CIARAN O' REGAN: All right, so Israel, I suppose a good place to start is how you got into combat sports, your academic pathway and how you ended up meshing together or to end up in combat sports research.

ISRAEL HALPERIN: Briefly, my background is the following. I pretty much dedicated my life to competing, training and coaching up until mid-20s. That was literally my whole life. I spent time traveling around the world for that.

I spent two years in the states, in California. I spend nearly a year in Thailand solely for training and competition purposes. I traveled throughout Europe, visited different gyms. So yeah, that was the only thing I've done up until my mid-20s. At one point when I was in Thailand, I woke up one day up, I was supposed to continue with my normal daily routine, which consisted of three to five hours of training a day. Just as I was preparing for one of my next bouts, I just woke up one day and I just felt I had enough. I felt the heat, tired and I just felt I couldn't do it anymore. I felt burned out, and that was indeed the day that I decided to quit.

Looking back, I probably didn't plan my training to the best of the knowledge that I had. Probably over training myself but that was the end of my competitive career and after which I decided to take the most natural path for me, was

just to try to be a scientist. So I completed my degree in physical education in Israel and after which I moved to Canada to complete my masters of science. I did that under the supervision of my Professor David Bain. He was a known expert in the field of applied exercise science. So I looked into topics that included muscle fatigue and different recovery strategies that included a stretching and self-massage with foam rolling, stuff like that.

After I completed my masters, I had a very unique opportunity and I was offered to complete my PhD in Australia in the Australian Institute of Sport, in their combat center. So I moved to Australia and spent three years over there. I worked at the Australian Combat Center, so that means I essentially worked as a support staff for the sport centers with the four Olympic combat teams. That included judo, taekwondo, wrestling and boxing. I completed my PhD while assisting the teams so whether that's testing, helping with the physical preparation part, planning up camps, stuff like that all while completing my PhD, which dealt with the effects that coaching feedback has on combat performance and also during this period, I also got myself a role as the head Thai boxing coach of a very competitive team in Australia, and I trained the current world champion. So that means I have a very intense period for me.

The mornings and middays, I work with the athletes in the Australian Institute of Sport, try to complete my research and then in the afternoon, I walk into to the gym and worked with the athletes who some competed internationally so have traveled a lot. It was a very intense period that was completed towards the end of 2017, and now I'm back in Canada working again with Professor David Bain on applied questions. Again, we're looking at the foam rolling stretching, and I'm still investigate the topic of my interest, which is coaching and coaching feedback as it relates to combat sports.

CIARAN O' REGAN: Something I think is worth mentioning and bringing up especially to any of the listeners that aren't themselves from a combat sports background is that you are a scientist and I suppose for myself, kind of an analytical thinker and often

that's not associated with I suppose combat sports to someone who isn't involved in combat sports. They might have the same knowledge of the intricacies and the nuance and the technique and the strategy, and all the less obvious aspects of combat sports. Or I think that it's a cool combination and a cool kind of pathway to see how they fit in and that wouldn't be the only one that I know.

A person like myself or Danny were both into combat sports and are both obsessed kind of science nerds as well interested in the combat sports world. It's just bit of a surprise to people as well their often, they're often surprised when someone's both a nerd and they happen to like fighting as well because it kind of dichotomy, they don't often go well together.

ISRAEL HALPERIN: I would always like to think of myself nowadays as being probably the best fighter scientist, and perhaps the smarter, the smartest of the fighters but I'm probably not neither of.

CIARAN O' REGAN: Yeah, I think the appearances can be deceiving. One thing that I think is an interesting path to go next is when you mentioned that you were working with the combat sport Center in the Australian Supersport. A very interesting discussion, I suppose, is the role of strength and conditioning in sports and support in combat sports and I suppose open loop sports in general with large amounts decision making that are highly skill orientated and highly based on motor learning and pattern recognition and very quick reaction times.

Why does that kind of cost benefit analysis of a general physical preparedness versus specific physical preparedness and training transfer regards to having a limited amount of hours in combat sports athlete training, and then what you choose to do with those hours? I've heard you voice on some pretty interesting views on these before, and I'd like to open this up for untangling some of this.

ISRAEL HALPERIN: All excellent questions. I'll start with end, I don't have any clear answers to any of them because I think, as you said, the nature of the sport of combats sports is so complex, and then every athlete has a unique story and a unique preparation

phase and so many different variables that we have to account for. So I start with the end, that there are no clear answers. They're all very athlete specific and sports specific and situation specific. If we try to unpack this big question into smaller ones, let's start with an obvious question, whether I think that strength and conditioning is important in combat sports, and my answer to that is a definite yes.

I think so. And in fact, I view myself as strength and conditioning coach as well, and I still work with athletes, with combat athletes, with boxers and kick boxers and some of the main athletes as a strength and conditioning coach. So I do think it has value. And if I didn't, I wouldn't see myself as one, I wouldn't be working as one. But then I think we move on to the next question. It's like, all right, what is the overall proportion? I think that's something you touched in your question is like, how should we break down, for example, a weekly training schedule of an athlete that has, I don't know, between five and 12 hours of training a week, how many of these hours should be dedicated to non-specific training?

And that is a place that, at least based on my experience right now, I would say that me, when I work as an S and C coach, I think that I try to limit that portion to as little as possible while still trying to milk out the positive adaptation aspect to it. Because the way I see it is the following. I try to free as many of the hours in the athletes week towards specific fight training, because if I train fighting specific aspects, then I have a high degree of confidence that we're going to see a clear carry over from the specific training, from the fight training into the actual fight competition. They're very similar therefore the degree of transfer should be quite high.

But the further we go away with the training into non-specific areas such as strength and conditioning. While I do see a lot of value in it, the degree transfer becomes a bit less clear to me. If I get an athlete stronger, I can imagine that I will carry over and make him a better athlete, but I'm not sure about that extent. Not sure about that extent. There's more question marks, at least for me. Which is why one of the questions that leads my philosophy as a strength and

conditioning coach is what is the bare minimum that we can do on a weekly basis that will still have all the positive aspects related to strength and conditioning, such as the reduction of possible injury, improved explosiveness, and so forth, but while making sure that we're limiting it as much as we possibly can to free as much time or specific preparation.

So that is my general approach that this is the question that leads to me is what is the bare minimum amount that we can get away with so we can freeze much time or the actual specific training. And to me, that also bores down to the next question. I don't think that asking whether any training intervention is good or bad, that's not... I don't think that's a very strong and powerful question because essentially, any training intervention that I will impose on an athlete that is within reason at least, we should see some positive adaptations.

So of course, it's good rather than bad. But the question that I feel is more sensitive to the situations that we deal with as coaches, not whether something is good or bad, but what should I be doing within a given unit of time? How should I spend that limited hours a week that I have and whether I can do something else that will lead to better adaptation that will benefit the athlete more. And this is a delicate question because within the given hour, if I decide to do one particular intervention, that means that I'm not doing something else and that's something else might overtime lead to a better transfer, to benefit the athlete more than doing something else so this is the question that I try to answer. I don't always have the answers, but again, that's what's leading my thinking and my philosophy when I work with athletes.

CIARAN O' REGAN: To people who are working in, especially someone who's been involved in a sport itself and then come out the other end of it, or potentially has been involved in working as a strength and conditioning support or sports science sport, to that sport. You have ended up with a bit more of a much bigger frame of reference for what the sport is, the demands of it. And it's not as simple in the response you give there is very accurate. It might as well because there is no black and white answer, there's nuance and I think that kind of answer

of well, it depends. There's a lot of nuance and complexity to the situation as each individual cases, and there's no definite answers here or there. And I couldn't agree more.

My own personal view I suppose is very similar to yourself that combat sports are so layered and complex and the split second decisions that need to be made to slip or to not slip, to [00:17:24], to faint and win and the pattern recognition or being able to pick up on the opponent's body movements. The split second nature of it in my eyes it means that ideally from a specific preparedness perspective, that you need to be spending as much time in front of an opponent as you can even in training, drilling and so that your brain is getting a chance, not just to practice the movement patterns of good punching and kicking mechanics, but also that your brain is getting a chance to see an opponent moving and to be able to chunk information together and to be able to chunk what a left hip looks like when a left hook is coming at you just before that split second so your brain can start to make those pattern recognitions.

The same as a baseball batter needs to spend thousands of repetitions in front of a picture to be able to chunk information together because the ball in baseball is moving faster than the human eye can pick up on. So you're actually responding to the movements of the picture before the ball ever leaves their hand, and it's the same in combat sports, especially in striking.

I think when it comes to strength and conditioning, I couldn't agree with you more. My own view would see it as a hierarchy of importance in terms of what the role a strength and conditioning coach plays, or if you imagine, like a pyramid to have an article on Sigma, like the three principles of strength and conditioning, from my view point, and the bottom of the pyramid is don't get hurt doing strength and conditioning, so don't be doing stuff that isn't suitable to the athlete and well, let may be obvious to myself, yourself. I've seen a lot of fighters unfortunately doing crazy stuff like high repetition, Olympic lifting when they can't even say, do an overhead squat because they're trying to be conditioned and these very high risk maneuvers are high risk means of

conditioning what they think is conditioning. So I have the base, the pyramid would be don't get hurt doing strength and conditioning as combat sports is a risk enough endeavor is without doing something silly in a non-specific endeavor.

The second most important thing in my eyes is, as you said, minimal effect. If those are regards to what training modalities can we do to minimize the highest percentage injuries in that sport or to address prehabing and preventing injuries that you have previously had just to keep you in the gym, to keep you being able to go to boxing practice or Muay Thai practice or jujitsu practice, to actually keep you on the mat in the ring in the gym because that's the most important thing.

Then the icing on the cake then is the, I suppose to sexy stuff. The improved rate of forced development, improved RSIs, improved maximum strength, that kind of stuff that potentially maybe might feedback in in a positive manner to improving on your sports performance, but that's the icing on the cake.

Based off the philosophy you mentioned as regards to the need for the specificity and how important it is for the fighters and as far as even athletes generally, even not just fighters, any kind of open loop sport, even look at tennis or badminton or any kind of open loop highly problem solving sport, we can obviously specifically relate this to combat sports and give much more specific examples in a sport that we don't participate in.

So based on the need for specificity, and based off the complexity in the nuance and the detail involved in combat sports, and the need for specificity as regards to not just the movements themselves, but also our ability to pick up on movement patterns and an opponent and so on. How would you go about from a practical perspective on putting together and structuring a training session or training plan, and I particularly think you could have some interesting answers to this because someone like you, you are I suppose, unfortunately a rarity it seems in the sports science world as a whole, in that you are a researcher.

That those research that in my eyes, is a novel contribution to the practitioner in the field as well as another contribution to the literature itself because there's a lot of sports science research and I think research in general, but especially in the sports sciences that's potentially, it's research carried out for the sake of research. To get publications and it's carried by people, who don't really have maybe not even an interest in how the research will be practically applied in the field itself, whether it be obesity, research or exercise, science research, but you straddled both words very effectively, and you're actually doing research that is practically applicable. So I suppose taking that, how would you apply or how do you design a training session based off the evidence base that you have read and also research that you have done on motor learning and so on.

ISRAEL HALPERIN: You know, one thing, my PhD was essentially on topic of motor learning and how that applies to combat sports. And I got to say that having a background in exercise physiology and strength and conditioning and so forth, I felt that motor learning is probably the discipline that it could have possibly the most positive impact on fight preparation and how training session is structured. And I've learned a whole lot during my time at the Australian Institute of Sport, interacting with some of the motor learning experts. And my research has really helped me become a better coach, I think. I hope so.

I'll tell you, in contrast to the strength and conditioning, which my answers were a bit more vague and uncertain as they should, I believe I've got clear some more of a clear answers as to how to apply some of the motor learning concepts and structuring a training session, especially of combat athletes, which is our topic of conversation. So I'll start with a few points. The first one is I travel around the world. I know I visited so many gyms and a very common theme that I see around the world is weekly training structures in which each day of the week is dedicated towards a single component, whether a physical component or a skill.

So for example, Monday is heavy bag day, Tuesday is a technique day and so on and so forth, and then there's a sparring day. So there's specific days that are dedicated to developing or working on skill. And I don't think that this is the best approach, and I'll explain why. There's a number of layers to that.

The first one was a logistical perspective. Let's say I'm with the team that I've recently worked with that had four-team competitive athletes. Some of them were fortunate enough to train full-time. They could have trained twice a day, that was their job. They made it a living off their fights. But most of the athletes, they're work a full-time job. They got families, but they can only train once a day, or maybe they can squeeze in a jog in the morning or something like that.

But naturally, the circumstances of life will lead to the fact that some of the athletes for various reasons will miss out on the class. They might get sick, they might have to pick up a child, they have a sick wife, something is going to happen. This is the nature of life. There's going to miss a session on a monthly or weekly basis for different reasons. And then what happens if an athlete misses out on a session that is dedicated, say to technique, that means that the team opened up a gap or that particular athletes worth of let's say, two hours of technique and he's behind now or if he missed the sparring session, then he's behind now.

So for that reason, I structure my classes in a way that we work, we try to work at least on all components on every session, a little bit of everything. And then if an athlete misses a session for whatever reason, he hasn't missed out on so much within every particular quality. He just misses out a little bit every day. So this is the logistical reason, especially by the way of an athlete misses a sparring day, then what? Then he actually missed out on a whole week worth of the most important aspect of his training or her training, which is why the way I structure my classes again, this is just logistically speaking, but we have all components mushed in into one class. Now I might emphasize one quality more than the other, but all are going to be involved.

The second reason is this, that when we have the athletes walk into the ring, they'll work, they don't have to express their various qualities in isolation, they have to put them all together. They have to apply the technique, to be explosiveness, to be fit and all these things that make more sense to me if you work on them together. So they blend well together. They glue within the same session rather than, again, one day that we dedicate, the one quality or one aspect and so forth.

Now, if we answer this question from a bit of a motor learning perspective, I will zoom in even more and talk about this particular aspect, and it's a term that's called contextual interference. And let's say that on one side of the spectrum, there's what we call blocked practice, and on the other side of the spectrum, we have what's called random practice. And of course, there is a lot of gray area between these two extremes.

Now blocked practice would be an example of working on that particular, let's say, skill in a set order. So let's say I'm working in a specific combination right now with a partner. So I'll practice it 20 times and then my partner will practice it on me 20 times. Let's say a punch and a kick or a block and whatever it is, right, a skill of component let's say. So we practice a set amount of repetitions before moving on to the next technique. We practice that first set amount of repetitions and we move on, and this is actually very common. I've worked in most gyms teams and I've seen that's the way that the skills are being practiced. We work on a set amount of repetitions before moving on to the next one.

Now a random practice on the other hand will be a mix, the different techniques up within the same session. So instead of finishing 20 repetitions before moving on to the next technique and completing 20 repetitions, or 50 repetitions, whatever the number may be, right. Rather than finishing one set of skills and moving on to the next, we mix it all up. So I'll do two repetitions of the first technique, then do one repetition of the second technique, then do four petitions of the third technique, and just try to mix it all up. And if we go through the complete extreme, we'll just do it randomly.

Now when it's done randomly, we got to keep in line that will resemble what actually happens in an actual fight, more so than anything else because that's chaotic. It's like a fight.

So if we compare these two extremes, the blocked practice in which we finish in isolation working on one technique for a set amount repetitions before moving on to the next one. In many ways it's cleaner. It's easier to complete within a class session and you feel and I want to emphasize the word feel that you're getting better by doing it this way. If you compare the first five repetitions to the last five after completing 50 repetitions, you will feel that you've gotten better compared to if you've mixed it all up in a random fashion.

However, what we do know from the motor learning literature, is that actually mixing things up leads to better learning despite the fact that on the immediate scale, we feel that it's not the case. We feel that if we first finished one set of skills before moving on to the next one, we'll feel that we actually get more out of it. But truth be told is that, and there's a whole lot of literature on this that showing us that structuring our training in a bit more random fashion, and it doesn't have to be completely random, you just have to mix things up a bit more, actually lead to better learning.

So this is why me now as a coach, after I've learned in this important concept, I structure my classes, and so we've worked on a bare minimum of technics and we alternate between them. So we don't just practice one set of skill before moving on to the next one. My goal is, and of course always to keep it within the level of the group that I'm with. If I see that they're all completely lost and I'm throwing all kind of techniques in them and nothing is being processed, then I'm doing something wrong. But my goal to try to find the maximum ability to process more than one technique and practice them at the same time, so I lead to deeper learning.

So if I'll just recap this rather than just moving from one technique on to the next one, trying to blend them on within the same, but the same period, it might not seem as if it's an

effective strategy, but it's a lot more effective than the alternative. So this is the first concept that I wanted to share.

CIARAN O' REGAN: One thing I think is pretty interesting to pick that apart to small a little bit, when you were saying chunking of patterns together. So for example, it might be two different combinations that set up or that come off a cross to the body, like flash jab to the head, a cross the body. A hook upstairs, flash jab to the head, cross to the body, then a cross upstairs, for example, those two combinations, the first two components are very similar. And then the third shot is either a hook or a cross of the same, would you structure them so that the combinations where I suppose related, or is that something that you consider or would you purposefully try and keep them more different? What I mean was for instance would there be benefits versus of one versus the other? And what will be a nuance I suppose to that of combinations that are more similar but lead the different finishes versus combinations that are less similar like there might be a kicking combination or a set up for a knee and the other one is a set up for a left hook to the head, for example. Any kind of thoughts I suppose, a nuance?

ISRAEL HALPERIN: Well first I'll say that this is an excellent question, no doubt about it, that's an excellent question. I don't have clear answers as to which one is necessarily better. And I'm not sure that answers exist. I think personally, I play with it. I'm going to have a set of rules, but I do let the concept lead my thinking and the structure of my class. So I think it can go either way. I think they'll be benefits to doing that one way and then there will be benefits to doing it the other way. I wouldn't have a person I wouldn't, perhaps do both as a function of the goals of my class, but there would be definitely benefits into how the two separate technics, because what happens and the reason that it leads to better learning, that random practice is because when you alternate between two very different types of technics, what happens is that first you have a good point of reference to compare one of the techniques to the other. So by having that point of reference, that leads to better and deeper learning, it's like, oh, okay, this technique, I'm doing it this way, and this is in contrast to the previous technique, which I'm doing it the

other way. But then you got more points of reference that you can compare one technique to the other, which leads to deeper learning.

Another possible explanation to why that random practice leads to deeper learning is because when you practice one technique and then you move to the other one, and then you have to go back to the first one, there's a period in which you forget what you just did. You have to refresh your memory and that forgetting and then refreshing your memory on a regular basis leads again to deeper learning rather than just if you continuously do endless amounts of repetitions at the same technique, at some point, you're not getting as much out of those repetitions because you're just going on automatic, you're not really thinking, comparing or have to refresh your memory and so forth. So I'm not sure whether that was the answer to your question, but this is how I would approach a problem.

CIARAN O' REGAN: Yeah, I like it. And I think that approach that you mentioned is actually something that I have experienced under the tutorage of some more experienced coaches, I suppose who would have come across that without even potentially even knowing that the research existed, or that there was any one on it but just to trial and error and having been around the game for a long time, but it's not that common. It's just as you said, more common ways as you said, the blocked practice with the same skill and repetition.

ISRAEL HALPERIN: That's understandable because it makes more sense. This is one of the cases that unless we had some actual scientific investigations showing this to be true, then why would anyone choose the alternative? I know I wouldn't, I mean this was a big surprise to me and when I was coaching before being aware of this literature, I was always doing blocked training. Why wouldn't I? It made more sense to me and the immediate responses that I'll be showing, that I'll be seeing with my athletes, it made more sense to me. This is actually one of those cases that you have to have research showing you convincingly otherwise be convinced. So this is quite counterintuitive.

CIARAN O' REGAN: And I think that's actually something that I've been inexperienced of but only very few coaches. I think some interesting components to it that for me at that end would be, for example, let's say a punching orientated drill where you're specifically working on a right hand verses right hand fighter, and you're specifically working on slipping their jab and throwing an overhand right at the same time as you're slipping say, inside the jab, try an overhand right. If that just is repeated over and over again, that as your partner's jab comes in, you could be already moving prior to the jab even coming.

So the pattern is not actually as close as it could be to a fight versus if for example, they throw the... one time you may be slipping to the inside and throwing an overhand right, if they're throwing a jab and the other time you might be slipping to the outside if a same direction, if they're throwing, say a right cross, and you're coming back with a left hook, or basically when there's the constraint, or there's two different... you're responding basically to something that they do at random, it keeps you in more of a position that you would be in a fight rather than knowing which direction are going to be slipping to a lot.

I made a mistake that when I bolted and slipped to the left because I'm trying to deconstruct it because I'm a south paw so I'm trying to think as a right-handed fighter for a second, I gave a bad example. But basically when there's the problem solving constrained to it, where you're responding because that's the kind of drill that I like to implement myself when I'm doing boxing drills with fighters is like they might throw one of two for me is a south paw position. They might throw a jab, I might decide that I'm going to throw an outside slipping left hand in response to their incoming jab and me as a south paw and them as a rightie versus they might through a right hand, I'm going to slip to the left instead and then come back with a left hook to the body or an overhand left for example.

Basically the constraint or the problem solving actually makes the drill more specific because you have to be more balanced because you could have to slip either direction or

you could have to block with either leg if it's a kicking counter drill, for example, rather than always blocking to the same side then as of result, you're standing a certain way that you wouldn't be in a fight because you know that that block is coming on that side.

ISRAEL HALPERIN: Very well said and these tie very well to the block and random practice. And again, random just is closer to what would happen in reality, which is why it's more specific and that, in fact, this is an excellent opportunity to move on to the next topic I wanted to touch is the perception and action, is something you've been touching on throughout this chat of ours, is that if you think about fighting for a second what it is, and you've said it and I repeated this, in a sense, it's a decision making sport. It's a decision making sport and it's important to make sure this is clear for anyone who's listening, and in fact, it's a problem solving sport because our opponent is a problem that we have to solve.

In fighting, the way I see it if I break it down, and if I somewhat simplified, there is always a three-stage process. The first one is that we have to perceive the information from the environment, and that would be our opponent. We see our opponent, we visually see him, we might even... it's not just vision, it's predominantly vision, but it could also be other senses as well. And based on that incoming information of the opponent, we have to process that information and based upon that information, we have to come to a decision as to what it is that we're going to do, and this is the part, the third and final stage is the actual mechanical output.

Based on the information that I processed, I came to a decision and that decision, for example, was right now I'm going to throw a kick and then I go on and throw a kick. This is how it works. There's a three-part process, the process information, based upon that information, we come to decision. And that decision is the mechanical or the physical output. This is continuously on going, it never ends. And just continuously keeps going with process information, make decision, make a physical output. And as we make that physical output we still process information and all these

stage are crucial to the success of a combat athlete, or in fact any other athlete from an open skill sports.

Now, what happens a lot when you go into the training environments, you see that one of these three stages, the one stage that gets the most attention is just the last part of the chain, is the physical output. So if I stand in front of a bag, of a heavy bag and I just punch it as hard as I can or I kick it or that's all nice, I can improve my kicking speed, my kicking power, I can improve my fitness, but just standing in front of the bag and punching and kicking it. I do not have to process any information, and I do not have to come to any decision based upon that information. So in fact, I'm neglecting two very crucial components of the steps involved in fighting, which is the processing of information in making these decisions.

So if you just shadow-box without having to do anything other than shadow-boxing, again, you're improving your physical output. You could improve your technique, the speed of your kicks and punches, but wait, you're not processing any information and based upon that information, you don't have to come to any decision. And this is in fact what separates better athletes from worse ones, is their ability to take advantage of that information that they're processing, anticipate what's going to happen and upon that anticipation come to a decision that would be to throw a kick or a punch.

And I feel, I think, based on my traveling and my experiences is that this should be more than working on these two stages is crucial and should receive a lot more attention in day to day training. So what I do these days... so I'll give you an example to make it actually account for these two other steps in a very simple fashion using an example. In most classes, you sometimes have the team partner up and one of the partners is holding kicking shield or holding two pads standing in place. And his partner has to throw kicks to the pads. His pads are as hard as he can. This is a very common drill that could be set up in more than one way, 10 kicks in one leg and 10 kicks with the other and so forth or any other combination.

Now instead of the person holding the pads standing in place and having the kicker, stand there and kick whenever he or she wants to, we're actually not getting any information processing in decision making, so instead of just doing that, how about have the person holding the pads stand in place, but at random times take a step forward, take a step forward and when that point has to step forward, you as the person who is required to deliver the kicks, you have to process that information. Now all of a sudden, the opponent is coming towards you. This is incoming information that you have to process, and based upon the information you have to come to a decision and that decision would be, should I kick now? Is he too far away? Is he too close right now and if I throw the kick then, I'm in the range that he's going to catch me with punches.

So just having this very small component of having your opponent take a step forward, and you have to time your kicks based on the incoming information based on you making that immediate decision and then and only then you throw the kick. We're actually coupling the perception with the action rather than just working on the action, in this case is the kick. What I try to do essentially, every component of my classes is to try to always include a perception component which by the way, if I'll be honest, it's not something that I've always done. I never realized how important that is. And this is a lesson that I've learned very well when I spent time in Australia, I'll even share with the listeners an example.

When I was working in Australia, I was coaching a world champion kick boxer. I've already had years' worth of experience. I've worked with UFC fighters, I've worked with Glory fighters, I've trained, I've fought. I felt I was quite confident in my coaching abilities. And I asked one of the experts from the motor learning department, from the skill acquisition and motor learning department, if you wouldn't mind to come and watch me give a session, one of the athletes I was working with and give me some feedback.

I'll remind you that at this point, I was already halfway probably through my PhD in Motor Learning, and that

person who came and watched, a friend of mine, he didn't have a strong background in combat sports.

So he sat there and I was drilling with my athletes, some footwork drills, some pads, and so forth. And at the end of it, when he gave me the feedback, he told me listen, there's barely any decision making involved. There's just the action component. There wasn't enough perception and action and that for me, I knew he was right and it was a bitter pill to swallow, but that made a huge difference in how I coach because I thought that was the man, I am aware of the literature, I'm aware for that importance, but for some reason, whole class somewhat skipped probably one of the most important components in any open skill training.

And from that point onward, I made sure that everything I do, or pretty much everything I do, there's always some processing information involved. There's always some perception and decision making involved because that actually represents what an athlete will encounter in the ring or in the cage.

CIARAN O' REGAN: There's two things off the back that one particularly related to what you just mentioned there about your colleague in the IAS observing the session from outside of the sport. We'll get to that in a sec.

First of all is one the thing you may find interesting from a practical perspective, is there's someone that we both know, John Caley. I was lucky enough, he's a fantastic sports scientist and I was lucky to have him as a boxing coach, most Fridays for years when I first started boxing. Even when we were and this is I suppose I started boxing in 2011 maybe, and even when we would do bag work, one thing that John used to get us doing a lot, even when we would do bag work, was for example to use different bags, to not always use the same one first of all, so that you don't get accustomed to certain ways and the second thing is to allow the bags to swing, and also that we used to do sprints of very short duration, with very high intensity, so that you have to adjust your feet.

So even when we were in response to wherever the bag was swinging while throwing the shots as many shots you could in a certain time period, so that you were forced to throw shots at weird angles, while leaning backwards, while leaning forwards, while slipping out of the way, while rolling, while turning because the bag is coming at you, while turning off hooks.

So something from that, even when doing bag work, I think there's potential ways of making it a little bit more this heated transfer because you're problem solving relative to even though the triggers are obviously different than when your opposite of human being, your triggers for when to throw a shot and when the block are going to be very specific. And that's why I couldn't agree with you more with regards to the problem solving.

And that's why from a coaching perspective for myself, what I enjoy doing the most as an athlete and what I like doing as a coach and working with people is loads and loads and loads of partner drills like when doing combination practice, doing them I suppose, the way that I've referred to them as I've been taught as the Dutch style combination drilling where your opposite people and throwing combinations at each other, not particularly hard, but you're getting that and potentially, it might initially start off say with a fixed combination, but then you might end up, as I mentioned earlier on, throwing a combination in response to one of many options that your opponent could give to you. So they step in and then it might be a mean response or an inside low kick. They step back and then it might be a kick to keep them further away, or depending on what they're doing, you're responding to a trigger that will be as specific as you can get to what you're going to experience in a fight.

You're triggering in your actual movement pattern as sport specific as it can get because it's actually the same movements and distancing that you will experience in a fight itself in response to whatever the trigger is to get you to do with regards to the movement in or out, the throwing of a certain shot that you have to block or slip a roll or catch a kick, and then respond with a certain thing or a certain

number or different options. So that's just one thing I've got to know in regards to my own experiential views, and based off what I found myself to be a benefit and also the input from John as well who we both know to be a fantastic sports scientist and accomplished boxer himself.

The second thing though, which is actually a question I'm planning getting onto was something that I've become very interested in general specifically when it comes to coaching and is something that I've actually heard you mentioned before in a different topic but you brought it up just there, which was that we all have biases as cultures, as practitioners, as human beings. We all have biases. We all have blind spots that we don't even know we have because we get groomed by a culture, whether it's an actual culture that you happen to grow up in because of your society or your nationality or whatever. But it can also be the culture within a sport so we can have these blind spots just like you had mentioned there specifically, but you were humble enough to acknowledge it. I think that's a sign of a good scientist, is that you're willing to change your views in light of evidence. That's the spirit of science, I suppose, is the desire to prove yourself wrong and the humility to change your views in light of evidence.

You mentioned there specifically that your colleague came from outside the sport and was able to notice that there wasn't the problem solving element to the triggering of the movement patterns from the fighters. I mean you started incorporating it. Would you have any when it comes to your coaching or when it comes to your own research, or the way that you view things, would you have any kind of, I suppose, queues or systems or way of thinking that tries to question your own biases about how you might be viewing something from a sports science perspective or even just a general life perspective?

ISRAEL HALPERIN: That's a great question. Well listen, me personally, I spend so much time reading about human biases. This is the type of literature that I enjoy reading. So I'm well aware of how biased I am and just being aware of that is how can protect myself against myself. That's especially true in ideal science.

Because I'm biased just like anyone else, I could try to be a bit more aware of that. And I have, if you ask me what the benefits were of my extended education throughout my PhD, I think they're just observing myself in the scientific method, which to me is in a sense, just a method to protect myself against myself and against my own biases.

I just kind of think myself, as I try to shutter myself, I try to wrap myself with this method, with this scientific method. It just helped me protect myself against my own biases. I'm not sure that I'm even successful at all times, but I am very well aware of that and I think this is my starting point. I know that I'm biased, I know that I favor certain, I don't know techniques or certain approaches, and I try to find a way to perhaps justify them, but it's an ongoing battle.

But I think the most important thing to understand is that I understand that that's who I am, being human and I'm not comfortable with the situation and I try to battle it, and I try to protect myself against myself with various strategies and one of those strategies of course, is scientific thinking and scientific thinking is not only limited to academics or those who do research. I think they're just trying to understand, trying to question everything, and try to see how I can eliminate other explanations from a hypothesis, try to isolate variables to the best of my abilities, even just in the training environment, which of course, there's always endless amount of confounding variables, but try to pick things apart and try to think about them critically.

I try to question myself is something I continuously do, and I'm in fact, very thankful for my education, not necessarily for everything I've learned in terms of motor learning or exercise physiology. Beyond that point it's just that the constantly question myself and question my colleagues and of course, in a friendly manner, but this is just a healthy process that to many people is, it's just not natural. And I understand why it's not natural; you have to fight against your own nature to become a scientist in many ways.

So I do that and I read a whole lot of psychological literature. And I think as a coach, what has helped me the most in

recent years, and you mentioned John, which had a humongous influence on my thinking and my coaching practice. One thing that I've noticed is that a lot of smart people do, and this is something I've adopted naturally over the years, is that I try to read very broadly outside my own field. And I noticed that when I read about other fields, I read it about medicine. What happens in medicine? I read a lot about psychology and I just try to expand my horizons, and I see the topics that at least on paper should have nothing to do with how I coach are actually the fields and topics that have the biggest influence on me.

Some of the books I've read about the philosophy of evidence based medicine. There's a book that I randomly encountered one day, on paper has nothing to do with me, nothing to do with the signs I do, nothing to do with my coaching, I'm not a medical doctor, and I'm not a philosopher, but yet I read this book which probably had the biggest influence on my thinking more than any other book. I see this trend that continues to take place, that when I start reading outside my own discipline, good things somehow magically begin to happen, the dots start to connect and it just expands my horizons, and I feel that it makes me a better scientist and a better coach. So this is perhaps a tip that once you enrich yourself to a certain point, I'm not sure what that point is because I suppose it depends on individuals, but always try to expand your horizons and go outside your comfort zone because interesting things tend to happen when you do that.

CIARAN O' REGAN: There's a brilliant quote from this Japanese swordsman Miyamoto Musashi who I have studied a lot for years, and he had a bunch of stuff that was in his book *The Book of Five Rings*. It's very specific to cutting someone up with a sword, but there's a spin off from a very general philosophical viewpoints in it, and one in quotes and one particular one is, to paraphrase it, he said, to know the way in one thing is to see the way in all things. So just like you mentioned there about reading broadly, you can pick up on patterns and also by going into other fields you may be in coming across a topic or a way of viewing things from another field that has not been specifically brought back into your field yet.

I suppose the creativity, especially in any field, what creativity is, is the combination of known parts in an unknown way. So the more unknown parts you have and the more you start to view these common trends in order feels, the better ability you have to put together analogies and metaphors, and to make sense in your own mind, and to apply language to a concept that you never had been able to articulate before and you can understand it better yourself and to also be able to explain it better to athletes as well and to anyone that you're working with. So I couldn't agree more as regards to the importance of reading broadly, and if even for just as you mentioned, the benefit of actually strengthening your own specific field to something I suppose that I wanted to bring up as well in relation to more to learning is something that I'm very interested in and I think, again, it comes down to the culture.

So just like you had mentioned earlier on about, you had trained for years and you have massive competitive experience and you travel the world training in martial arts and it wasn't until someone came from outside of the sport and pointed out something that you had been used to doing, that you were like that makes that makes total sense. But it was like a blind spot that you had and that so many of us have in all different aspects of our lives that we didn't even notice it. You didn't even notice it.

And I think something that I particularly is my career across on both the strength and conditioning perspective and motor learning perspective in relation to the culture of fatigue in combat sports training because it's supposed to lay the ground for later foundation for the question, for anyone who's not in the combat sports world was listening to this is anyone who's been in a fight or has been in a combat sport, especially knows how dramatically unpleasant it is to be exhausted when your opponent isn't and you're getting hit with shots or whatever but you can't respond to, your arms are heavy and everyone's experienced that, especially when they first start, and especially when they first start sparring and they're on the receiving end or they first get into fights and they're kind of less efficient and less equipped to pace

fights or sparring sessions et cetera. Or they're just in over their heads with a better opponent.

As a result, there's a massive bias I suppose, in combat sports towards what is perceived as conditioning or fitness and what we technically term as energy system development and as a result that we potentially might get carried too far where a session isn't seen, or a drill isn't seen as valuable unless it's creating fatigue and unless it's getting you huffing and puffing and breathing heavy, and unless that's making you tired best. Because that kind of perception is well, if it's not hard, what uses it because I want to be fit so I don't get fit in a fight. This was the layman view on it.

But I suppose the cross over between the two, while very well maybe the case that a certain amount of energy systems, development and stress and energy systems is important. Obviously, there's also the reality that there is a potential that high levels of metabolic fatigue can interfere with more learning abilities and not just more learning abilities from acquiring a skill, but also, for example, from speed or power development to being able to just like a sprint or a track sprinter, 60-meter, 100-meter sprinter or they know that when they need to sprint max velocity to actually push the boundaries of their speed development, they need to have short enough reps or in terms of time and effort, but long enough recoveries, so that they're not in a high enough level of fatigue, that they're not actually able to move quickly enough, so they need to take long enough break.

So I suppose from a combat sport perspective, take that same idea of being fresh enough to actually be able to move and not just technical precision, but with speed and with power with regards to developing punching power, speed or combination, precision in footwork and timing between your set ups to your shots in your distancing, whether it be on pad work or bag work, for example.

Would you have any thoughts on the role that metabolic fatigue would play in motor learning and speed or power development across a spectrum? Not just from, not just from the perspective of learning the new skill and developing

power in the most accurate way possible, which you assume anyway. Again, I'm not an expert in this here but you assume would be when you're not in a very high level of fatigue all the way across the spectrum of fatigue to being able to produce the repetition of a skill at high level of fatigue when you are exhausted and what are your thoughts as regards to I suppose training processes to take both of those or that spectrum of fatigue into account.

ISRAEL HALPERIN: Oh, well, it's a big question and interesting one too. I think my answer here, well again, some will find it disappointing, but the key answer here is I suppose it depends. Like you said, you're definitely not going to get quality motor learning if you constantly take. It's just not going to happen. And also if you're constantly fatigued because of the practice, your ability to develop maximum qualities such as explosiveness, and speed and so forth are naturally going to be affected, negatively affected.

On the other hand, like you said, I'm in a fight, at the end of the day, fatigue... Just yesterday, there was another UFC, we saw two heavy weights get fatigued rather quickly. Fitness, especially in NMA still plays a big role. You see people fatiguing more so than you would think that you should at this point. So how exactly should one balance out the training fresh and the benefits that comes with it is perhaps better motor learning, better ability to observe and have your techniques learned as well as your ability to express maximal values of force or power and so forth. So this will be the benefits versus being constantly fatigued or just being run down by metabolic fatigue, achieved by any one way, then you could possibly sacrifice explosiveness. You can possibly sacrifice maximum levels of force and your learning ability, and then you got to juggle these two, because both of them are important.

And how exactly to do that will really will depend on so many different factors that's really hard to come up with a perfect equation. But I think coming to terms with this, some sort of a dilemma, and then having to come to some sort of a solution, understanding about that by doing one, you're potentially sacrificing one variable and vice versa. Then you

got to come up with a plan, how you get both involved. Because surely if say that, you're constantly practicing your technique when you're fresh, but then in a fight, all the sudden you're really fatigued what happens to your technic then? So it's also got to be practiced under fatigue conditions. But it's really a delicate question, and I would say it's more so art than it is science to plan out exactly how to juggle these two competing variables, so to speak. Because you got to have both to some extent, how exactly you plan it out. I suppose that depends on the athlete.

I've worked with athletes that were extremely explosive, and I also had that camp for that and their papering strategies. And then I had athletes that were not named explosive so I mean knowing these two facts change the way I would approach a problem, and this is just accounting for one variable out of many. So I realize what you're saying, I think coming to peace with this problem that you pose is important, but I don't have a solution to this interesting problem. It's just how we juggle both of these two factors together. They're trying to milk the positives out of both approaches so to speak.

CIARAN O' REGAN: Brilliant. I'm loving these responses because in combat sports, I suppose there is so much history in combat sports and there's a lot of I suppose, unfortunate dogmatic thinking with regards to black and white. Like you have to run a certain amount of miles a week in order to be fit for a fight or you have to be able to do a certain amount of rounds of sparring in the training camp or else you're not going to be ready to fight. There's all these very definites that are more, that are dogmatic, they're supposed to use the phrase or not evidence based. They're not... they're just based off someone's opinion off what might have worked for them when they were a fighter or some opinion that was expressed by a course that they once had, who had a very strong opinion and happened to have achieved success with particular fighters.

I think this kind of nuanced viewpoint that you're putting forward to these responses where you're acknowledging the complexity of the situation and that there is no dogmatic

answer, that you essentially need to be aware of your own biases, be aware of expose the overarching principles that you're trying to achieve, and then adapt the methodology to address those principles depending on a case by case basis and the situation that you have as regards to time within a session, the amount of sessions within a week, the amount of athletes within a session, equipment that you have in the gym and so on and so on and that there's nuance and that there isn't definite responses and there isn't black and white answers to this stuff.

ISRAEL HALPERIN: There's never black and white answers. I mean really, just even summarize my approach is the following, if I'm hired by an athlete, what I try to do is try to gather as much information as I possibly can from as many channels as I possibly can. And that means speaking to the athlete, speaking to his or her coach, trying to see, like you said, what equipment do we have access to. When is the next? Does the athlete have experience doing strength and conditioning? I'll do some physical tests to try to gather again some information and based on this incoming information that I try to come up with a plan. Now it's ongoing and never ends.

We start a session and we try to get immediate feedback from that session. What did you think? Did you like the session? And then the athlete is like, well, you know what? This exercise kind of hurts my back a little bit. Well, let's just change the exercise, no worries, and then we just constantly, we make mistakes, and we constantly adapt and it's ongoing, it never ends.

I've been working with some athletes for over five years now and we constantly change. It's always fine tuning. And I always try to be, personally, I really value the feedback that I received from the athlete. For me, it’s probably the most important channel of information that I can act upon. So I try to always get to the point that I communicate and work with the athlete. It’s not that I'm a boss and tell her or him what to do. It’s like well, what do you think? What do you think should be done?

And I value his input or her input, and we work according to... and I try to get involved in the process as soon as I possibly can because at the end of the day, first, I got to say that the athlete is the one in my case, because I only work with combat athletes. They're the one that are putting their health at the risk and walking into the ring. So I want to know what they think. My underpinning philosophy and approach, this problem is I think that the athlete in front of me is a responsible accountable adult that wants the best for himself or herself so knowing that, having that as my underlying philosophy, let's work together and try to solve this problem to the best of our both abilities.

How to solve the problem together, working on it together, rather than me telling the athlete what to do, assuming that I have the answers. This is a wrong approach. We have no idea how our complex systems such as human is going to adapt and respond to a given stimulus. We just don't know that. We just have to see how it unfolds. Based on how it unfolds, we change and adapt and we should do it together rather than the coach deciding for the athletes, turning the athletes into this passive being, thinking that someone else knows better, what's best for it for them. I don't like that approach. It doesn't sit well with me knowing what I know about how humans adapt.

And the fact of the matter is we can't really predict what's going to happen. We got to let things unfold and emerge. These are two of my favorite terms; Let things unfold and let them emerge. And this is why over the past, I don't know how many years, but how many athletes I've worked with, not once have I repeated the same program twice, it just never happens. And I'm not talking about just between athletes; I'm even talking within the same athlete over time. They change, things happen, they mature, they gather injuries, they change their perspective, they may change a coach and may not work full time. Things always change, and they constantly got to adapt.

We don't have answers that we try to force upon the athlete, we see it, let the situation unfold, and based upon that, we come to decisions together and try to make the best educated

guesses that we can, and this is what they are. They're educated guesses. We try to use evidence based practice, research that's been published an incoming information based upon all that information. We try to come to a solution. Sometimes it works better, sometimes not. It constantly adapts and change. This is my general approach to the problem.

CIARAN O' REGAN: Just like you like to read outside your feel and your sport, I also like to study other coaches and other sports and hear their viewpoints, and one particular guide I think you may enjoy if you haven't come across is. Steve Magness is his name. He wrote a book *The Science of Running* and he has a website and he is podcaster. I can't remember the name at the moment but he talks a lot about coaching as a two-way street. That it's body direction, that you can't, as you said, just force or have this definite plan, and then regardless if the athlete is a circle or a triangle, you're going to fit them into the square and that's it, and that you're going to force force something rather than take the athlete's viewpoints and enjoyment levels and everything into account.

I heard you mention before in another podcast about enjoyment, for example. I suppose how that would fit into it? I think even from a physiological level it regards to adaptation and training. When you view what training is, is that physical training is just a stress applied to the body, and that stress is not going to have the same result if the hormonal and biochemical situation in the body is different. Because any time you apply stress to the human body, that is getting overlaid unto, I suppose like a certain environmental situation. And if someone is psychologically stressed or they don't enjoy the session or they don't have a goal and they are questioning, and they're doubting what's going on, and if you're not picking up on that and adjusting and figuring it out that their recovery capabilities are going to be potentially worsened because they are in higher levels of psychological and emotional stress, doubting and questioning whether or not they should be doing or shouldn't be doing something. And if you're not opening them up and potentially getting their feedback and making these adjustments based off what they're enjoying that you're potentially not going to be

making the most of their adaptive abilities to the stress that you're putting them under in the training.

ISRAEL HALPERIN: 100% and I'll even add on to that, and this is actually a topic that I've investigated, and I've conducted a few studies on it, and there is in fact one review that should be published any day now, I think, and journal submitted it to a journal, strength and conditioning and the title of it is *Autonomy*. And I think we titled it Autonomy: a missing piece of a successful program, something along these lines. And we do know now even in combat sports, one of the studies that I've done by providing athletes, not just athletes actually, with choices as to what should be done, leads to considerable positive influence on their motor learning, on the exercise and hormones and on their performance. I have even shown that when we let athletes choose the order of a combination rather than have and deliver a combination in a set order, if you let them decide on that order, they will actually punch harder and faster. And these are competitive athletes that I've tested.

Small choices should always be an integral part of any program and any interaction between coach and athlete. But that's not always what we see, right. Sometimes see this dictatorship in which the coach tells the athlete what to do, deprives the athlete of a choice as to what should be done, and that we know by now based on a lot of accumulating evidence from different disciplines that providing humans with choice is a necessary requirement to achieve optimal adaptation, be it learning or performance. So always incorporate some choice within the athlete. Which exercise would you like to start with first?

You see things like that, they're not necessarily crucial for the success of a physiological program with that in the background. I would always recommend to coaches let your athletes make some sort of a decision. It doesn't have to be a huge decision to have a positive effect but humans just thrive on having some autonomy, some control over their environment. And even just some of the research done by Gabriele Wulf has shown that letting subjects choose the color of the golf ball. Supposedly a choice that is meaningless

in the success of golf padding and accuracy. And it was shown repeatedly now that letting subjects choose the color of the golf ball leads to better learning and accuracy in the golf task. And you're like, wait, why would that have anything to do with it? But the very fact that they're provided the choice led to a better performance.

They're not showing that to be true with punching performance among competitive athletes, so something is a simple strategy is allowing your athletes to make some sort of a choice, be it a smaller one or a bigger one, that's up to you I suppose as a coach and the unique interaction that you have with your athlete is crucial to their overall success.

CIARAN O' REGAN: I think for strength and conditioning coach who listen to this who are not involved in combat sports and there's practically applicable stuff that's quite simple to implement like even working with personal training clients or working with regular people or even with team sport athletes, we have a squad where just like you mentioned about which exercise you like to do first is really simple stuff.

I actually learned this off... I first saw this in athletes at a big baseball game. Jim Wendler who is a powerlifting coach and he's famous for writing the 5/3/1 powerlifting program but he also has done work with football players and high school football players. He does simple stuff like for example, rather than having this is the exact session and for example, the total volume, he might have, I try to implement a lot of programs as this as well where you might have two main primary lifts within a session like say a front squad and a bench press and then assistance work that can be implemented such as upper back movements, like rowing, dumbbell rows, chin-ups, pulling orientated stuff.

That there's a certain repertoire that athletes can choose from whichever one that feels the best for them and that there's total amount of reps prescribed to get done during the session in any kind of order that they want, in any kind of way that they want throughout the session and it gives that kind of freedom to choose the kind of movements that feel the best and it realistically, what really matters is the total

volume that is accumulated and the quality of the movement pattern and what's going to go secondary on the list was if potentially there's bit of extra fatigue and a bench press because it happened to do a few sets of extra chin-ups between sets.

In the long term, is that really going to be more detrimental than the athlete actually choosing to do when and having the extra bit of enjoyment and that extra feeling of, like you said, autonomy and empowerment, and if as all other things that go with that like the competency and their feelings that they are being trusted to make decisions and the buy in that they might get as a result in the enjoyment and freedom to express themselves within certain constraints could potentially is more of an intangible nuanced way of approaching coaching rather than, as you said, being very strict or being dictatorial. And this is a way to do it and don't do it any other way.

But there's one last thing I want to touch, which was very interesting. And this is applicable to anyone in the exercising, science or sports science field or human research in general, is your research on the internal validity in exercise science and the different factors and confounding factors that can affect results. I suppose, is there any chance you could tell us about that story and the work that you've done and looking at the confounding factors affecting study outcomes?

ISRAEL HALPERIN: Yeah, this was a review paper that we published in 2015, and this was after I have experienced conducting research in a number of laboratories and of course when we do experiments, when we do randomized controlled trials, one of our main goals is trying to isolate the intervention to the best of our abilities so if we can be a relatively confident and stating that the intervention, whatever it may be is the cause of the outcome.

So we want to be sure that whatever, let's say, we want to see if the caffeine influences a sprinting performance. So we want to isolate every other variable that could influence sprinting performance other than the caffeine. Then we can

conclude with a high degree of confidence that the caffeine is what caused the improvement in sprinting performance. I'm just using that as an example of course. How do we achieve this goal? We try to isolate as many variables as we possibly can, and what I've noticed throughout the years in exercise science usually scientist control for many variables such as warm up. We want to make sure that all participants do exactly the same type of warm up, because if some athletes will do a more fatiguing or more intense warm up compared to the others, then we're not going to be sure whether it's the caffeine that influenced sprinting performance or could it be that some athletes warmed up harder in a more intense fashion and that could be the reason why we saw improvement within the sprinting performance.

So when we have two competing explanations, we'll say that the internal validity of the study is lower rather than higher if we isolate. For example warm up is something that we try to control first. So all the participants will usually the same warm up at the same intensity and so forth. And by having everybody do the same type of warm up, we're isolating that as a variable that could explain the outcome. So people also control... scientists also control for nutrition that have athletes trying to eat the same amount of calories prior to the intervention so then we can isolate that as a variable.

Temperature, if some of the athletes would complete the sprinting test in high temperature versus low temperature, if the air conditioning is on on one occasion and off on another, then we can say, wait, is it the caffeine? Or could it be that the fact that the room was in a chiller, colder and that assisted the athletes to perform better, we're not sure. So the more variables which we could control for keep things constant across subjects and across testing days, the more certainty we can have in the cause and effect relationship. And this, of course, is that one of the key goals of every exercise scientist or every other scientist for this matter.

Now, as I said, I've noticed there are the years that exercise scientists typically control for the same confounding variables that could influence the outcome, and that is usually warm up, room temperature, hydration status, and

so a few other and warm up. But what I've noticed throughout the years with my experience, that exercise scientists do not commonly control for other confounding variables that can easily affect the outcome measure, but usually they're not control. And one example would be, for example, if there's music in the room, if you want to, again, if I'll use that caffeine example, I don't know where I got that from, but let's... let's keep going with that. If I let some participants have caffeine and others not. And then I test their sprinting performance and on one, in some occasions, there's music playing in the background, and another case music is not being played in the background. Well, is it the caffeine that's influencing performance, or is it the music that's motivating people to go hard, we're not sure, but this is something that is not always controlled for when you read scientific studies.

Another example is the type of instructions. We do know by now and I'm not going to get into that with too much detail, but some type of instructions have a considerable effect on performance. If I instruct you how to do a certain exercise in one way versus another, I will not be at all surprised if under some explanations you will produce greater force output or power output compared to others. So if the instructions are not fully controlled for, then we introduced a confounding variable from the back door. Then now we cannot be too sure whether our intervention, the intervention that would like the study that is under investigation in the current study is what's changing the outcome measure, say, sprint performance, or is it another explanation?

Now what I've tried to do with that paper myself and my colleagues is try to introduce other confounding variables that are very important to control for when we conduct studies, but also when we test our athletes. It's not just limited scientific research; it's also true for any testing environments.

If you, as an S and C or as a personal trainer, you want to see if your athlete or trainee's getting better or stronger and you want them to do a max out test on the squat, using body weight or something like that and then on one of the tests

you provide certain instructions and there's music in the background, and he warmed up in a particular way, and then on a different day that that you test them, all these variables changed, then you cannot be sure whether that change them being observed in the test is due to the success of your program, or it could be that anyone of these other interventions that are known to influence performance and perhaps that they're interacting with one another. We don't even know that, whether they are the ones that are influencing the outcome.

With my paper, we try to introduce other ones which are instructions, music, number of people in the room. So this, I think people understand naturally that there's many investigators in the room. And right now I'm going to ask you to do as many pushups as you can, and there's 20 people looking at you. You're probably going to perform better if there's no one in the room. That's something that, at least in my research holidays we always try to control, control for gender because we also know, and that's, again, not too surprising when we think about it, if there is a number of females in the room observing a male performing a physical test, and it's likely that the male will do better if there's females in the room compared to if there's males, it's just human nature, it's fine.

So these are things that have to be controlled for, and we just introduced them and explained why, in addition to all of the common variables such as warm up, and nutrition, and hydration and temperature, we got to account for some of these other hidden variables that have not received enough attention in the exercise world.

CIARAN O' REGAN: Really, yeah, I found that paper, particularly in your discussions of it before, another interview was very interesting and I specifically wanted to highlight that just for, there's a quite a wide audience that Danny has on this podcast and a lot of the people potentially from science backgrounds would understand that these different factors are contributing.

But I specifically wanted to highlight that for maybe people who earned from exercise science background or research background, but maybe more from listening to this, maybe combat sports background. And in regards to having an idea of the different factors that go into research and the different thought processes that go into ensuring study validity and study power just to create some kind of an awareness of the debt of I suppose effort that goes into doing science as well as possible. Trying to uncover research answers.

So I'm conscious of your time and I'm going to thank you very much. That was a fantastic discussion and hopefully we'll be able to do it again, someday. In case people want to follow you on social media, where would they find you? What are your handles for Twitter or Facebook?

ISRAEL HALPERIN: I would say Twitter and Facebook, just my name, Israel Halperin. I'm somewhat active on both. For now the best place to find me, if you Google my name, you'll find some of the, if you go to ResearchGate or Google Scholar, you can search my name. You'll probably find some of the studies that I've done most of them related to combat sports. So if you're interested in that, you'll have access to them. I upload all my studies as PDFs to ResearchGate. You'll be able to find out there.

CIARAN O' REGAN: Brilliant. Thank you very much Israel.

ISRAEL HALPERIN: Thank you very much. I enjoyed this conversation very much. Thank you.