and everyone went insane.

[0:54:59]

So anyway, there's a lot of push back from universities to not take advantage of the cost savings that can occur with online learning. Because there will be jobs lost and that's understandable. But yet the cost savings for students can be enormous. We're talking about going from $1,500 of credit for a course, to like a hundred dollars per course. Which means that people could go through college and get a college education without those enormous college debts.

So the change is going to be coming and I think it's going to be a little bit like e-book. I think it's going to be, for a longtime everyone was like no, electronic books, they're not going to happen. And people won't really like it when that happened. And then all of a sudden they found a really good mechanism for making it work and boom. Everybody started buying e-books. And I think that it's going to be like that with online learning.

Right now, it's very difficult to get college credit for any course you're taking through a massive open online course. There are few but I think that when a university actually breaks through and is able to make that happen cost effectively, it will start to grow very rapidly and I think it'll have a very major implications.

And I think a lot of universities don't really want to look at that because they'll see everything that's going on around them and they'll say this is the status quo. It just can't change and they don't want it to change. And they can't envision it changing so I think a lot of them are going to be surprised when that change does happen.

Robb: And perhaps a bit ill-prepared to instead of planning for that change and adapting to it, they're going to be reactive to that process.

Barbara: I think so. And what's difficult is when you look at universities and how much construction actually goes on in many universities of classrooms, of new buildings and so forth. And yet with what's going on with online learning, it actually – more emphasis, I mean at least in my opinion, much more emphasis should be on putting materials online and actually not so much on increasing the enormously expensive infrastructure.

But yet, you know universities don't get credit for not building their infrastructure. I mean if they put up some big building, they sort of get credit for that. So there's this sort of whole impetuous that kind of drive them in a direction that is countered to everything that is happening with the online world. So it's going to be interesting to see what plays out.

Robb: I wonder if there would be a story where online universities will basically come in and start taking over that market share and be the pirate ships that start picking a way at the establish castles of these academic institutions.

Barbara: Well – a lot of times online universities are for profit and that they're good but they don't really cut the cost for the student. And that's what is really needed is to have very low cost, good learning but very low cost. And that's what I think some of these massive open online courses can do for people actually make go through a conventional university.

For example I do learning how to learn through the wonderful university which I really love, the University of California, San Diego. And so let's say they have a wonderful Calculus course that was able to be online and they're able to figure out a way to do grading for massive quantities of students. That's not easy.

So let's say they get a good course like that set up and you're able to get it so that gets credit and students pay like maybe a hundred or two

hundred dollars to get this course and to go in and take a test and show that they have mastered the material. Wow, that would be just a tremendous boom for students. You know to get this much lower cost.

[1:00:00]

And in many ways, a much better education because people often don't think about the fact that it's a statistical truism to say that half of all professors are below average and that average is actually sometimes really pretty low. So if you have someone who's a phenomenally good teacher and you put him online in a really well done course, you know what that course is going to blowout over the water 95% of the usual courses that are taught in Math.

So I think there's going to be some interesting fall out as the university system actually turns into something that's a bit more capitalistic and that you actually have classes that compete against one another so you get really good national or international classes that are truly outstanding in Calculus or Physics or whatever you want to teach. And it's going to be exciting.

Robb: Yeah, we've been working for a couple of years with state University of New York in New Paltz. And they've developed a really fantastic evolutionary health program, a certificate program and I've actually helped him steer a little bit towards folks who just want a general understanding and then people who are in medicine and so we've got a couple of different tracks with it. But we've kind of been in a holding pattern because the administration insist that people should pay out of state tuition for this online course.

And that would end up making the whole certificate program about 12 or 15,000 dollars for virtually everybody on the planet. And I said we might get a couple of dozen, maybe a couple of hundred people to do that. But if we're able to drop this whole thing down so it was maybe a $1,000 for the whole course. we might get a couple of hundred thousand people. And immediately, it's the same distribution cost, there's no difference. It's electron seal uploading and downloading.

But we could potentially get tens of thousands, hundreds of thousands of people around the world taking this course, doing the certificate program and then your revenue is much, much greater at the end. And it was a

fascinating thing to look across the table at some of the administration where they were kind of like okay I totally see the numbers but they just kept back coming around. But the rules are that out of state stuff but you guys can change that right?

And I said yeah we can but this is the way it's been done you know. It was really interesting exchange talking with those folks. And I think that we will crack that nut initially or eventually but it was very interesting for me being more business entrepreneurial oriented, it seemed like crystal clear you know just the numbers and also if you're just focused on education, do you want more or fewer people getting exposed to your curriculum.

And then on the other side of that, would you like to make more money and aggregate for the school or less and keep this thing really exclusive. And that was actually those folks you could see some smoke coming out of their ears like they were really churning on that trying to figure out what the story was.

Barbara: Well I think the way to provide some motivation is to present the context of reality. And the reality is if you don't get out, if they don't get out and do that quickly, somebody else could do it. That's happening now in the data sciences. The great thing is that wonderful companies like Coursera. And Coursera is truly – I think people often discount the wonderful things that companies and businesses can do.

And you know for some reason it's like way better to volunteer for a company that or for a non-profit business that supposedly helps people in Africa when you're actually hurting people in Africa because that assistance is going to support a dictator who's usually kind of bad. And there's all sorts of research that shows that's true. And yet going to work somebody like Ford where you're producing a car but people actually really need and it's truly helpful to them particularly – people in social structures right? Whatever your status.

If you're poor or you're rich you need transportation of some sort. So it's really helpful. I guess I get on my high horse but business and corporations can be truly – some of the most beneficial things, they can be misrun just like governments can but they can also do great things.

[1:05:06]

And one of the things that Coursera is doing now in data science. So a lot of people who have trained you know they got a Computer Science degree, it's five or ten years old the knowledge they got is becoming obsolete. How can you retrain yourself? How can you get something that shows that certifies that you are more up-to-date?

Well a good way to do that is to go through Coursera and get a very inexpensive certificate. And what people do is I'll take three or four coursed. Pay $49 a piece for each one and then combine them all together and that's like a certificate that shows you're kind of up-to-date in all these various fields.

And the new data science certificate program that they have, some of their courses will get and I'm not kidding about this, 10,000 people purchasing a certificate. And so do the Math. I used those Neanderthal genes and you can see that it's extremely low cost way for individuals to prove that they're up-to-date and it's actually a very low cost way of helping people to stay up-to-date.

By doing this in vary mass scales, they're able to develop excellent programs that are still really low cost. And so if you just use something like this for the exercise, the evolution sort of approach, wow, I'll sign up for it. I think that'll be great.

Robb: I say this a lot on the show but I have this sneaky suspicion that markets and decentralization maybe a much better approach than central planning and stuffy hard to change institutions and clearly there needs to be a little bit of collaboration between both of those but it's just interesting that a lot of the- again this is a gut level deals and maybe you and I are both wrong on this. Only time will tell.

Maybe this is our leap of intuition that's wrong but I have this sneaky suspicion that in the United States, we don't produce enough Math savvy people, enough engineers to meet the needs that we have here. We basically have to import folks and that's in large part via our graduate students come from abroad in a lot of the higher technical fields and then we make it very hard for those folks to stay here which is a whole other topic.

If we spend all that money educating and we should make it really lucrative for them to stay here and integrate with what's going on. But all

that stuff aside, also let's make it really, really easy and really affordable for our indigenous population to be at the top of the food chain on these technical side instead of making it a complete pain. And there are a lot of businesses like Google and Twitter and Intel that would benefit from having a top of the food chain very well educated group of technically savvy people.

And then as you pointed out a society at large benefits on just a multitude of levels were eradicating a number of ills all at once. And that just seems like a beautifully elegant way to address this versus a top down very slow to evolve approach.

Barbara: Well one thing that I find very encouraging is recently President Obama announced on behalf of the Department of Education that they would – that the Department of Education is now going to support continuing education credits through the use of Coursera mooc for all three million teachers in the U.S. So you can select from 50 courses amongst 50 educational related courses including learning how to learn. And use them to help increase and improve your attempts at continuing education in learning.

And I just think that, my hat's off to the Department of Education because they are co-opting something that could be controversial and could be kind of against what some teachers might like to see but yet they're using it to fill an important gap. How do we provide very high quality continuing education credits for our teachers but do it a low cost.

[1:10:15]

And I just got to hand it to them. They've really been innovative in kind of taking this in hand and incorporating it into how they're doing things. And I'm hopeful that this maybe a very positive indication of better things yet to come.

Robb: That's fantastic. Professor Oakley, it's just been a huge honor to have you on the show. You are the author of A Mind for Numbers. You developed the Coursera program learning how to learn. When is the next book due out?

Barbara: Oh the next book is I'm working on it now. I'm so excited. It will probably be another year and a half or so and I think people will like it very much.

It's sort of innovative insights into how really cool people change their lives for learning. So I think it'll be a lot of fun. And it's just been a genuine honor to be on the show and thank you so much for having me.

Robb: Thank you and are you willing to, I'll put you on the spot here. Can you comeback on the show when the new book comes out and can you also put Reno on your book signing list and I'll whip up a bunch of people to come out for the book signing. Does that sound pretty good?

Barbara: That sounds like a deal and actually my sister-in-law lives in Reno so we come out every year. And so we'll definitely have dinner too if you guys are available.

Robb: Fantastic. I will barbecue up a storm for you guys. That will be amazing.

Barbara: Alright. In fact we're having one of your recipes this evening.

Robb: Oh nice, right on. Right on, fantastic. We've had professor Barbara Oakley on the show again. A Mind for Numbers is the book that she currently has out. We're going to have links to the book to your Coursera course and again huge honor having you on the show.

Barbara: Oh thank you again.

Robb: Thanks, take care. We'll talk to you soon.

[1:12:23] **End of Audio**