SUPERIOR COURT OF NEW JERSEY
LAW DIVISION, CRIMINAL PART
MIDDLESEX COUNTY
INDICTMENT NO. 17-06-00785
APP. DIV. NO. _____

STATE OF NEW JERSEY,	:	
	:	TRANSCRIPT
vs.	:	
	:	OF
DARRYL NIEVES,	:	
	:	HEARING
Defendant.	:	

Place: Middlesex County Courthouse
56 Paterson Street
New Brunswick, NJ 08903

Date: October 13, 2020

BEFORE:

HONORABLE PEDRO J. JIMENEZ, JR., J.S.C.

TRANSCRIPT ORDERED BY:

CAROLINE V. BIELAK, ESQUIRE, A.D.P.D. (Office of the Public Defender, Middlesex Region)

APPEARANCES:

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I N D E X

(Hearing commenced at 10:50 a.m.)
THE COURT: All right. Emily, are we on?
(Extended pause)
THE LAW CLERK: Yes, Judge. We're live.
THE COURT: All right. So we're back on the record. Darryl Nieves, Indictment 17-06-785 on file 17-837. Continuing with testimony in the Horne [sic] hearing.
Who is on for today, as far as experts?
MS. RUE: Good morning, Judge. We have Dr. Van Ee for today.
THE COURT: Okay.
THE LAW CLERK: Is Mr. Van Ee appearing virtually?
MS. RUE: Dr. Van Ee is here in the courtroom.
THE LAW CLERK: Okay.
THE COURT: Have him come up. Yeah. Doc?
MS. RUE: Emily, just before we get started, he's in the waiting room as well. That's the virtual. I think that might be the confusion. Because he's going to share his screen like Dr. Scheller did two weeks ago. So if we could just let him in? Okay.
THE LAW CLERK: Okay. I'll let him in right now.

MS. RUE: Thank you. So, yeah, sorry, no, I'm realizing the confusion now.
THE COURT: Doctor, I'm going to give you the option. You can testify with your mask on, you can testify with it off, you'll be behind -- but you'll have to remain behind the plexiglass.
DR. VAN EE: Yes, sir.
THE COURT: What I will ask you to do is also either move that mic closer to you or you can hold it in your hand if you'd like, like -- like a game show host. Because I want to be able to record everything that you say with or without the mask. Okay? So --
DR. VAN EE: (Indiscernible)
(Extended pause)
DR. VAN EE: Your Honor, do you suggest putting it -- holding it or not holding it?
THE COURT: You can hold it, if you'd like. You can place it somewhere. I just need you to be able to get your voice. So, if you're not a loud talker --
DR. VAN EE: Is this pretty good right now?
THE COURT: Yeah, you're perfect.
DR. VAN EE: Okay.
C H R I S A. V A N E E, DEFENSE WITNESS, SWORN

THE COURT: Please state your name for the record and spell your last name, if you don't mind?
THE WITNESS: Chris Alan Van Ee, V-A-N space E-E.
THE COURT: Okay. Your witness, counsel.
MS. RUE: Thank you, Judge. I don't know if you want to -- for us to place our appearances on the record?
THE COURT: You can. Yeah. All right. It's five minutes before --
MS. CRAVEIRO: Good morning. Vanessa Craveiro for the state.
MS. RUE: Danica Rue and Caroline Bielak on behalf of Darryl Nieves, who is present in court seated in the gallery.
THE COURT: Okay. Your witness.
MS. RUE: Thank you, Your Honor.
VOIR DIRE DIRECT EXAMINATION BY MS. RUE:
Q Good morning, Dr. Van Ee.
A Good morning.
Q And if you can't hear me, just let me know, since I've got the mask on.
A Will do.
Q Where do you work?
A I work at a company called Design Research

Engineering. And it is located in Novi, Michigan, just outside of Detroit.
Q And what do you do there?
A I am an engineer for that company. And my specific are is impact biomechanics and mechanical engineering.
Q Okay. Do you have an undergraduate -- pardon me -- undergraduate engineering degree?
A I do. I went to Dordt College, which is in Northwest Iowa, and received a degree in engineering. Mechanical engineering was my study there.
Q And do you have any advanced degrees?
A Yes. I went on to graduate school at Duke University. I have a Ph.D. in biomedical engineering from Duke University.
Q Okay. And what is orthopaedic and impact biomechanics?
A So, let me back it up a little bit. So, biomechanics is the application of mechanical principles to biological structures. When you look at orthopaedic biomechanics, it's applications as they relate to orthopaedics. So what types of screws or what types of materials should implants be made out of. Those engineering questions that are related to the implants or the procedures that an orthopaedic

surgeon would do. That's orthopaedic biomechanics.
I have done some of that, but primarily what I have done is impact biomechanics and impact biomechanics is actually the study of the human body and how it responds to forces or accelerations when they impact the body or when the body is moved and how those forces and accelerations translate into physical loading and property of the tissues of the body and how they become injured. So, if I get hit in the shoulder, how much force goes into my clavicle and how much force can my clavicle take. So, when you're trying to answer whether a certain side air bag or a certain structure of a vehicle is sufficient or is the best we can do, you need to know how strong the different parts of the body are. That's impact biomechanics.

Q And that's where you practice.

A Yes, primarily.

Q Are you a medical doctor?

A No, I am not a medical doctor.

Q So, what is different about what you do compared to what a medical doctor does regarding impact injuries?

A Sure. Well, primarily, I mean, I don't work at a hospital, I don't see patients ever. I mean, that's

not a part of what I do. While a medical doctor is -- has -- needs to -- like an ER physician needs to identify an injury when it comes in quickly, stabilize that patient, rehab that patient, none of that is any of what I would ever do.
However, if you want to understand how to design a dashboard so that you don't break somebody's hip in a frontal crash at, say, 35 miles per hour, then you need to know how the hip breaks, what are the forces that cause it, and how different types of padding affect those forces that get to the hip. That's the area that I work in and that's actually a project that I worked on at University of Michigan.
So, all my work is related to understanding the mechanics of how an injury takes place and then, once those under -- once you understand that, you can then evaluate designs or evaluate in this case a forensic history that's given and say can that account for what we see.

Q Okay. What kind of things did you work on when you were getting your graduate degree at Duke University?

A Sure. So, one of the biggest projects I worked on and was a subject of my Ph.D. dissertation was actually understanding how the frontal air bag

interacts with the human either when they're out of position -- so they're too close to the air bag -- or as they're moving into it in a crash scenario if they're initially seated properly. So that involved first off understanding how an air bag interacts with a person, where it touches, and then how does it create forces in the neck?

What we saw when air bags first started -- so, I started Duke in 1992. Air bags became prom -- or universal in all vehicles in '95. So I'm there three years before air bags are in every vehicle. And then -- or in SUVs and trucks I think it was '97 or '98. So I'm there right at this time where air bags are coming in the fleet of automobiles and we're starting to see people who were injured by air bags when they deployed.

Particularly one injury. There was an injury where the base of the skull would either break or separate from the top of the neck. And this was a tension injury. And so -- but we didn't know how much force it takes. And so I did tests with human cadavers and I did computer modeling to help account for the differences in muscle tone between a cadaver and a living human to give the Department of Transportation ideas on where to set force levels or

injury reference values for crash test dummies when they're evaluating air bags.

So, first it was figure out the force it takes to break the neck. And then, once you have that sort of data with a crash dummy, you can then say here's air bag 1, air bag 2, air bag 3, put your dummy in front of each one, measure the forces when the air bag goes off and say are we in a safe region, are we in that transition region, or are we at a high risk for a neck injury.

So, I didn't do the air bag testing, I did the work to give some of the foundation that they can use when they evaluated air bags.

Q When did you obtain your Ph.D.?

A Two thousand.

Q And then what did you do after that, work wise?

A Sure. My first job out of grad school was at University of Michigan Transportation Research Institute. And I continued my work in impact biomechanics. I did the hip injury project there, I did a neck injury project there. We looked at -- did research on injuries to pregnant mothers and their unborn babies to try to figure out what's the best kind of a seat belt or what's the best way to restrain

a pregnant person so that you decrease the chance that they would have an injury to their baby or themselves in a crash.

Aorta injury was another big part of it, which is the second leading cause of death in car accidents is a ripped aorta. Behind head injury. So we were trying to do -- with cadavers and computer models, trying to figure out a model how -- what are actually the mechanics that govern when you get a ripped aorta. Because if you don't know if it's overall acceleration, is it distortion of the chest, if you don't know, you can't design so that you limit it or mitigate it.

Q And what -- I'm sorry. Where do you current work now? At Novi?

A So, Design Research Engineering. It's in Novi, Michigan. And then I'm also an adjunct professor at Wayne State University.

Q And what do you teach there?

A So, currently I'm not teaching any courses. I have taught graduate level courses in biomechanics in the past. But I still have -- I think it's two right now -- graduate students working on their Ph.D.s that I'm helping mentor. One was looking at blast injury to fighters -- or people in the military in the field,

what controls -- what are the important factors to determine when our war fighters get injured in the field when there's an underbody blast. And the other one is looking at -- going to be looking at cervical spine injury and specifically as it relates to some sorts of degeneration that occurs as we get older and may make the cervical spine more vulnerable to injury in a car crash.

Q And what is Design Research Engineering, the company you work for? Can you just explain what kind of company it is?

A Sure. It's a consulting company. So, it's a bunch of engineers, there's a few naval architects as well, and we try to answer technical questions. Typically, clients are attorneys that call us and sometimes it's industry as well. And they ask us to look at different issues. And if it's in an area in which we have expertise, then we try to offer assistance in answering their technical questions.

Q What types of attorneys ask you to do consultant work?

A I've been asked by everything from the Air Force JAGs to the Innocence Clinics throughout the -- throughout the world, actually, as well -- and -- and so criminal def -- criminal attorneys, criminal

defense attorneys, occasionally a prosecutor, and then lots of different attorneys relating to plaintiff or defense cases, and then the other type would be attorneys that work for companies who may be interested in patent litigation or marketing claims and things like that, where they're trying to protect company -- company trademarks or -- or inventions that they've come through, or evaluate a current product that they have for safety.

Q And, I mean roughly, what percentage of the consulting work that you do relates to shaken baby syndrome or abusive head trauma would you guess?

A Wow. That's a tough question. I -- it depends. Maybe -- maybe a quarter to a third? But it -- it depends on the time.

Q Okay.

A Sometimes it's -- you know, I won't do any cases like that at all or have any work related to that for two, three, four months in a row, and then I'll have back-to-back cases on something like that where for a given couple weeks that's mostly what I'm looking at. So it just depends on the time.

I could say my testimony history is heavily weighted towards criminal cases as it relates to those issues, and that's primarily because my civil cases

generally settle and they don't go to -- many times they'll go to depo and certainly not to trial, where these cases almost always go to trial in one shape or another.

Q And how many times have you testified as an expert before in the area of biomechanics relating to abusive head trauma or shaken baby syndrome?

A It may be -- it may be even greater than 80 times. I'm not sure. It's around I would say 70-80, but it may be more than that. It's not a number that I have counted up.

Q Okay. And how many states have you been qualified as an expert to testify in this area?

A Many, but I -- I -- definitely more than ten.

Q How about New Jersey?

A I have testified in New Jersey on this topic before, yes.

Q You've been qualified as an expert. In biomechanics.

A Yeah, the -- yeah, --

Q I mean, --

A -- I came, I testified as an ex -- and gave expert opinions on a topic related to abusive head trauma.

Q Okay. What other non-litigation consulting

work do you do?
A Sure. So, I'm a reviewer for multiple journals. Journal of Biomechanics, Annals of Biomedical Engineering. I work with the Society of Automotive Engineers. I'm an editor for one of their -- or associate editor for one of their journals. I have worked with the National Institutes of Health reviewing grants to help prioritize which have good scientific merit, in terms of helping them decide what they should fund.

I've also worked with the U.S. Army. And that -- for that I was, for a week, I was at Fort Rucker, Alabama working with their -- I think it's called their Head and Spine Unit -- looking at injuries that occur to war fighters in the field and how can we best protect them, and that included both looking at epidemiological data, as well as designs they have come up with to try to protect people.

Those are some examples of things that I've done.

Q Okay. What is your experience in the biomechanics of traumatic injuries to children?
A Sure. So, I began with my training at Duke, where we were trained specifically in the orthopaedic biomechanics class about how the tissues in -- change

through maturation. So, you start out as a infant and as you work all the way up to being elderly, how the properties of bone, ligament, muscle, how those things change. And they change not just in terms of geometry, but actually the structure itself, the material itself changes.

While I was there, we also -- when we were looking at the air bag injuries, we were also looking at air bag injuries to children and how that was different than adults. And how the injury patterns varied based on their unique -- the unique geometry children as well as their -- the strength of their skeleton and other structural components.

So then, after Duke, I was involved in a study while I was at -- actually, this was actually after I was at Design Research Engineering and I went back to Duke and worked with Michael Prange on a study looking at the properties of the infant head, in terms of impact, how stiff is it, and what are the accelerations that are measured when it contacts a hard surface, and then compared that to the crash test dummies that we have that represent children. So, validating that.

And then, since then, I have done additional work looking at developing a risk curve for skull

fracture for infants based on -- and this is peer reviewed and published -- based on crash dummy responses. And so if I measure, say, 82 Gs on a crash -- on the CRABI 6 crash test dummy, that correlated approximately to a 50 percent risk of skull fracture for an infant. And then for less Gs, then obviously the percent would be less, and greater for greater accelerations.

Q Could I just interrupt you for a moment? Can you explain what you mean to us non-engineers what Gs mean?

A Oh, sorry.

Q Sure.

A Sure. So, when we measure acceleration, we -- as we sit here on the world we may -- we have one G of acceleration acting on us. That's what makes us contact the earth or the floor and it -- and that's one G of acceleration. If the floor is taken out from under you, you would begin to accelerate towards the center of the earth. And we'd accelerate at a level of one G.

When I'm in a car and I'm coming up to a stop light, I can hit my brakes really hard and slow the car down very quickly and I may get over possibly, if I have really grippy tires, possibly over one G.

Typically, it's more like .7, .8. But if I then have my car hit a curb or run into a tree, suddenly I can create acceleration levels that are much greater, there may be 20 or 40 or even 100 Gs of acceleration.

And the force that it takes to stop something, to create those Gs, is directly proportional to the acceleration level, the Gs, as well as how much something weighs. So, force equals mass -- how much -- how much mass something has or its weight -- times acceleration. So, if I say something is 100 Gs for a head impact, compared to 50 Gs, I know that the force on the head for the 100 Gs is greater than it was for the 50 Gs by a factor of 2.

Q Okay. And you've mentioned that you were published in a peer-reviewed study? What was the name of that study?

A Well, I've actually got a large number on my C.V. The one that I was talking about was the -- it was with the American Society of Mechanical Engineers. They have a transactions set where they put their scientific peer-reviewed papers. And so I have a study on skull fracture in there, as well as a study on the production of subdural hematoma and retinal hemorrhaging from an impact.

Q And when was that published? Do you recall?

A About 2009.
MS. RUE: At this time, Your Honor, I would offer Dr. Van Ee as an expert in the area of biomechanics.
THE COURT: Any objection?
MS. CRAVEIRO: Generally biomechanics? Okay. Just I have one question.
VOIR DIRE CROSS-EXAMINATION BY MS. CRAVEIRO:
Q Dr. Van Ee, you testified that you have previously -- that about 25 percent to 30 -- to one-third of your cases are involving abusive head trauma and shaking. Can you tell me what percentage of those cases involve just shaking alone as a mechanism of injury?
A So, first -- well, let me just clarify two parts first. I think I was -- I was estimating on -- based on time, not number of cases.
Q Oh, okay.
A So, 25 to 30 is maybe about the amount of time I'm spending on those topics versus other topics.
Q So, in what --
A And that's a rough estimate. It might be more cases than that, because I usually spend less time on those cases than I do on a typical civil case.
Q Okay. So you spend --

A (Indiscernible) -- so it may be --
Q -- less time on those?
A -- more cases than that?
Q Okay. And when you say that you spend 25 to one -- a quarter to a third of your time, what range are we talking about? How many years then?
A Oh. So, I've been doing consulting since 2002.
Q Okay.
A I don't know that that number has been the same all the way through, but there certainly have been an element of this abusive head trauma or accident-related scenarios that I have looked at over the years.
Q Okay. So, in the cases that you testified, how many of those dealt with shaking alone scenarios?
A So, that's a great question and I can't tell you the answer, because we don't know what happened. Right? In most of these cases we don't know what happened. And in some cases it's clear there's trauma. Other cases -- and I think maybe in a case like this that I -- and I'm not involved in much of the medical part of this case, but a case like this we don't actually know if this child was shaken or not. Is the defense position, at least. And I know the prosecution feels differently. But I have no other

way to determine whether --
So, are you saying or asking are there allegations of shaking without impact?
Q Yes.
A That's less common. Particularly more recently, given the knowledge that we have in the scientific community about shaking without impact. I don't -- I think that's come up in a couple cases, but even in this case I think I -- I understand there was testimony that there may have been impact into a soft surface, so I -- I can't -- I can't think of a case, as I sit here right now, that there was no discussion of shaking without impact at all.
Q Okay. And how many of those cases dealt with short falls?
A Many. It's a really rough guess, but -- and it truly is a guess -- but I would say maybe on the order of 70 percent.
Q Seventy percent?
A And maybe it's more.
MS. CRAVEIRO: Okay. No further questions and no objection.
THE COURT: Doctor, you're saying all the cases that you reviewed were -- always involved shaking with impact? As far -- as best of your -- as

best of your recollection?
THE WITNESS: So, through the -- so, this case I thought was a shaking-only case until I read --
THE COURT: No. Forget about this case. You're talking about --
THE WITNESS: I -- I -- I --
THE COURT: -- one-fourth to one-third of the time that you've spent in your professional career, or maybe about that, dealing with cases involving either shaken baby syndrome or abusive head trauma -- phrase it that way -- without an understanding as to what actually occurred, but it's characterized as this kind of case. Now, when you've taken a look at that scenario, and if I understand your testimony correctly, those scenarios that you reviewed or considered in your professional career, did they always involve a shaking with impact that resulted in the injury?
THE WITNESS: Your --
THE COURT: As opposed to a shaking with no impact.
THE WITNESS: I understand your question, Your Honor.
THE COURT: Okay.
THE WITNESS: Unfortunately, in most of the

cases we don't know what actually happened.
THE COURT: Okay.
THE WITNESS: I have looked at video where there was only a shaking event, but there may have been an impact off video that we didn't see. So I just -- I -- I just can't tell.
THE COURT: The aerials [sic] are always different -- the variables are always different then; right?
THE WITNESS: They're different and then there's, you know, eight to ten people all hypothesizing different things about what actually occurred, so there's all different -- in every case it seems like -- so --
THE COURT: Is the com -- can we narrow it down to one common variable, that being an injury to a child?
THE WITNESS: The only thing I would -- distinction I would put there is injury kind of in -- I would say infers trauma.
THE COURT: Okay.
THE WITNESS: And so, if it's a traumatic case, then absolutely there's, you know, there's trauma in some cases that I have worked on. The defense's position was that there was no trauma

whatsoever to the child and it was a -- a medical event that resulted in the child's collapse.
THE COURT: I guess what I'm really -- aside from a shaking, trauma, impact, injury -- when you were asked by defense counsel before about cases that you were consulted on and she used the phrase shaken baby syndrome or abusive head trauma, --
THE WITNESS: Yes.
THE COURT: -- you indicated to one-fourth to one-third of the time that you have been consulting has involved those kinds of cases.
THE WITNESS: Yes.
THE COURT: I guess what I'm trying to understand is, with those kinds of cases, was there an injury or something wrong to the child? I don't mean an injury by way of impact, I don't mean -- was there something wrong with the child that you were asked to come in and help decipher whether there was impact, no impact, trauma, no trauma, shaking, no shaking, the one thing is that something was wrong with the child that needed attention. Is --
THE WITNESS: Absolutely, except I wouldn't be asked to address the non --
THE COURT: Okay.
THE WITNESS: -- the medical part of that.

THE COURT: No, no. No, but --
THE WITNESS: Yeah.
THE COURT: -- at least all the children that you were asked to consult in, --
THE WITNESS: Ab --
THE COURT: -- despite the fact that defense counsel characterized it as a shaken baby case, again, you don't know if there was any shaking, you don't know if there was any impact, you don't know if there was any -- I want to -- I don't want to say trauma, but you don't know the cause, you're just dealing with an end result. And the end result is the child -- there's something wrong with this child and they're trying to figure out what -- what -- what the cause of it was.
THE WITNESS: That's a good explanation of that whole group of cases, I think.
THE COURT: Okay. All right. All right. I'm just trying to get an understanding, because I got lost there with your testimony going back and forth with regards to you saying there's no impact, there is impact, there's no shaking, there is shaking. I just want to be clear. We have a -- we have a child who is -- needs attention, medical attention, and you have been asked to consult in those cases. And counsel

characterized it as shaken baby cases, but we're not really sure whether it was shaken baby.
THE WITNESS: Right. I would call them cases like that, if there's allegations of shaking.
THE COURT: Okay. All right. All right. So I'm going to allow -- I'm going to -- with no objection from the state, you're going to be qualified as an wit -- as an expert witness in biomechanics.
All right. Counsel, your witness then.
MS. RUE: Thank you, Your Honor.
DIRECT EXAMINATION BY MS. RUE:
Q Dr. Van Ee, can you -- I know you did briefly on voir dire, but can you just explain the science of biomechanics simply for us again?
A Sure. So, as it relates to this case and what I've done, it would be specifically impact biomechanics, and that is looking at the human body as from a mechanical perspective trying to understand what are the forces or accelerations that give rise to injury. And then the forensic aspect of that is, if you have injury that could be identified as trauma, what are the types of things that are compatible with -- with producing that. So, if you have a -- if you have a given history and you have a specific trauma, you can then evaluate is that consistent with what we

see or not.
Q Who first hypothesized the premise that angular acceleration can cause intracranial injury?
A As I have been taught and understand it -- I certainly wasn't alive at the time, but Dr. Holbourn from the U.K. looked at that in the 1940s and his idea was that angular acceleration -- so, how quickly the spin of something changes -- and I can talk about that if you want -- but specifically how quickly the spin of the head changes could give rise to things like subdural hematoma, intracranial hemorrhage, hemorrhage inside of the skull around the brain.
Q Okay. Do you want to explain a little further what you mean by that?
A Sure. So, it's easier to start out -- we talked about Gs already.
Q Mm-hmm.
A That's linear acceleration. So, acceleration along a line and it's how quickly you come to a stop or, if you're already stopped, how quickly you accelerate out. But it's always along a line.
Angular acceleration is the spin of something. So, if you have a merry-go-round and it's going around and suddenly it is stopped abruptly, how quick that stop occurs is angular acceleration. If

the stop occurs fast, there's greater angular acceleration. If it occurs slowly, like you just put your foot against the side of merry-go-round and rub against it and it slowly comes to a stop, that's low angular acceleration.
When you have high angular acceleration -- think of the kids on that merry-go-round -- all of a sudden it just abruptly hits something and stops, all the kids on the merry-go-round will continue to go forward from their position. Right? The kid on this side is going to forward this way, and the kid on this side is going to go forward this way, if this is a merry-go-round going around like that.
If you think of the merry-go-round as the skull and the children as the brain trying to keep up the path of the skull, whenever you have that differential angular acceleration, there's going to tend to be separation unless there's force there to hold the children in place. So, if they're holding onto a bar right around them and you suddenly stop it, they might be able to ride that position down and not get dislodged.
So, this idea that the brain has to accelerate due to changes in the skull motion creates sheer forces around the -- as you move away from where

the center of rotation is, you move to the outside of the brain, those forces get bigger and bigger to -- in order to stay with the skull.

It's thought and it's been shown in studies with both animals and human cadavers, and we have seen it in sports events where a boxer may take a hit or a football player takes a hit, these angular accelerations can cause concussion and they can cause subdural bleeding, and in some cases diffuse axonal injuries or actually breaking or stretching of the nerves in the brain. The axons. You can break those, as well.

So, those are the types of things: concussion, subdural hemorrhage, and DAI, those are some examples of things that are associated with angular acceleration.

Q Okay. What safety measures -- when that -- when that premise first came to be accepted, what safety measures came from that?

A So, yeah. I mean, obviously it -- it's always an evolution. That's the 1940s. In the '60s there was a bunch of more studies done by the National Institutes of Health looking at primates in producing subdural hematoma. This was done Ommaya. And they started to understand the role of angular acceleration in

combination with linear acceleration, because it's very hard to get -- and this is important.

If I'm hit in the head, almost always I get rotation. Like, if I'm hit in the chin, I get a lot of rotation, but my head doesn't move as far, it just more rotates. If I get hit more towards the center of my head, I get more translation and less rotation. So both of those can give rise to injury. And so when we develop air bags, helmets, seatbelts, the interior -- all the interior components of a vehicle, they test it by taking a crash dummy head and throw -- and shooting it at, like, the -- the A-pillar, the thing that goes between your windshield and your -- where your door connects up and the hinge --

Q Mm-hmm.

A -- in the door, that level, they shoot a crash dummy head at that to make sure that that trim on there has enough give that it's unlikely you're going to suffer a head injury.

So all head injury, they look at these factors. Now, most of the time, just to make it easy for designers, we look mostly at linear acceleration, but angular acceleration is always associated with any linear acceleration. And if you have both, both contact, angular and linear, that's the situation

where injury is most likely to arise. Angular acceleration all by itself, without contact, the threshold for injury seems higher than if you have contact with it.

Q So, how does shaken baby syndrome or abusive head trauma relate to biomechanics?

A I would say it's more -- biomechanics is a way of looking at that topic. Right? It's a way -- it's the method of science that's been developed by humans to look at the mechanics of injury. And so shaken baby syndrome is a hypothesis that says, if you take a child and hold them by the torso and shake them -- at its simplest form -- the head goes and back and forth and the hypothesis was that you would create these angular accelerations of the head that are sufficient to rip bridging veins and cause injury to a child.

Biomechanics would come in and say, well, what are those angular accelerations and are those angular accelerations consistent with what we know causes injury in a car crash or in a fall or are they inconsistent with what we know causes injury. And that's how it's evaluated. So it's a way of looking at that topic. That's the relationship.

Q Is it fair to say that it's a way to test the hypothesis of shaking or is that a wrong way to

put it?

A Yeah, no, that is -- you can use the science of biomechanics to test it, but there's ever -- there is no perfect test ever of anything, but, yes, it is one of the sciences that has been used to test the hypothesis of head -- shaken baby syndrome.

Q Okay. And what is the difference, from your perspective -- not as a medical doctor, but as a biomechanical expert, what is the difference between pediatric anatomy and adult anatomy?

A Well, as it relates to this topic, --

Q Yes.

A -- the big issues are the -- the -- the most major issue you think of when you think of a child -- if -- a child versus an adult, is the weakness of the neck of the child. Particularly an infant. They have a very heavy head, which represents a large proportion of their body, whereas an adult it's less than 10 percent of our total body weight and we have a strong neck that holds it up. A baby can't even hold their own head up.

So, you have this really weak neck, this large head, and in cars we learn very early on that if you put a child in a car seat, particularly in an infant, in a forward-facing car seat and they're in a

frontal crash, and in a front crash their -- their chest is strapped to the seat, but their head does this. And it stretches that neck. And when they were in crashes of significant magnitude, the upper part of the neck and the head began to separate and they caused spinal cord injuries in young infants.

That's why in -- I think it was around the '80s they began to take children and put them in rear-facing -- particularly infants -- rear-facing child seats. And in other countries they actually do it until age four. But they put them in a rear-facing car seat so that you can directly hold the head in that frontal crash. And frontal crashes are the most common type of crash. Because if you go off the road and hit a tree, it's a frontal.

Q Mm-hmm.

A If you're rear-ended, somebody else had a frontal. Right? So frontal crashes are the ones that are most common, so let's protect the children in the most common crash. You take infants, you put them in a rear-facing child seat where their head is supported in that frontal crash, as opposed to making the neck do the work.

So, we know that necks of infants are very weak and vulnerable to injury. Other aspects are also

important looking at the thinness of the skull of the infant, as well as the different properties of the brain and other tissues of an infant, those also play a role as well in trying to understand when infants will suffer a head injury or not.

Q And maybe you already explained this with that answer, but how do those differences in anatomy affect the injury tolerance of a child or an infant compared to an adult or a full-sized person?

A Yeah, I think I explained it. I mean, in short, if you've got a structure that's weaker -- injury tolerance is how strong the structure is. If it's -- if it's weak, you need to know that so that you can try to protect that part of the body in a crash.

Q Is there a controversy in how biomechanics relate to shaken baby syndrome?

A I don't know if there's a controversy in the biomechanical community. I think there's certainly topics of discussion and research that people are looking at. I'm sure -- well, I've seen testimony of physicians who say that biomechanics doesn't necessarily agree with what they understand to be the clinical picture and so there could be controversy there as far as what role that plays.

Q You mentioned before I believe the Ommaya

study.
A Yes.
Q Can you explain what the relevance of that study is from a biomechanical standpoint?
A To shaken baby syndrome?
Q To shaken baby syndrome.
A So, as I understand it -- and I was born in 1970. These studies were done in the late '60s and around this same time there was a doctor named Caffey, I think was the last name, proposed that the studies that were done by Ommaya about the National Institutes of Health -- and these are studies done on primates, where they were put in a chair, strapped, and then accelerated so that their head snapped back like that in a really extreme whiplash sort of motion. Some of these primates had subdural hemorrhages and neck injuries associated with that.

My understanding is Caffey said that supports this idea that shaking could cause injuries to children. Ommaya came back later and said, wow, I don't know that Caffey understood these represent approximately 30-mile-per-hour crashes. This is not something that a human can generate in shaking. And then wrote about that in a subsequent peer-reviewed article that was published.

So I think there was some misunderstanding of the biomechanical study of Ommaya by Dr. Caffey at the time, but I don't know that that fully was realized by physicians, and I think it's still confusing to some physicians still to today.
Q Okay. And when you say it's still confusing, what is confusing exactly?
A That the Ommaya study supports the idea of shaken baby syndrome. I mean, really loosely, sure, if the head is allowed to -- this free motion, could you create a subdural hemorrhage? Possibly, but the levels of force are far beyond what a person can generate in shaking.
Q Okay. What is the difference between a whiplash event and the shaking event?
A Well, the Ommaya used a sled or a -- a test contraption that they had it in a laboratory that would accelerate this chair with the primate in it at speeds representative of a 30-mile-per-hour crash. So that's -- that's that whiplash there. Now, some whiplash events, if I'm just sitting at a stop light and I get rear-ended at five miles per hour, I could look at the head acceleration for that and compare it to a shaking event. If it's a -- you know, certainly not a 30-mile-per-hour crash, but I think

accelerations in whiplash could be 5 to 10 Gs and I think that's consistent with shaking. In a low speed whip -- or a low speed rear-end sort of accident.

Q Would you expect to see subdural hematomas in that kind of level of 5 to 10 G incidents -- whiplash events?

A We don't typically ever see anything like that. Now, that there's always an exception to the rule. I mean, if somebody is particularly vulnerable. Or it's just like riding a roller coaster. There has been some people that have gotten off a roller coaster and have had a subdural hematoma, but it's a very, very rare that under those sorts of exposures that somebody would suffer a traumatic injury.

Q I want to -- you wrote a report relating to this case; correct?

A I did.

Q And we've marked it as D-14.

MS. CRAVEIRO: Oh, yeah. That's fine.

MS. RUE: Okay. I just want -- do you have a copy of it or -- I just want to --

THE WITNESS: I have it on my computer, but I don't have a physical copy.

MS. RUE: Okay. Well, I'll provide you --

If I may approach, Your Honor?

THE COURT: Mm-hmm.

BY MS. RUE:

Q I just want to ask you about, on page 4 you wrote that -- regarding the hypothesis that shaking is, quote, "likely to result in injurious angular acceleration/deceleration resulting in direct damage to bridging veins and diffuse axonal injury while simultaneously not injuring the neck or torso cannot be scientifically supported."

What does it mean that these injuries -- meaning damage to bridging veins or diffuse axonal injury -- what does it mean that those would not exist without neck injuries?

A So, in short, we know the neck is very weak and vulnerable to injury. And under that motion, the first place to look for injury, from a biomechanics standpoint, would be the neck. The idea that you can create a subdural hemorrhage by ripping a bridging vein, if that is indeed the mechanism, for a normal healthy child without injuring the neck, the data does not support that, because the angular accelerations that are created in shaking, they are less than what we see in even a one-foot fall. So, one-foot fall on the carpet, we typically don't associate that. If the baby is sitting up and falls over and hits their head

on the carpet, they may cry a little bit, but we wouldn't associate that with a subdural hemorrhage or a massive traumatic head injury. But the angular accelerations in that fall have been measured and published in the Journal of Neurosurgery and they're greater than what we see in a shake.

So what that means is that -- look, I don't know if shaking can or cannot give you what they call the triad, but the hypothesis that links these two up -- so you have the medical findings and then you have a physical situation -- in this case, an abusive shaking -- but does it match? Do the injuries match, in terms of where the forces are created and what we see? That's the question. And the data that we have in biomechanics says if you start shaking a child like that, that neck should be where injuries should start and we're well below the levels of what angular acceleration is associated with head injury.

So that's -- that's the point there, is we don't know if you can get there with shaking for the head, but we know you can get there for the neck.

Q And you know that through research; is that right?

A Through re -- yes.

Q So what research has been done in this area

that supports what you're testifying to?

A Sure. So, one of them is where do you see injuries in children? Where do they actually -- where -- where we have verifiable -- look, these cases are very difficult, because while there are a few videotaped incidents of both accident and abuse, we don't have much to really know exactly what happened.

But if you go to things like car accidents or household falls, you start to get a better idea of a verifiable situation where you have multiple witnesses and say here's what happened and here's how the child responded, you can get an idea of what types of impacts result in subdural hematoma, as well as what types of impacts result in neck injury. And so those data -- that's the beginning. So you get some idea. Then you can do tests with human cadavers or animals to try to explore those relationships further, and then you can do computer models. Those are primarily the main tools that we have available to us.

When you're doing tests with cadavers or animals, you may also use a test device that allows -- say you just want to focus on one topic, like just what types of head accelerations occur when I slam the head into a bench versus a child sitting on this bench and falls off onto the floor, what are the differences

in accelerations. And then you can use things like crash dummies to get an idea of what's going on there.

But they're just measuring the acceleration. That's all they're doing. They don't predict injury in and of themselves, because a crash dummy doesn't have a brain or blood or things like that. It's just measuring the acceleration. You still have to have those injury reference values to take that data and make meaningful inferences from it.

Q Okay. Can you tell us about the Prange study? I believe you mentioned it before. And I don't know if you want to reference --

A Oh, sure.

Q -- the PowerPoint that you -- it's in the report.

(Extended pause)

A I'm trying to share my screen. I'm not sure --

MS. BIELAK: There's usually -- there's usually a bit of a lag I think for a minute.

MS. RUE: Yeah, I think there's a couple -- it lags for a few seconds.

(Extended pause)

UNIDENTIFIED MALE: (Indiscernible)

MS. RUE: Great.

BY MS. RUE:

Q And can you describe or just, you know, outline for the Court what this study was?

A Sure. So, this was done at the University of Pennsylvania. Michael Prange was the lead author. This was published in 2003 in the Journal of Neurosurgery. What the authors did in this study is they developed a crash -- a test device that represented the weight and relative size of a one-and-a-half-month-old infant. And then they took this test device and they had people shake it and they had people slam it onto a piece of foam that represented a crib mattress -- so a soft surface -- and then they also dropped it onto concrete or carpeted floor or the crib mattress from one foot, three feet and five feet, and then they, finally, they also slammed it against a wooden bench and then a wooden bench with carpet on it. So they did all these different things.

And what they were trying to understand is what's the head acceleration that's happening under these situations. Then they -- they varied this along with a study that was done earlier, looked at the properties of the neck, as well as skull stiffness, to figure out are those big factors. And so they tried to do their best to envelope the response between a really stiff neck or a really soft neck, so it

envelopes the response of a real infant. And these are the results that they got.

Q If you could just explain them --

A Yes.

Q -- to us.

A So, let's first look at this plot. The bottom is called peak change and angular velocity. That is how fast the head is spinning or not spinning. So that's the speed of the spin. And then, on the Y axis is actually how fast that speed changes.

So if I'm driving in my car and I am going 40 miles an hour, and I hit my brakes when I get to a stop light and I slow down slowly, you can think of the 40 miles per hour would be what's on the X axis. It's how fast I am moving. And if I hit the brakes slowly, I am not going to rise very high on the Y axis, because I have a low level acceleration. If I hit a brick wall, I am still at the same place on the X axis, but I would go really high up on this graph, because I have really high acceleration. Now, that's linear acceleration.

This is the same thing, except it's a spinning effect. So, when the head is shaken, it changes direction from one direction to another direction as it's being shaken, and so there's

acceleration and deceleration at each point. When the head is falling, while it's in the air, the head probably isn't really spinning at all, but upon impact it quickly rotates in response to the big force that's created on impact.

Q And that -- and pardon me. That would be not just shaking, but shaking onto different surfaces that you just outlined before that are listed.

A Right. For any of the -- so, if you shake -- if you think of a slam onto this wooden bench compared to a slam onto a mattress, the overall head speed might be very similar, but the change in that speed is going to be very different. Because if I hit this, that speed changes almost instantaneously. If I hit a mattress, it slowly comes to a stop and then begins to accelerate back out. So, how fast that speed changes is what makes -- what determines whether you go high up on this graph or just across laterally.

So, what we have here in the grey spot -- can you see my cursor? Yes. So, right here is shaking. That's this grey circle I'm looking at. The angular velocity -- in other words, the speed of the head is actually it's greater than what we see here with a one-foot fall onto foam or carpet. Right? There the head doesn't spin that much. But the

acceleration, the change in that spin, is actually very low, how fast that spin is changing, and that's why it doesn't go up very high on this plot at all. And as you move higher up and further right, the risk of injury goes greater.

Q So what --

A Particular as you move higher up.

Q Okay. So what was the -- what were the findings? If you could just --

A Sure.

Q -- explain them.

A So, here's shaking. Here is a one-foot fall onto carpet and here is a one-foot fall onto concrete. So, both the one-foot falls onto concrete and carpet have greater exposure, have greater head angular acceleration than that is achieved during shaking.

Now, if you look at right here we have one-foot fall onto foam. That's a very low exposure. And then here with the triangle is a five-foot fall onto foam. Again, very soft, you don't have much rotation or spin and you don't -- and it doesn't change quickly.

But shake you have more spin, but it doesn't change quickly either, but as soon as you start to get impacts with the head hitting something, those angular

accelerations start to rise and then they really rise as you start to move up into three- and five-foot impacts onto these surfaces.

Q And those would be the hard surfaces, the concrete -- the one-foot concrete, three-foot concrete and five-feet concrete.

A Right, as well as the five-foot carpet --

Q Five-foot carpet.

A -- are way up there. And there's another one they did. They also looked at -- in addition to what we talked about, what -- what about if you slam into a soft surface? And that's what we see right here. There is the -- the slam into a soft surface. So you still get the same head speed you have during shaking -- very similar; right? -- but when you hit that soft surface that speed doesn't change that quickly. It changes faster than it does during a shake, but not as fast as it changes in even a one-foot fall onto carpet or concrete.

So that's what-- that's what Prange found. And at the end of their study they said, look, we still don't have any data that says that shaking can give rise to the injuries associated with it and they -- and be -- they actually said that the term shaking should not be used in legal settings, is their

conclusion and what they wrote in the Journal of Neurosurgery.
Q And why did they say that?
A Because there's not a scientific basis from biomechanics to support this idea.
Q And that was with the size of a one-and-a-half-month baby approximately?
A That's right.
Q So how would the analysis change of a baby who weighed 8 kilograms or a little -- like, 17-and-a-half pounds?
A Well, that's going to make -- the -- the more -- whatever you're trying to shake, the heavier it is, the harder it's going to be to shake. And so you will create less overall head acceleration as the child you're -- one is trying to shake gets bigger. There is a study that has looked at that and it really drops a lot as you start to get up into 10 to 15 pounds. Just because you can't generate the same forces or move the head the same way.
Q So, is it fair to say there would be even less of a -- I don't know how to describe it.
A Both the angular velocity and probably the angular acceleration would be less than what we see here.

Q Both would be less.
A Yes.
Q Okay. Are you familiar with the Jenny study?
A I am.
Q Can you describe that for -- for us today?
A So that's a more recently published study, although she was doing work back in the early 2000s already with the crash dummies that she was having made in Japan. The recent Jenny study had a crash test dummy that represented the fifth percentile newborn of the Japanese population. So it weighed around five pounds. So it represents a really small baby. And they had that shake -- they shook it and again they weren't able to reach the thresholds associated with injury. And then when she first published some of this data back in the early 2000s, she looked at falls and there it showed that the accelerations in a fall were much greater than that during a shake.
Q And when you say the injuries, what are you referring to?
A So specifically in her study she said that they were not able to reach diffuse axonal injury thresholds and she didn't specifically state about the

subdural hemorrhage thresholds, but did suggest that the biomechanical data did not support the clinical thinking about how shaken -- the shaken baby syndrome hypothesis.

Q Okay. Have you personally conducted any studies related to biomechanics of allegations of shaken baby syndrome or abusive head trauma?

A I have.

Q Can you describe those?

A Sure. One of them is actually published in this textbook. It's called Forensic Neuropathology. And there's a section on biomechanics and some of the work that I did is actually shown on this plot here. And I was just looking at the same topics that Prange has looked at in the past and then in comparing it to other things that we know. I have a more of a car background, so I wanted to include some of that.

So these are all linear accelerations that we're looking at. And here is shaking way down on the bottom. Here is a one-foot fall onto linoleum, a two-foot, a three-foot, a four-foot and a five-foot fall. So these are just horizontal falls right onto the ground or on a linoleum floor and measured the head accelerations the same.

Then this green dot comes from actually an

article where they reconstructed NFL football players who suffered a concussion on the field. They took the video, brought it back to the lab and looked at the closing speed of the helmet-to-helmet contact. Then they put helmets on two crash test dummies, ran them into each other at that speed, and measures those head accelerations. So, for the ones that concussion, that happened at about 100 Gs. And that's what you see in that green dot right there.

The bottom blue dots are car crashes without head injury. So these were children who were in car crashes and they did not suffer head injury, yet they sustained -- you know, they still experienced up to 50 -- almost 50 Gs. And then we had three children who suffered subdural hemorrhage and skull fracture as a result of being impacted by an air bag in the front seat of a car, and the accelerations they experienced were between 100 and over 200 Gs.

Q Is that the top --

A That's the top red.

Q -- right --

A So what you see here -- right? -- is here's exposure for shaking, here's exposure we know that causes injury to children, including subdural hemorrhage and skull fracture, here's where falls come

in, and then here's car crashes that don't have injury.

And so what we get out of this is if shaking producing accelerations to cause injury -- that doesn't mean that shaking doesn't cause injuries some other way that we don't yet understand -- but if it's head acceleration, as has been hypothesized, then all the things that happened above shaking should be causing injury as well. So these car crashes where these kids don't have injury, they should be injured. And one-foot falls on the -- on the linoleum, those kids should be injured. And that's not what we see in everyday life.

So there's some -- that's the questioning and how biomechanics can question this hypothesis that are these head accelerations big and are these head accelerations causing injury or not to the head.

Q So I want to go back. During the voir dire, the state and court were questioning you about shaking alone versus shaking with impact.

A Yes.

Q And I believe you testified -- well, you said, well, with the knowledge we have now, you seldomly see allegations of shaking alone. Can you explain what you mean by that?

A Sure. It's -- I guess there's a -- some of the stuff that I've presented here, along with other studies I've looked at and said we don't know that shaking can actually give the injuries that are associated with it. And the evidence base is weak. And so we do know that impact can do it. And in many cases there's actually evidence of impact on these children. Sometimes, if the child lives, that evidence is never seen, but there are studies out there where children have died as a result of abuse and when they -- and at autopsy they are able to see signs of impact that were not able to be appreciated prior to autopsy.

Q And what would those be?

A It may be a subtle skull fracture or bleeding -- subgaleal bleeding of the scalp, swelling of the scalp, some different things that maybe aren't as clear when you're looking at the body -- the baby in a hospital. Now, with advanced imaging I think there's fewer and fewer of those things, but it can still happen is my -- is my understanding. A radiologist would certainly be able -- a radiologist or the forensic pathologist would be able to talk about this at much greater depth than I could.

Q Okay. Does a study exist that shaking alone

-- that -- that supports a position that shaking alone can cause the injuries associated with shaken baby syndrome?
A Does a study exist. I haven't seen a biomechanical study that shows yes indeed -- there's -- there's biomechanical studies that say maybe and maybe it's this way, and that's the most I've seen a biomechanical study do. Certainly there are other studies or review articles that say shaking does cause these injuries. And I -- and -- and I think there's confession articles where they -- people have confessed to shaking a child and the child had the injuries associated with shaking. That's primarily, that I'm aware of, that supports this idea that shaking can do this.
Q Is there a biomechanical study that has -- with dummies, animals -- that has shown that shaking alone can cause retinal hemorrhages and subdural hematomas? That you know of.
A I would say -- be more specific.
THE COURT: One second.
A The way we --
THE COURT: At the same time or individually?
MS. RUE: Both injuries you mean, Judge?
THE COURT: The way you were asking him, you

were asking him a question can it cause those two injuries simultaneously. Is that what you're asking?
MS. RUE: Yes. I apologize if that wasn't clear. Right.
BY MS. RUE:
Q And either in a -- in a study with dummies or a study with -- that have been done with animals. And a biomechanical study. Have -- has there ever been a study where those two injuries of subdural hematomas and retinal hemorrhages been proven through those studies that those exist from shaking alone?
A No, I don't know of a study that has proved that that can happening from shaking alone.
Q Okay. What is the Leestma study?
A Leestma is this textbook that we just talked about.
Q That's what you just showed us now.
A Yeah, that's this --
Q Okay.
A -- textbook.
Q And what conclusions did you draw from your contribution, the study that you had published in that textbook?
A I mean, it confirmed the other studies. Like, what Prange and Duhaime and other people have

published as well about the relative accelerations of the head in shaking compared to falls.
Q Okay. Are there any video-recorded instances of abuse shaking that indicated the outcome of the triad of symptoms?
A The video -- there are some video instances of shaking that have been caught on nanny cams or different sorts of camcorders. I am not aware that any of the video-captured events had injury that was reflective of what that those are associated with shaken baby syndrome.
Q So, in your review of this case in particular, what conclusions did you draw?
A So, in this case I was just asked to come in and talk about the biomechanical background of shaking and comment on the hypothesis and what biomechanics has to say about it, specifically as it relates to this case, like the details of the case. I did not review case materials other than testimony that's been offered. So that's it. I don't have any diagnosis or anything like that -- nor would I ever produce a diagnosis, I'm not a medical doctor -- about what happened in this case.
Q Okay. And then the opinions that you've testified to today on biomechanics, are they to --

within a degree of reasonable -- pardon me -- to a reasonable degree of certainty?
A Yes.
MS. RUE: Just one moment, Your Honor.
(Extended pause)
MS. RUE: No further questions, Judge.
THE COURT: We're going to break in a half hour for lunch. Do you want to start now?
MS. CRAVEIRO: Sure.
CROSS-EXAMINATION BY MS. CRAVEIRO:
Q Now, doctor, you mentioned that you're not a medical doctor; correct?
A You are correct.
Q So you don't have any medical degrees; isn't that right?
A Correct.
Q And you also mentioned that you don't diagnose or treat any patients in your work.
A Correct.
Q That also includes in the topic that we're discussing here today, abusive head trauma and shaken baby syndrome; correct?
A I don't treat or diagnose that ever. Correct.
Q Okay. And you've never actually been taught what a forensic examination for child abuse entails;

correct?
A No.
Q And you have never been trained in diagnosing a child with abusive head trauma. Correct?
A Correct.
Q And you've never conducted an examination for abuse -- for child abuse; is that right?
A No.
Q And you've never even been consulted when one of those exams was conducted; correct?
A You mean, like, while the exam is going on? No.
Q Yes. And so you don't actually have any firsthand knowledge of what a child abuse pediatrician does when diagnosing a child with abusive head trauma; correct?
A No, I have no firsthand knowledge. It would only be what they would tell me they do. That's it.
Q Okay. And even in your field, with the biomechanical work you've done, you've never actually examined a living infant in your cases; correct?
A You're talking about medical examination, we do evaluations with infants and car seat fit and things like that, but nothing like a medical examination, no.
Q And nothing related to abusive head trauma or shaken baby syndrome; correct?

A I would say generally you are correct, yes. I mean, certainly we have looked at head size and relative anthropometry and things like that, that relate to the biomechanics of those topics, but not any evaluation, like a medical evaluation, never.
Q And when you're looking at the head size, are you actually looking at infants themselves?
A Yes.
Q Okay. And so most of your experience in this realm of abusive head trauma or all of your experience of abusive head trauma and shaken baby syndrome comes from the work you do with test dummies and review of literature that also uses these test dummies and animals; correct?
A I think it primarily comes first from understanding living tissue and the relative size of children. The test dummies are what -- what biomechanical engineers kind of produce. Like, it's the ultimate product, like, after you -- that's the product that goes out to the mechanical engineers who are the designers of child seats and things like that. So, it's the background work to the crash test dummy that is a lot of what I do.
Q Okay. And but that work that you've done with the crash test dummy in that field was mostly

dealing with the automobile field and auto accidents; correct?
A That's one application. Certainly, there's a lot of money to look at automotive safety, and that's funded by the government, and so -- and we've done infant cadaver studies looking at head impact. Those are typically funded by the U.S. government for transportation-related research.
Q And you're familiar with the scientific method; right?
A I am.
Q And in your field, you use it all the time; correct?
A Generally, yes.
Q And it's generally accepted within the scientific community; correct?
A Yes.
Q And the basic scientific methods, you start with a question; right?
A Hypothesis of some sort. Yep.
Q And then you do some background research; correct?
A Evaluate and understand the factors. Yep.
Q Mm-hmm. And then you, with this hypothesis, then you come up a pro -- with a procedure to test

that that hypothesis; correct?
A Correct.
Q And then you obtain data through the procedure you set in place; correct?
A Hopefully, yes.
Q And then you analyze that data; correct?
A Yes.
Q And then you'll draw conclusions based upon that data; correct?
A Yeah. I think that's a pretty good explanation.
Q And some of those conclusions will include whether the results align with your hypothesis or whether they diverge from that hypothesis; correct?
A That's right.
Q And in this, you may also collaborate with others in different subspecialties and other professionals to conduct further experiments to refine that data; correct?
A Yes, that's fair.
Q And then you do that to draw more sound conclusions; isn't that right?
A Yes.
Q And you do that to make sure that your conclusions are reliable; right?
A Yes.

Q And usually, if all those steps are taken, you can -- the results of the study can be accepted by others; correct?
A That's certainly -- you know, whether somebody accepts it or not hopefully has something to do with how good your study is, but sometimes it doesn't.
Q And the reliability of that study; correct?
A Correct.
Q And so would it surprise you to know that the child abuse pediatrician uses a similar approach when diagnosing abusive head trauma?
A I don't know what -- I don't know that they have a test or any evaluation that they do. I don't -- I don't know that they can employ the scientific method.
Q Okay. Well, in your report you state at the end of the report:
"Even if shaking can result in injuries associated with it, it cannot be said with any level of certainty that when those findings exist in a given child that the child in question must have been shaken, as other conditions have been known to result in similar findings."
That's correct' right?
A Yes, that's correct.
Q So, in that statement you're saying that

shaking can cause injuries; correct?
A I'm saying if.
Q And so there hasn't been any biomechanical studies to suggest that shaking cannot definitely cause injury; correct?
A I would never say it can. Absolute -- shaking can absolutely cause injury. The question is, can you get the subdural, the encephalopathy and the retinal hemorrhaging without any other findings from shaking. That's the question. And I don't -- right now there is not a mechanistic explanation that allows one to go from shaking to those injuries that said that -- that's how that works, that's how it makes sense.
Q Okay.
A That's what's been tested.
Q Okay. And correct me if I'm wrong, but in your report you're saying that you can't just assume that a child has abusive head trauma just because he has the triad of symptoms; correct?
A Certainly cannot do that.
Q And because there's other conditions that can cause that; correct?
A Right.
Q Okay. Well, did you know that child abuse pediatrician doesn't assume that a child has shaken

baby syndrome or abusive head trauma solely from the child having the triad of symptoms?
A I would hope they would not. That would be horrible.
Q Okay. And did you know that this child undergoes a comprehensive evaluation in getting diagnosed with abusive head trauma?
A I hope that's true.
Q But you don't know this.
A I am not a medical doctor, I have not been trained in that, and I have not evaluated their procedure.
Q Okay. So you also don't know that the exam includes consultations with --
MS. RUE: Judge, I'm going to object. He just said he doesn't know what they do. So the answer is inherently going to be no.
MS. CRAVEIRO: That doesn't mean I can't ask the question. It's a different question.
MS. RUE: Well, --
THE COURT: Let me hear what the question is. I'm going to allow the question. I'm just -- go ahead and ask it.
BY MS. CRAVEIRO:
Q Okay. And so you don't know that the exam

includes consultations with other doctors from other subspecialties; correct?
A That's certainly reasonable. I mean, they need to get the different data from the other physicians.
Q And you don't -- but you didn't know that they did that; correct?
A Oh, I'm aware that they do that. It was testified to in this case.
Q I'm sorry?
A I'm aware they do that. It was testified to in this case.
Q You listened to the testimony in this case before you testified here today?
A I received a transcript.
Q Of whose testimony?
A I thought I had --
(Extended pause)
A Give me just a second.
(Extended pause)
MS. CRAVEIRO: Judge, I don't know if you just want to take lunch early so the doctor can look for --
THE WITNESS: Dr. Medina.
BY MS. CRAVEIRO:
Q Okay. And that's the only person you

received testimony --
A No, I saw some --
Q -- transcript from?
A -- from Dr. Scheller and from Dr. Mack as well.
Q You say transcripts of their testimony?
A Parts of it, yes.
Q Just parts of it. Not the whole thing?
A Well, I got a whole transcript, but my understanding is Dr. Scheller hasn't finished yet, so I have not -- I don't have testimony about what he has not testified to yet, but I -- I mean, I read through the transcripts that I received.
Q Okay. And you also read through Dr. Mack's full testimony?
A Well, everything I received, yes.
Q Okay. Okay. We'll come back to that later. Let's -- and going back to the procedure that a child abuse pediatrician undergoes. Then, because you read Dr. Medina's testimony, you know that they consult with other subspecialties; correct?
A I know that she did.
Q Okay. And you know that she also -- that the infant in this case underwent several different tests and exams that were ordered by those special -- subspecialties; correct?

A My understanding is that, yeah, they did do evaluation for that, but I -- I don't know the details of that.
Q Okay. Well, you read her testimony, so obviously you know there was genetic testing done; correct?
A I don't recall what testing was done.
Q Okay. So you don't recall whether there was blood testing done; correct?
A I don't. I don't know what specific testing was done. I know that she mentioned they did multiple different tests or that tests were conducted that she looked at, but I don't know the details of those tests or what those tests are used for specifically.
Q Okay. And you don't know what tests the infant underwent for brain analysis?
MS. RUE: Judge, I'm going to object at this point. He's an expert in the area of biomechanics. I think we're way far afield from that.
THE COURT: You're asking him about if he knew about any of the tests that any of the other doctors involved in this case did?
MS. CRAVEIRO: Yes, Judge. And as it relates to --
THE COURT: They --

MS. CRAVEIRO: -- a diagnosis of abusive head trauma and shaken baby syndrome. And that's exactly what he's been testifying to the entire time.
MS. RUE: No, he's been testifying about biomechanics.
THE COURT: Well, let's -- you first want to ask him has he been familiar with or reviewed any of the tests that any of the other doctors who actually dealt with this child -- right? Is he familiar with it, has he seen it, does he know that's what they do? That -- is that what you want to ask him first? Without going through --
MS. CRAVEIRO: I will ask him --
THE COURT: -- each doctor individually?
MS. CRAVEIRO: -- that, Judge.
THE COURT: That -- that's what you -- that's how I'm interpreting your question. That's what you're asking him; right?
MS. CRAVEIRO: Yes and no. So I will -- yes.
MS. RUE: Well, Judge, I'm also going to object on hearsay grounds, because the state is asking him to repeat what he's read regarding prior testimony, so it's not -- it's -- it's hearsay.
THE COURT: Well, look.

MS. CRAVEIRO: This is a motion hearing.
THE COURT: He's -- some -- he -- somebody provided him with transcripts of the other witnesses who testified for a reason. So my question to you, doc -- Mr. Van Ee is this. You read the transcripts of the people who testified before.
THE WITNESS: Yes, Your Honor.
THE COURT: Okay. Why did you read those transcripts?
THE WITNESS: I wanted to see what they said about biomechanics --
THE COURT: Okay.
THE WITNESS: -- and if it -- how it related to what I have done in this case, which was a general review of shaken baby syndrome and the biomechanics associated with it.
THE COURT: Did anything that you read in any of those transcripts so far -- because Dr. Scheller still has to testify -- did it influence or affect your testimony today with regards to biomechanics and your expertise? And the conclusions that you draw or didn't draw?
THE WITNESS: No, Your Honor, because my conclusions in this case aren't case specific.
THE COURT: Okay.

THE WITNESS: Does that make sense?
THE COURT: Yes, it does. Yes, it does. Your conclusions are based on your own training and experience and what you perceive from this particular case and not from the testimony; is that accurate?
THE WITNESS: Right. And not even case specific. I mean, it's --
THE COURT: Okay.
THE WITNESS: -- more general.
THE COURT: Okay. Are you familiar with what any of the other doctors in this case -- the examinations that they did of the child at the hospital? Either be --
THE WITNESS: As far as what they specifically did, I did not look at that --
THE COURT: Okay.
THE WITNESS: -- in any depth.
THE COURT: Okay. Do you know what they're supposed to do in examining a child in this particular instance?
THE WITNESS: I have no expert --
THE COURT: Because you're not medically trained; right?
THE WITNESS: Right. I have no expert opinion on what they should or shouldn't do.

THE COURT: All right. Is -- does that -- is there anything else to add to that, Ms. -- because I needed it for clarification where the testimony was going.
MS. CRAVEIRO: I can --
THE COURT: Was there any --
MS. CRAVEIRO: Yes, Judge. I'll continue.
BY MS. CRAVEIRO:
Q So, to be clear, you didn't review any of the medical records associated with this infant's case; correct?
A I have not.
THE COURT: Okay. All right. Sorry if I didn't cover that.
Q Okay. And your conclusion that there are other conditions that -- that result in similar findings as injuries of a shaken child, if those were taken into consideration when coming up with a diagnosis of abusive head trauma, that makes it less speculative of a diagnosis; isn't that correct?
A Can you -- I'm sorry. Can you repeat that?
Q Okay. So, you can't assume that just because the child has the triad of symptoms that he has abusive head trauma; correct?
A I would never make that diagnosis ever in the

first place. Right. So --
Q Okay. But that's what you wrote in your report. That that assumption --
A (Indiscernible) cannot do that.
Q -- cannot be made. And that's because you're saying there are other conditions that -- that cause these injuries; correct?
A And we're not sure shaking can't. So it's both those things; right?
Q Okay. But that's not what you wrote in your report. And --
MS. RUE: Can we --
THE WITNESS: What page?
THE COURT: Doctor why did -- doctor, --
MS. CRAVEIRO: Let's --
THE COURT: -- why did you make that conclusion in your report?
THE WITNESS: So the report, if you'll read it, it -- it -- there's a whole section that talks about the lack of scientific foundation for shaking and then there was a study that was done --
THE COURT: From a biomedical perspective.
THE WITNESS: From biomechanics. Yep.
THE COURT: I'm sorry I said biomedical.
THE WITNESS: No, you're -- you're fair,

but --
THE COURT: I meant biomechanical.
THE WITNESS: You're right. Then I talked about a review that was done in I think it's Switz -- Sweden or Switzerland --
THE COURT: Sure.
THE WITNESS: -- where they looked at the findings associated with shaken baby syndrome, which is retinal hemorrhaging, brain dysfunction and subdural hemorrhage.
THE COURT: Now, was that a medical review or a biomechanical review?
THE WITNESS: There was both in there.
THE COURT: Both in there.
THE WITNESS: They reviewed all the biomechanical literature, they reviewed medical literature and everything else, --
THE COURT: And when you say they, who do you mean by they?
THE WITNESS: The -- can I just refresh?
THE COURT: Sure. Yeah.
THE WITNESS: Thank you.
THE COURT: Nobody minds; right? Nobody minds?
MS. CRAVEIRO: No.

MS. RUE: No.
MS. CRAVEIRO: Doctor, you're referring to the SBU assessment; correct?
THE COURT: Doctor -- I forgot his last name though.
THE WITNESS: I am referring to that, yes.
MS. CRAVEIRO: Okay.
THE WITNESS: So, it was published in 2017. The first author is Lynøe, L-Y-N-O-E.
MS. CRAVEIRO: And in that --
THE WITNESS: The --
MS. CRAVEIRO: Go ahead. I'm sorry.
THE WITNESS: I'm still answer -- should I finish? I'm -- I can stop.
THE COURT: Go ahead. You can answer my question and then we're going to do a -- we're going to take a break for lunch here, because we're going to -- and Ms. Craveiro is going to pick it up from here and we'll -- you know, we'll --
THE WITNESS: So their finding was:
"After performing an extensive review of the scientific basis of the shaken baby syndrome, these authors concluded that the systemic review indicated that there is insufficient scientific evidence on which to assess the diagnostic

accuracy of the triad in identifying traumatic shaking. It's very low quality evidence. It was demonstrated that there is limited scientific evidence that the triad, and therefore its components, can be associated with traumatic shaking."
And so, in referencing that, I said, look, here we have these questions about whether shaking can or can't do it from a biomechanics standpoint, I am aware of cases where other traumatic events, like a short fall, can give rise to some of the injuries that we see in shaken baby, and in cases I have testified in as part of my expert experience, people have said that the retinal hemorrhaging and the subdural and the brain dysfunction meant that this child was shaken and they were very stuck with that idea. Even if in one case where there was actually videotape of the fall that the child died from. Somebody said, you don't know if they didn't shake that child when that video was turned off. They were so stuck on that idea of shaking causing this.
So, when I write that at the end and I say, look, if you just have these three things, we don't know, first off, if shaking can do it, and even if it does -- so that's a hypothetical -- even if it does do

it, just having those three things certainly doesn't allow you to go back and say that shaking was the cause. And that was -- that's -- that's the entire -- that's all I meant to say when I wrote that.

THE COURT: Okay. Great. Let's end right there on that point. Ms. Craveiro, you can pick up your cross, and I'll need everybody to come back at 2:30 so we can continue this. Okay?

Doctor, from now until then --

MS. BIELAK: Two thirty?

MS. RUE: Two thirty or --

THE COURT: -- don't discuss this testimony with anyone.

THE WITNESS: Okay.

THE COURT: All right? You can ask questions about where to go eat lunch or something like that, but with regards to this particular testimony or what has left to be done, don't discuss it with anyone. Okay?

THE WITNESS: Yes, Your Honor.

MS. RUE: And, Judge, 1:30 or 2:30?

THE COURT: Two thirty.

(Luncheon recess from 12:18 p.m. to 2:34 p.m.)

THE COURT: All right, so let's get on the record. Noemi, you got me back on the record?

(Pause)

COURT CLERK: Judge, are you ready to go?

THE COURT: Yep, let's go.

COURT CLERK: Okay. Going live.

THE COURT: So then we are back on the record, State versus Darryl Nieves, Indictment 17-06-785. The file is 1700050837.

All right, Ms. Craveiro, you were on cross-examination before we broke. Your witness.

MS. CRAVEIRO: Thank you.

THE COURT: And Doctor, you're still under oath, okay?

THE WITNESS: Yes, Your Honor.

MS. CRAVEIRO: Thank you, Judge.

BY MS. CRAVEIRO:

Q Okay, so I believe we left off talking about the SBU report, Doctor; correct?

A I think so.

Q Okay. So that -- that review that was conducted in the SBU report, they didn't actually include any ophthalmologist in that; correct?

A I'm not sure if there was an ophthalmologist. I know there was biomechanics included in the advisory panel and the papers they went through, but I don't know about ophthalmology.

Q Okay. But ophthalmologists are the ones who are most equipped to diagnose and treat retinal hemorrhages; correct?
A Diagnose and treatment, absolutely.
Q And that is one of the so-called triad symptoms of abusive head trauma; correct?
A A finding, yes.
Q Okay. And that SBU report, it did review thirty biomechanic articles; correct?
A I don't know what number it was.
Q Okay. If I show you the report, will it refresh your recollection? I believe you said you had a copy, or no?
A My computer had a copy. I haven't looked at it in a little while --
Q Oh.
A -- but.
MS. CRAVEIRO: I want to say -- did you guys put it into evidence already?
MS. RUE: No.
MS. BIELAK: No.
THE WITNESS: They looked at a bunch of them. I certainly would agree with that. I just don't know the exact number.
BY MS. CRAVEIRO:

Q Okay. So if I told you that Page 59 of that report said thirty scientific articles in biomechanics which were identified in literature search were studied more closely, would you agree with that statement?
A I have no reason to disagree it.
Q Okay. And are you aware that the SBU report in that section found that the results presented in the articles that they were reviewed were very diverse and -- were very diverse?
A The results were diverse?
Q Yes.
A Sure.
Q And based upon their review, do you agree that the SBU was able to draw no conclusions with respect to the minimum forces required to cause injury from shaking based upon biomechanical studies alone?
A I wouldn't disagree that that may be a conclusion they drew. That -- that sounds reasonable.
Q Okay. And in the SBU report are you aware that they found two studies that were of moderate weight? Moderate quality, I'm sorry.
A For biomechanics or for the -- to support the idea that the triad is associated with shaken baby?
A To support the hypothesis that isolated traumatic shaking can give rise to the triad.

A Yeah, I think there's two confession so-called studies that they identified of moderate evidence or something, whatever you said.
Q Okay. And when you said "confession studies," you mean studies where an infant was found to have injuries such as subdural hematomas, retinal hemorrhages, and encephalopathy and people -- certain individuals confessed to shaking the children; correct?
A At some level, yes. That's generally the -- the idea.
Q Okay. And those studies, would those be Vinch -- Vinchon and Adamsbaum?
A That sounds right.
Q Okay. And in the -- do you know the Vinchon study, Vinchon?
A I know of it. I have read it in the past, but I haven't read it recently.
Q Okay. And so do you I guess agree with their conclusions or do you know their conclusions?
A That there were -- I mean, as I understand, very limited, but their conclusion was we have some people who confessed to shaking and we have injuries that are associated with that. And on the other hand, you know, there's under what conditions did they get the confessions, to what did the people all confess to,

compared to maybe one thing about shaking. So I think there's -- there was a lot left out in terms of the details of the confession and under the -- the conditions under which they got the confession.
But in general, the idea that what you said earlier, I -- I don't disagree with that and the -- the SBU did not either, that that -- they're of moderate evidence value.
Q And they actually gave some moderate weight to it; correct?
A That's the mod -- that's why they rated it moderate, yes.
Q Yes. So that means that the results -- Vinchon's results that the study confirms that the high -- that there is a high diagnostic value with retinal hemorrhages, subdural hemorrhages, and signs of impact for a differ -- differential diagnosis between accidental trauma and inflicted head trauma, that that is of moderate weight; correct?
A You're mixing up a lot of stuff there. So they looked at the study. They said look, this is not a perfect scientific study. I mean, there's limitations to what you can get from a confession study, right. And they said look, there's something of value here. Don't just dismiss it outright. But -- and so they

said it has moderate scientific weight. That doesn't necessarily mean that there's moderate scientific weight on the overall conclusion. That's not what the SBU said.

They said the study, if you look at the data, what they did, there's moderate weight to that, and you can draw your own conclusions. Because when they draw their conclusions at the end using all the best evidence available, there's very low level of evidence to support this.

Q But --

A That's -- so that's the conclusion of the SBU, and I think that's what you asked me.

Q But you also don't -- aren't even aware of who actually was in the SBU, because when I asked you if they had ophthalmologists you don't know.

A Everybody's listed who is in there. I mean, I've had -- I know -- met two of the people who are part of that personally, but the rest of them I don't know them personally and their names don't mean -- I don't know their back -- each of their backgrounds.

Q Okay. And so if I tell you there are -- there were no ophthalmologists consulted in this SBU report, would that change your opinion on its validity as far as it goes, the conclusions that it draws?

A It goes to who was involved in the study. I don't think it goes to the validity.

It -- I mean, look, one person's validity, how much stock they put in it, that -- that's a personal position. The SBU from what I can tell was done well from an engineering perspective. It was a decent review. It met high quality standards for any perspective, and that's all I can comment on.

Q So then what you're saying is that we should look at your opinions today as far as it goes for what you're saying about whether or not shaking can cause injury and make our own conclusions of that; correct?

A Absolutely.

Q And they're not the be-all, end-all; correct?

A I'm not the judge. I -- absolutely. I'm an expert here to help you with my area of expertise and answer questions related to that. I'm not here to impart my thoughts on how this case should go. Absolutely not.

Q Okay. And you spoke about bridging vein ruptures in your testimony. You agree that ro -- severe rotational acceleration and deceleration forces have been associated with cerebral bleeding; correct?

A Yes.

Q And you agree that the bridging veins -- that

bridges veins can rupture from forces created by this acceleration and deceleration; correct?
A Sure.
Q And it's this bridging vein rupture that causes the subdural bleeding; correct?
A That's one source of -- of subdural bleeding, yes.
Q Okay. And when we're talking about acceleration and deceleration forces, we're talking about moving back and forth in a severe fashion; correct?
A Well, when I talk about acceleration/deceleration my first question is are you talking linear or rotational. And if you're talking about linear, then it's along the line. If you're talking rotational, then it's a rotation of the object. So it just depends on what -- what you're saying.
But I think as I wrote it in that paragraph in my report that I think you're reading from --
Q Uh-huh.
A -- we're talking about rotational acceleration and rotational deceleration.
Q Okay. And rotational acceleration and deceleration are associated with what? Moving in a circle?
A Movement.

Q Movement.
A It's a kinematic movement.
Q Okay. And you also reference the Ommaya study, and that's also what the Ommaya study found; correct?
A What is -- what the Ommaya -- that could be associated with intracranial bleeding --
Q That bridging veins were particularly liable to rupture because of the one whiplash event with no shaking; correct? Or with no impact, I apologize.
A Ommaya looked at the effect of rotational acceleration on the heads of primates --
Q Uh-huh.
A -- and found that rotational acceleration could give rise to neck injuries and subdural hematomas of -- in the brain.
Q Okay. And this rotational acceleration that came from one single whiplash event; correct?
A Yes, that's correct.
Q And that one single whiplash event with no impact; correct?
A That's correct.
Q Okay.
A And that did not contact anything, right.
Q And so even in those cases where there is one

-- and when we're talking -- strike that.
When we're talking about whiplash, we're talking about the violent flinging of the head onto the neck by a rear end collision; correct?
A So, interesting. So the head initially doesn't move at all. It's the body that moves. The neck pulls the head along with it. So it's not the flinging of the head on the neck. It's the body movement and the head is forced to follow what the neck is doing. So the neck is pulling the head along, then the head gets up to speed, and the body may stop and then the head goes and pulls the neck.
Q Okay. So is that -- it was with that one single event that Ommaya was able to find that bridging veins were particularly liable to cause ruptures; correct?
A I think so, yes.
Q And that subdural hemorrhages were caused because of that; correct?
A Yes.
Q Okay. So wouldn't violent and repeated shaking cause more movement of the head than a single whiplash event?
A It's the level of acceleration. That's the key. I mean, if you want to talk about movement of the head,

I can get in my car and drive from here to Michigan. That's a lot of movement of the head. It's how extreme is that movement in terms of acceleration or deceleration. That's the key. I can jump rope all day.
Q Yes.
A Well, I can't, but somebody could. Our body could -- our body is made to be able to withstand lots of movement. It's when those movements are abrupt is when injury often takes place. So, the key is how abrupt are those transitions or changes of movement, and that's the -- the kinematic quantity associated with that is called acceleration.
Q Okay. And so violent shaking, that would be a higher acceleration than just jumping up and down; correct?
A Oh, sure.
Q And that would be -- never mind.
So you -- the -- the diagnosis of abusive head trauma, you don't dispute that the medical community does recognize it as valid; correct?
A No, I don't -- I don't dispute that.
Q Okay. And you don't dispute that the mechanism of -- shaking alone as the mechanism of injury is widely accepted in the medical community as

well; correct?
A It depends on the medical community you're talking about. Within ophthalmology, radiology, pediatrics I think it's more widely accepted. If you talk to forensic pathologists, it's less widely accepted. So it depends on which group you're talking about based on my limited info. But I think there's actually a study there where they interview or do a survey of the medical community to check that.
Q Okay. And in that survey are you aware that the results came up that it was generally accepted in the scien -- in the medical community?
A Again, if you look at -- you have to look at how you define the medical community and who you're interviewing.
Q Okay. And now you also mentioned the 1987 Duhaime study. The study didn't say that shaking alone can never cause injury; correct?
A No, it did not. It shouldn't be used to say that.
Q Okay. And it specifically said that our conclusion that shaken baby syndrome, at least in its most severe acute form, is not usually caused by shaking alone; correct?
A Yeah, it's what it said.
Q Okay. And so in that situation, the most

severe and acute form would be fatality; correct?
A Yes.
Q So, what it may have been suggesting or what it was suggesting is that in those situations shaking alone is not usually the cause of fatality; correct?
A What they're saying is they went and looked at children -- I'm trying to remember if it had died, but there was a group of children of -- they looked at, and I want to say approximately fifteen. I don't know exactly the -- fifteen had died. Some of those they said had been shaking alone. They looked, and they found evidence of impact in each one of those dead children. So, it clearly wasn't shaking alone.
And they said -- and then they did a physical study where they had the University of Pennsylvania football players shake a test device that represented a one-month-old child, and the accelerations that they measured were very low and below the level of where they thought injury would take place for a child. And they said look -- it doesn't look like shaking is responsible for this because the accelerations are low, and when we look at the ones who were fatality injured, they show signs of impact, that they did say that some of the ones that were fatality injured they did not know that there were signs of impact until they did an

autopsy, which they said so maybe there's children who are alive who suffered impact but we don't actually know they suffered impact because you can't do -- obviously, you're not going to do an autopsy on a living child.

Q Okay. And so again, shaking alone -- shaken baby syndrome in its most severe form is not usually associated with shaking alone, that's what she was -- that's all Duhaime was saying; right?

A That would be a very short paper if that's all she said. That was one of the conclusions --

Q Was one --

A -- that the authors drew.

Q Yes.

A But there's a very long paper with a lot of data and a lot of evidence that goes with it and a lot of other conclusions and findings, so I don't think that's all she was saying, but that certainly was a part of it.

Q Okay. But isn't -- that would be -- the beginning sentence of a last paragraph it -- where it says, "It is our conclusion that shaken baby syndrome at least in its most severe acute form is not usually caused by shaking alone."

A That is a conclusion. I don't disagree with that.

Q Okay. And in -- that was not Duhaime's only article. There was another article that was written in 2019. Correct?

A She's written maybe close to a hundred articles.

Q And one is entitled Abusive Head Trauma: Evidence, Obfuscation, and Informed Management; correct?

A No idea.

Q Okay. So you're not aware that in that study Duhaime also states that abusive head trauma is a universal phenomenon reported and studied around the world?

A I don't know what that article states.

Q Okay. And so you also don't know that it states --

MS. RUE: Objection, Judge. He hasn't read the article.

MS. CRAVEIRO: Okay.

THE COURT: Sustained. If he doesn't know the article, you can't question him on it.

MS. CRAVEIRO: I will move ...

BY MS. CRAVEIRO:

Q You also mentioned Cory's study. In Cory's study they were able to show that the forces generated by shaking of a child can make -- can in many cases

exceed the minimum forces needed to cause injury; correct?
A They found that if -- so they had a very unique situation. If I -- can I talk about it?
Q Go ahead.
THE COURT: If it's -- if it's the answer to your question you can, yeah.
THE WITNESS: Yeah. So Cory, what they did is Cory and Jones are the two people who wrote it, and what they looked at is when the chin hits the chest -- so they have this test device where the chin hits the chest and where the back of the head hits the spine. So it goes clunk, clunk, clunk like that when you're shaking it.
When those impacts occurred, they were having headic (phonetic) linear accelerations on the order of 100 Gs. So those impacts are on the order of 3, 400 pounds between the chin and the chest.
When that happened, like I said, they had these accelerations that are almost a factor of 10 greater than what Duhaime got when they did theirs. So this thing is going clunk, clunk. It's an impact. It's not an impact against another surface, but it's an impact, chin to chest, head to the back of the spine.
And they found that during those impacts they

were able to reach the threshold for concussion, but they were not -- even with those impacts were not able to reach the levels of subdural or diffuse axonal injury. And that's all written in -- in my report. Jones has a summary of all of that study. And that's similar to what the Jenny study shows too.
BY MS. CRAVEIRO:
Q And in the Cory study, didn't he state that the authors concluded that it cannot be categorically stated from a biomechanical perspective that pure shaking cannot cause fatal head injuries in infants?
A They did. I fully agree with that.
Look, the -- what it comes down to is we don't know, but the data we have says you really need to question whether this can do that or not and you can't just assume that it does. The data -- so, where you talked about the scientific method earlier, we said look, you test a hypothesis. That's been tested by multiple people using different methods, and every time it's come back is that it doesn't look like it fits. It's not the end of the story. It's not where we're -- we're not done because you can never have the perfect test. But the data that we have suggests that there's good reason to question that the rotational accelerations are sufficient to rip bridging veins.

Q And if we're talking about the medical side of that, when you -- when doctors say okay, we're not done and we're not sure, what would they have to do to make them more sure and to continue their process? Wouldn't that be conduct more tests?
A Their process is to treat children and take care of children. I --
Q I'm sorry?
A Their process is to treat children and take care of children. What do you mean finish their process?
Q I'm saying in a diagnosis when they're not sure, if -- if we're talking about a differential diagnosis and we're -- like you said in your report, that it could be this or it could be that, so we can't assume it's shaken baby syndrome, wouldn't the next steps be to continue more tests and try and rule out these other possibilities?
A Absolutely. I would hope they do that. And then you always have the "I just don't know" at the end of the day. Sometimes there's things we just don't know.
Q Okay. But just because bi -- in biomechanics we just don't know, can't we look at other things like the confession studies that help us say yes, there is a basis for it if we're looking at these certain parameters?

A Absolutely. I think that's what the SBU says.
Q Okay. And so if a doctor used that in making a diagnosis, would that be a reliable diagnosis using that kind of process?
MS. RUE: I'm going to object, Judge. This is outside the scope of a biomechanical expert, to testify about a doctor's diagnosis and the reliability of it.
THE COURT: Doctor, are you able to testify to -- are you able to answer her question? Do you have a basis for it?
THE WITNESS: Generally, I feel like I could answer it. Specifically, I can't speak to a doctor's method.
THE COURT: I'm --
THE WITNESS: But when you have incomplete data as a scientist --
THE COURT: I'm going to allow a general -- I'm going to allow a general answer based on what you're -- and hear what you have to say. In the end I'm deciding credibility all of this anyhow, so.
THE WITNESS: That's correct.
THE COURT: Okay. I'm going to overrule it just for that.
THE WITNESS: As a scientist, you need to

look at your -- the question you have and the data you have and the reliability of it, and you can say there's a trend or you can say this conclusively shows, and sometimes you're in the middle of those yet.

And what we have is we have a trend of data that says this doesn't look like it fits. That doesn't -- that doesn't mean we close the book and say we're going to never look at this object -- or this scenario again, but it does say you need to look at the data for what it is and if there are other things that are reasonable you consider them.

And you always got to realize we don't know everything, and so you -- to some extent you got to always have the we don't know or we don't have a definitive answer on that yet. We're going to do the best we can with what we have but acknowledge that sometimes we just don't have a final answer.

BY MS. CRAVEIRO:

Q But you're saying that in the biomechanical world that -- or correct me if I'm wrong, that the -- the science isn't there and that all of the biomechanical experts are kind of in the same viewpoint as you; right?

A The science isn't fair?

Q Isn't there, I'm sorry. That's why I'm

trying to speak closer to this because, you know.

A I think within the biomechanical community it's consistently written that there's controversy about this, that there's data that calls this into question whether shaking can do this by the mechanism identified of rotational acceleration.

There's other hypotheses that maybe there's something that's happening in the upper neck that affects breathing that then results in hypoxia and the lack of blood flow or lack of oxygen causes brain swelling and that's the method. That may be right. We may find out that's how it works, but we don't know that yet.

So we just don't -- from a biomechanic standpoint, we don't have an answer that says oh, here's exactly how this happens. Like we do about a broken hip or a broken femur when you're in a frontal crash. It's pretty clear how that all occurs. But on this it doesn't look like it fits, at least not based on the way it's been hypothesized.

Q And you mentioned Carole Jenny, but doesn't she also agree that there is extensive evidence that violently shaking a young infant can cause serious head injury?

A She would say that, yes.

Q Okay. And --
A Look, if you violently shake an infant, there's no doubt you're going to cause serious injury and maybe even death. The question is would it show up with just the triad and nothing else. That's the question.
Q But aren't there also certain limitations in biomechanical studies?
A Absolutely.
Q Okay. And so don't those biomechanical -- the limitations in the biomechanical studies, especially in this realm, cause reliability issues with the findings?
A I would say that the limitations are understandable. They're objective. You can state them. Limitations in -- in studies that related to confession data are much more difficult to wrap your mind around -- my mind around, at least -- and get a handle on what's going on there.
We have objective scientific methods to do these things. Certainly, we don't know everything about it, but it should fit generally with the data that we have.
Q So, when someone says I shook a baby, you have a problem with that more so than using a fake baby and shaking that and testing if that fake baby is going

to have injury than someone saying I actually shook this child and created -- and then the child was later found to have injuries?
A What I have a problem is -- and I have seen this specifically in my cases -- is when they take somebody, put them in a room and say, you shook this baby, you shook this baby, and they're like I didn't, I didn't. When I went over to the crib the child was not responsive. I picked him up. I did shake them to try to get them to respond. And I had that shown in my cases as that is evidence that an abusive shake took place. That to me is not evidence of an abusive shake whatsoever. And those cases --
Q But you also --
A -- have then gone on to help people say that then proves that shaking -- I have very limited access to confessional data, but the confessional data that I have seen that they have -- that I personally have viewed where they say this supports shaking in my opinion does not. I'm not saying that what they said is completely wrong, but it does not seem to fit.
I've had cases where they say the child was shaken where there was massive skull fractures. They may have shaken the child, but the child had an impact to the head. So I've seen both sides where there's

both clearly abuse to a child and some where there's a complete question on whether there is. And in each case, the State said this child was shaken based on this confession, and to me, it didn't fit.

Now, I haven't looked at the confession data from the -- I have not had the opportunity to look at the specific confession data from these studies. I think that would be very useful to do. One of the studies said analyzing these confessions is beyond the scope of the study.

I was like that's like me saying if I go to the lab and measure a bunch of head accelerations in car crashes and then don't tell you what car they were in or how fast the car was going when we rammed it into the wall or even what crash dummy was in there but then say oh, these cars are completely safe, but the cars in the crash conditions we're not going to really tell you about it. It's completely useless data, if that makes sense.

That -- so I have a problem knowing how to interpret that kind of data as a scientist when in fact I have biomechanical data where it's more clear. We can have a legitimate scientific discussion about the limitations as well as the strengths of the data, and we could sit in a room and debate that and that's fine,

and that's what's done in the literature. And that has consistently come back and said look, we don't have the final answer, but there's good reason to question whether shaking can or can't do this through the mechanism of angular acceleration.

Q Okay. So you have no dispute with shang -- shaking and an impact causing those types of injuries?
A Impact could absolutely cause injury to a child, no doubt about it.
Q Okay. And shaking along with that will as well; correct?
A So would driving to McDonald's and impacting the child. I mean, the shaking may or may not have anything to do with it.
Q Okay. And in this case you have no idea what happened; correct?
A I have not reviewed the facts of this case.
Q Okay. And going back to the limitations, when we're talking about infant models, the biofidelity of these infant models, the ones that are used, there are severe limitations with that; correct?
A There are limitations, yes.
Q Okay. Because obviously, they don't have blood flowing through them and -- and the neck is usually made of rubber or hinges; correct?

A I don't know of any rubber hinges, but there is rubber.
Q No, rubber or hinges.
A Or sometimes hinges.
Q Yes.
A Or different other engineering materials. And no, it's not -- it's not a model of an infant. It's a test device that tries to capture the important mechanical factors that are relevant to the analysis being done.
Q Okay. Test device. I was trying to use "model" instead of "dummies" to make it sound a little better.
Okay, so the -- the Prange study that you brought up, didn't Prange also recognize that the neck in his model couldn't mimic the neck of a real infant?
A It could not mimic a real infant exactly, no. I mean, even one -- my neck doesn't mimic your neck, right. Everybody's neck's a little different, and then a test device is another abstraction from that.
Q Okay. And so these limitations on the biofidelity of the doll will cause issues with the accuracy of the studies they are used in; isn't that right?
A I think you need to understand the limitations and be careful when you're interpreting the data from the

limit -- from these studies to understand. So if they tested a neck that's way too floppy and they test a neck that's way too stiff, then you know that the actual response of someone is going to be in the middle, right. So that's the way engineers do things.
Just like my car doesn't have to be crashed with me in it for me to understand whether the seatbelts or the air bags are going to work. They can crash it with a fiftieth percentile dummy, which is not the same size as me, has no blood, no skin, anything else. They can crash it with that crash dummy in a laboratory and have some idea, well, what's going to happen to me if I fall asleep and fall off the -- go off the road and hit a tree.
So you could do scientific extrapolation using properly validated and properly formed test devices with good data to interpret that from. And those are the same methods we're using with shaken baby, analyze it, as we use when we design helmets for children, playground -- playground surfaces.
When the NFL comes and says what type of helmet should we use for our football players or what should the AstroTurf be like, all that's the same science and so it should -- it doesn't matter if I hit my head in the car or hit my head on a football field

or hit it on a soccer goalpost. The mechanics are governing that, and so that's impact biomechanics. And so we're just try -- using those same techniques when we're looking at this particular topic, shaken baby syndrome.

So if a -- if a pediatrician says I believe in car seats and I believe in air bags and I think people should use them, but then they say ignore biomechanics when it comes to shaken baby syndrome, that is not a logical position.

Q Okay. But do doctors say that? Is that an actual position?

A They don't say it that way, but they do say I -- the -- in my experience, I've had physicians say, look, what I see in this biomechanics doesn't fit with what I understand and what I think occurs in shaken baby, so I'm just going to dismiss biomechanics as being unrelevant [sic] or the dummies aren't perfect, they're not living humans, so I don't think they have any relevance to this topic. I'm just going to go with the confession.

Q The dummies aren't real children; correct?

A And I don't believe that that is a proper scientific position. Go ahead.

Q The dummies aren't children though; correct?

A No, they're not children.

Q And they can never react the same as a real infant would; correct?

A No, they never -- it's a test device.

Q Okay.

A Just like a thermometer has nothing to do with my skin, and yet I can use this glass and mercury thermometer and put it in a thing of water and figure out whether if I put my hand in there would I burn my hand or not. That thermometer has nothing to do with a human.

Q Okay. There are also limitation --

A And it measures the temperature of that water that I can then use with an injury reference value to figure out whether I would be burned or not.

The crash dummy does the same thing. It measures the temperature of the trauma. So I would know what -- idea of what would happen to somebody if they were in that environment.

Q Again, but depending on how good your thermometer is depends on how good the reading you're going to get from the thermometer; correct?

A Absolutely. (Inaudible).

Q So there's still always going to be inaccuracies, whether you're using a test dummy or a

thermometer; correct?
A There could be inaccuracies, but those are the --
Q Okay. That's -- that's a yes or no question.
A My point -- my point is that -- my point is --
THE COURT: No, it's not. I ask -- I need people to be able to answer the question. If you want a yes or no question, ask a proper one.
THE WITNESS: My point --
THE COURT: But nobody can cut off a witness. I'm sorry, Doctor.
THE WITNESS: Sorry.
My point is if you accept that science can help us protect children with bicycle helmets or playground flooring or child seat development, that same science should be valid when you apply it to another environment.
If you don't agree with both, you can say, look, I think all this research is baloney. That's at least a logical position. But you can't accept it one place and then not accept it another. That was the only point I was trying to make.
BY MS. CRAVEIRO:
Q Okay. And the validity -- injury thresholds, there's also issues with scaling and its validity; correct?

A I think there are legitimate scientific questions that could be raised and discussions that could be had about that topic, yes.
Q Okay. And there are no validated injury thresholds for an infant brain; correct?
A I don't think as a categorical statement that's correct. I think we have ideas about where things can happen. I think that's somebody who's setting up to ignore what we know in biomechanical science about what causes injury.
Now, can I give you a specific number? No. But there certainly are ranges and if a one foot -- if one can agree that a one-foot fall does not cause injury from acceleration/deceleration, then accelerations on that same level or below shouldn't cause it then either, no matter how they arise.
Q Okay. And these -- the injury thresholds, they're usually estimated from scaling or extrapolating of adult and animal data; correct?
A Yeah, that's primarily where they first started. There have been additional things that have been done, including some of my own studies that have been published where we can use either infant cadaver data or we can use actual videotaped accidents where children have been hurt and help check those estimated

values to see if they're accurate or not.
Q And the scaling from animals to infants hasn't been validated either; correct?
A Well, that's exactly what I'm talking about. When you do these other studies with infant cadavers as well as studies looking at injuries to children where we know the circumstances, that's how you validate these other methods. And that's fur -- been further along than when the dummy was first developed in the late '80s, and that's exactly the point of those studies, is they do validate the methods as being useful and reliable.
Q The methods of the scaling or --
A Yes. Yeah, actually, I mean it -- it's very surprising. When we did -- I did that study at Duke where we compared the infant crash dummy head. So we had the crash dummy that represents an infant. We took its head, we tested it in the same fixture where infant cadaver heads had been tested, and it came out as being a fit.
And I remember sitting there with other researchers, some -- one of them who was almost 70 years old at the time who has seen the very beginning of impact biomechanics, and we all commented on how John Melvin, who worked at GM, one of the original

impact biomechanics people who said here's how hard that head should be based on these scaling techniques you're talking about. Looked at skull thickness, looked at overall head size of an infant, said here's where I think it should be, set the parameters for the crash dummy should be, made it.
They developed a cash dummy, and then we checked it against an actual infant head about 10, 15 years later and it came out and it fit. And we were like how did he get it so accurate? That was -- that was our response. So that's the point. That's how this works.
Q Are you aware of the Schiks article, Luuk C-H -- S-C-H-I-K-S?
A No.
Q Okay. Thresholds for the Assessment of Inflicted Head Injury by Shaking Trauma in Infants, a Systemic Review?
A I haven't seen that.
Q Okay.
A What year is that?
Q That is a recent one. 2019. 2020, actually.
A Yeah. So my report in here was written in 2019.
Q Okay. And so doesn't the reliability of the prediction of risk of injury to an infant from shaking

based upon the use of these different thresholds, isn't there an issue with their reliability because of the -- its limitations?
A You need to understand -- look, if I came in here and said today shaking absolutely cannot do that, that would be -- that would be an unfounded scientific opinion. That would be an unreliable opinion.
But if I came here and said -- which I have today or have attempted to -- and say look, the data that we have draws this into serious question. We have the best data. We've applied it. We've looked at it. Multiple people have looked at it using computer models, multiple test devices. And looking at it in terms of what we know what happens in cars, accidents, or falls and you look at it and you say I don't know that shaking is going to do this, it doesn't look like it fits. That I think is a reliable opinion, even within the limitations that we have of the data.
Q But still, the biomechanics can't say, as you just said, that shaking can't cause these types of injuries, correct, or it hasn't come up with that conclusion yet? Correct?
A Yeah, I would never -- yeah, you can't rule that out, absolutely.
MS. CRAVEIRO: No further questions.

MS. RUE: I don't have any redirect, Your Honor.
EXAMINATION BY THE COURT:
Q Doctor, in your field of biomechanics, does any of it involve your study of the weaknesses or strengths of living tissue?
A Yes. Yes, sir.
Q Yes, sir? To what degree?
A That's ultimately what we're trying to get to in every single study, if it -- what is -- we do test with cadaveric tissue. We do test with animal tissue, which the reason they do animals is because it's live tissue.
Q Uh-huh.
A We do computer models, which can sometimes bridge the gap between dead and alive, right. They'll -- the whole purpose of half my dissertation was how is cadaver different than a living human when it interacts with an air bag.
Q Uh-huh.
A So, it addresses that directly. And to the extent we can have actual living data of people, that is the best, but under many circumstances that's neither morally or physically possible.
Q What living tissue do you test that's most

closest to that of a -- a baby? I meant that as general as I --
A Yes. So --
Q And here's -- here's what I'm getting at.
A Yeah.
Q This entire discussion that has to deal with the neck and the skull and the inside of the skull. So what issue in your field is being tested that comes closest to what would normally be the skull of a baby, the neck of a baby, given that you're talking about a neck being weaker for a baby, and a baby skull could vary? Thick, thin, skull, et cetera. What --
A Yeah. Let me try to address that question as best I can. So, neck I think is very critical to this.
Q Uh-huh.
A The earliest data that is on record -- and it was used in the development of the baby crash test dummy -- was data that was back -- collected back in the late 1800s by I think it was a pathologist or obstetrician. I don't know if they even had those names back then. But they were stillborn children. But he was wondering how hard -- how much can I assist a mother when they're giving birth to a child, how much can I pull on the head and not injure the kid.
And so these children had died, and so he

actually did experiments with them pulling on the head to figure out how much force does it take to separate the head from the neck, to get an idea of how hard he could pull on a child's head to assist in birth. That data was about all the data we had that was specific to infants until much more recently.
At Duke University they did additional studies on infant cadavers again, so dead tissue, but pulled on it until it was -- until it broke.
But then what we also have is we have field studies of car crashes where we actually have physical evidence of exactly what happened to the car, how fast it was moving when it hit something, and we have children with injuries from those crashes. And these are --
Q Children or babies?
A I'm sorry?
Q Children or babies?
A Babies.
Q Okay.
A Typically under 1 year.
Q Okay.
A So infants. And I personally had one of those cases in Philadelphia and another one in northern Michigan where children were in forward-facing child

seats and we know generally about the Gs that the car experienced. We can then calculate what are the forces that that neck experienced, and then we have the actual injuries associated with that. So we know under those conditions here are the injuries you get when you get tension.

You then put a crash dummy in that same sort of seat under the same scenario and say here's the force that a crash dummy gives under the conditions in which a child is actually injured. So you can start to match up numbers from a crash dummy to outcome of an actual child. That's as close as we get to testing live human infant tissue.

Now, the cadaver model obviously has limitations. It's dead tissue.

Q Uh-huh.

A But there have been lots of studies, including -- I did a study where we looked at how muscle changes for 72 hours postmortem. So we had a living animal. We were testing the tibialis anterior muscle on the front of the -- in front of the calf, and we looked at what that muscle was like alive, and then we looked at what happens postmortem. So -- and we looked at it in ways which are relevant to cadavers, how they're stored. So we looked at it if you just do in normal

air, 100 percent humidity, as well as if you froze it in the freezer and you thaw it, how do the properties of that muscle change.

And that's been done for bone. That's been done for ligament and tendon. It's been done for brain tissue. Some of those tissues keep their properties, even through freezing, some don't. Muscle, brain, not very good. Bone, pretty good, as long as it stays hydrated. If it gets really dry, it behaves very differently.

So there's a lot of studies that look at the cadaver model relevant to what happens in living people and what are the limitations of that model. And that data is used by the DOT, of the military, and NASA when they develop their injury criteria for people.

So that's that whole area of science. I mean, I obviously walk in here walking with a history of all the people that have worked in biomechanics, and that's how we approach that topic. I hope that helps explain your question.

Q It does a little, Doctor, it does. And I appreciate it because, you know, I'm still left with all of these studies that involve animals because they're the closest to live and, you know, the study of primates, even small primates. But me as the

layperson, I'm saying to myself, you know, these animals were born, developed, however you want to say, to live some place other than a baby crib, to live some place other than the inside of a home, okay.

You would assume a primate was born and developed over years to be able to live in a jungle, in the environments of a jungle. So if you're talking to me about, you know, whiplashing a primate, well, is -- is the skull of the primate by nature thicker than that of a baby routinely because of what -- what's entailed in being a primate living in a jungle? Is the muscle tone of the neck, even of a baby primate, going to automatically be stronger and thicker than that of a baby because of what it takes to be a primate living in the jungle? See, those are the things that as I'm listening to everybody during the questioning and testimony I have to assess and go through my mind.

So when you're -- and then so if you get the study done with regards to the primate, for example, and you try and extrapolate -- extrapolate to how it applies to a child, I -- you know, the movement from the primate to the child, the pathway starts to get a little murky and cloudy for me because there's never been a test -- a -- a test done, from what I can -- from what I've gathered so far on a live child or live

children to see what kind of force it takes to shake them and what's the resulting injury of that just by shaking alone. And, you know, who can generate enough force to shake that kind of baby.

And that's what I'm being -- being asked to decide here, so that's -- I've asked questions of the other witnesses as well, and you're biomechanics, that's why I'm asking you this question, to help bridge that gap for me and if your discipline allows for it.

A Sure. Obviously, I can't bridge the entire gap. It's a big gap.

Q Yeah, okay.

A And I recognize that. Let's first talk about animal studies as they relate to humans.

Q Got it.

A And it depends on what you're doing. Like I don't expect that a baboon is going to put the same force on a seatbelt that I would in a frontal crash, right. There's differences in size.

Q Uh-huh.

A There's difference in skeletal structure, everything else. And you're right, skull thickness does vary. Like -- I mean, there's been studies that have been done with -- with pigs, right, and they have a very thick skull.

So, the first step is to figure out what am I specifically trying to get from an animal study, what am I trying to -- what am I trying to do there. And one of the things Ommaya was looking at is look at an animal that has a relatively big head compared to its body and yet the neck is stronger, obviously, in a monkey compared to what you have -- or in a primate compared to a young infant. But what they were able to show is that you could get these subdural hematomas through this angular acceleration.

So -- and I'm just going to talk about it in terms of subdural hematoma or concussion. So he was able to induce concussion and subdural hematoma using primates. Now, building on that data, we then have data from boxers who were willing to put accelerometers on their head and walk into a ring and get pummeled by somebody else. It's just part of their nor -- and so we get an idea of what kinds of exposures these people are experiencing.

So we take data from different size primates, and depending on the size of the brain, they have scaling techniques that say look, if you're doing a rat, if you're doing a very small monkey, if you're doing a baboon or a rhesus, you know, based on the brain mass or diameter, here is where we think injury

is going to take place. And as the brain mass and diameter gets bigger, it takes less overall acceleration. It's just like the (inaudible) getting bigger and bigger. And that was postulated by Holbourn back in the 1940s.

And if you plot on that same data, you have squirrel monkeys and you have larger monkeys and then you put human tolerance based on things like boxers or some NASCAR riders who are riding around with accelerometers on their head, and so we have data on where some people unfortunately get hurt in real life and you put on a li -- you put it on plot, it fits in terms of that two-thirds power factor.

And that's been published and it's part of the basis that the DOT uses when the National Highway Traffic Safety Administration says all right, you may have a new air bag. You put a child in front of the air bag, blow that air bag off, you got to be below this level for a 3-year-old and below this level for a 6-year-old, below this for a 12-year-old.

Those techniques are used for that. I certainly didn't develop them. I mean, there's a long time history putting that forward and putting it all together. And it is a study in and of itself to understand how to use that. So that's subdural and

concussion.
So we have some human data, we have some primate animal data, and they've tried to link it up. Because we do have -- we're not completely devoid of the human data. We have some. What we don't have is much for children, and I fully agree with that.
But if we're completely off, if -- let's say it took -- let's just pull out a number. Let's say it takes only 1,000 radians per second squared to give a subdural for a child. That's all it takes.
There was -- there was a researcher in Florida who put sensors on his own kid when the kid is playing in a jump room, like a -- you know --
Q Yeah, I got it.
A Thank you.
Q Yeah.
A He actually measured on the order of 800 or 900 radians per second squared where this kid is just bouncing around doing that jumper room. So the idea that it's 1,000 radians per second squared causes a subdural, that's probably not the case. Because some kid's going to be in there and the brother's going to throw a toy and hit them in the head and they're going to get over 1,000. That's probably not doing it. If a child had a really unique susceptibility to injury,

maybe. But for most people, that's a relatively safe region. So we have some data of what kinds of rotational accelerations it takes to cause injury. Is it 10,000?
So with a human cadaver adult, they had them fall backwards onto the back of the head in a controlled environment and then injected the vasculature to see did we produce a subdural under that condition, and they found that about half the time if there was 10,000 radians per second squared they got a subdural. So they said for an adult, falling on the back of the head 10,000 is enough. That fits with the boxers, which are typically running in around the 5,000, 6,000 range.
Now, where is the infant? I can't tell you exactly where the infant is, but we do know that if the same test device that's used in the shaking, if you just drop it onto the floor you can get numbers on the order of 10,000 from a three to five-foot drop.
I also have video of a child falling from about 50 inches right onto her forehead, suffering a fatal subdural hematoma. So I took a crash dummy, did that same thing, did that drop, measured the rotational acceleration, and it far exceeded that 10,000 number. So it says look, this dummy correctly predicted whether

there was going to be injury or not for that condition.
It's not perfect, and it's certainly not complete, but to say we don't have any data or to say that our data is so limited that we can't tell anything I don't think is being fair either. Because we certainly don't do that in any other area of our life.
Q Well, I know you utilized the phrase "showing a trend versus conclusively establish."
A Yes.
Q We're looking to get to that point or science is looking to get to that point of conclusively establishing; right?
A Yes.
Q Okay.
A Can I add one other --
Q Yeah, sure, since I asked.
A The only thing else, you know, unfortunately we do have video of some people shaking children. I've only looked at -- close at maybe three or four of those videos. In those cases the children did -- thankfully, did not suffer any of the injuries associated with shaken baby syndrome. So we have some little -- that's such a minuscule amount of data. But when you're talking about having no data, a minuscule amount is still significant. It's certainly not enough to say

conclusively anything, but it does say does this fit with what we're seeing in these experiments with computers or experiments in a laboratory with dummies, and it does seem to fit.
Q Is the sample of those videos of people shaking babies, is it enough to even draw any small conclusion from it? Or is it just -- has anybody done that or it's just too small of a sample?
A Case study data in general you have to be careful with. It's really easy to say this could never be true or this can be true --
Q Okay.
A -- because all you got to do is show one piece of data that says oh, it is true or no, it's never not true because here's the case, right. So, if it's a short fall or a shake, you could -- a single case study can throw a scientific theory completely out of the water, and you need to be able to recognize that.
Normally, those are malformed scientific theories, like they were never formed properly in the first place or we would never -- or you wouldn't have to throw it out.
Q All right.
A But beyond that, I think you need to be pretty careful about what you do with case study or unique

data like that.
MS. CRAVEIRO: Could I ask a question, Judge?
THE COURT: Yes.
RECROSS-EXAMINATION BY MS. CRAVEIRO:
Q In those nanny cam cases that you're talking about, do you know what kind of examination the infants underwent?
A Other than -- it depends on the case. But normally I would say they went to a physician, they were evaluated, and no injuries were identified. That's -- the ones I've reviewed, that's the info that I received.
Q Okay. So you don't know if they went and had a comprehensive exam by a child abuse pediatrician and had a skeletal mus -- skeletal survey done or hematological or any of that stuff?
A So like in one case, it was on the news. Like this child was seen shaking, and they brought the child to the hospital. I can't imagine that -- I don't know, but I can't imagine that physicians would say this child was seen shaken on video, we're only going to just look at him and then let him out of the hospital. I think they would be -- had a good interest in looking at that in great depth, but I can't tell you exactly what was done.

MS. RUE: I don't have any questions.
THE COURT: Doctor, thank you very much.
THE WITNESS: Thank you.
THE COURT: Greatly appreciate it, okay? We have your -- Dr. Scheller coming back on Thursday?
MS. RUE: He's back Thursday, Judge. He -- his train arrives at about 10, so --
THE COURT: Okay.
MS. RUE: -- he should be available from 10:15 until 12:45.
THE COURT: We'll get him in, and we'll get him out.
MS. RUE: And then he -- and then he's, yeah, back on the train.
THE COURT: We will prioritize him.
MS. RUE: Thank you, judge.
THE COURT: So all right. We're adjourned until then.
(Hearing adjourned at 3:35 p.m.)

CERTIFICATION

I, TERRY L. DeMARCO, the assigned transcriber, do hereby certify the foregoing transcript of proceedings (page 1 through page 75, line 23) recorded on CourtSmart, Index Nos. from 10:50:02 to 12:18:32, is prepared to the best of my ability and in full compliance with the current Transcript Format for Judicial Proceedings and is a true and accurate compressed transcript of the proceedings, as recorded.

/s/ ***Terry L. DeMarco***	AD/T 566
Terry L. DeMarco	AOC Number
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CERTIFICATION

I, SANDRA HICKS, the assigned transcriber, do hereby certify the foregoing transcript of proceedings (page 75, line 24 through page 124) on CourtSmart, Index No. from 2:34:28 to 3:35:03, is prepared to the best of my ability and in full compliance with the current Transcript Format for Judicial Proceedings and is a true and accurate compressed transcript of the proceedings, as recorded.

/s/ Sandra Hicks	AOC 711
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