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Leveraging New Technology to Help Parents Foster Rich Language Environments, in partnership with American Cochlear Implant Alliance

Presenter: Dana Suskind, MD

I am the executive director of the American Cochlear Implant alliance, but I have a really long history of working in the field of hearing loss for nonprofit and for profit organizations in the field. And so we're very excited to move forward with this series today, and if we could go to the next slide. This series is called the power of Parents. We need to go back to catch those first slides, I think. Is it back or forward?

Okay, we'll just go from here. And just a bit about the organization first. We are a membership organization that's focused on cochlear implants and access to care generally. And our members are across the care continuum, including physicians like Doctor Suskind, who's with us today, but also lots of others who are on cochlear implant teams. And we have a website that has lots of information for those of you that are in or outside of cochlear implants.

And we're very collaborative with other organizations. I've just spent the first two days of this week with educators of children with hearing loss, and they are very active in our organization as well. So join us, we're happy to have you, and go on to the next slide. Our mission is to advance access to the gift of hearing, and we address those factors that contribute to underutilization of cochlear implants and really work to improve awareness regarding candidacy and outcomes. And this series is part of that awareness raising effort.

And go on to the next slide. This series is called the power of parents in fostering language in deaf and hard of hearing children. It's a two part series series. And this course today is the first part in this. And it's really such a huge time now for children with hearing loss, because unlike the bad old days, when I first got into this field 30 years ago, we would find the kids who had hearing loss when they were two and a half to three years old, and they weren't talking.

And then it was very difficult to help them get up to speed. It was hard to get parents to be able to be the child's first teacher. So that has all changed with early intervention and early identification of children. And we are finding these kids now screening 98% of children when they're born, within days or weeks of life. And we routinely fit technology now at two weeks of age, and are able to look to parents as the child's first and best teachers, using the language of the home and allowing families to integrate that into the fabric of the family.

And we've been using this term language nutrition for all children, with or without hearing loss, to really emphasize that way of thinking. And 30 million words really elevated awareness of talking and interacting at home for lifetime achievement, and was honestly the inspiration for an initiative that we have going on right now on the power of parents. Looking to parents who do have the tools with this group of educators that I was with this week. I asked them yesterday how many of them had read 30 million words, and I would say 90% of the hands in the room went up. So, really critical resource that Doctor Susskind has provided.

Okay, go on to the next and last of my slides. So this is the initiative we've been in, working on listening, language and literacy. Really high priority for us in encouraging families of children with all levels of hearing loss to foster literacy. And doing that in the home, in the language of the home, when they're comfortable talking and interacting and emphasizing the benefits for social and emotional well being, using those sounds of hearing, those sounds of language to facilitate reading and writing. And you're going to learn a lot more about that from Doctor Susskind.

So, with that, I am really thrilled to introduce Doctor Dana Susskind, someone I have known for, I guess, about maybe twelve years, for their team years. And she has, as I noted, been the inspiration for our listening language literacy initiative. She's the founder and co director of the TM center for Early Learning and Public Health. TM

stands for 30 million words and also the director of the pediatric cochlear Implant program and professor of surgery, pediatrics and public policy at the University of Chicago. She is a recognized thought leader on the national and international stages, and she has dedicated her research and clinical life to optimizing foundational brain development and preventing early cognitive disparities and their lifelong impact.

And her work is focused in particular on helping parents leverage their power as brain architects. So, so thrilled to introduce doctor suskind. Thank you so much, Donna. I can't believe how long we've known each other. But we stay.

We're still the same young ones when we first met, but it's such a pleasure to be here. It's really a joy. And look at this moment in time. I wear lots of professional hats, but still my roots, and really, my heart remains firmly planted in the world of hearing loss. It's where I learned about the power of parents and the power of parent talk.

And, you know, but I remain committed to helping children with hearing loss. And that commitment really is that thread that connects me to this somewhat unconventional career path. And it's what brings me here today to discuss what I consider one of the most important opportunities facing us at this moment. That is the opportunity to leverage emerging technology to not just more fully understand human development, but really to help optimize foundational growth. That happens in the early years for all children in both deaf and hard of hearing children, and typically hearing children.

And I always like to say we live in a world driven by smart technologies and big data analytics. The truth is, hearing aids and cochlear implants are just part of it. And at this moment, we gather lots of information on every facet of our life. But other than cochlear implants and hearing aids in early childhood, the most critical period for brain development has really been largely left behind by this data revolution. And I believe

that we can and really need to seize this opportunity afforded by these new cutting edge tools to advance the science of human development.

It's the key to helping prevent cognitive disparities taking root and really alleviating entrenched educational disparities that hold a sizable portion of our population behind, both with hearing loss and without. It's the key to unlocking biology's greatest gift, one that we all know so well. It's a short period of time in which we can either set up a child for success in life by nurturing their foundational brain development, or not. And the importance of these first years of life and their impact on a host of different outcomes, because we know it's not just educational attainment, but lifetime earnings, physical health, we know that these early years have a huge impact on all of it. And although we've known this for some time, and we've learned a tremendous amount about what we need to do in those early years, there are actually quite a few questions, important questions, that still remain.

And the truth is, we haven't learned how to optimize the development of all children at a population level. And I think that this is because we don't really understand how to deep level the mechanisms underlying that development and as a result, how to measure it. But today in my discussion, I'm going to share why. I think understanding those mechanisms, the whys and the hows that explain the scientific phenomenon of early brain development matter a great deal, not just in research, but in making a difference for all kids. Before I enter in, these are the disclosures and really the learning outcomes that we hope to share today with you all.

One being the relationship between a child's early language environment and their future skill formation, to recognizing the importance of being able to identify the underlying mechanisms responsible for the optimal development of children, for not just language development, but school readiness and lifetime success. And lastly, identifying potential positive impacts and several potential risks associated with these

new emerging smart technologies that I'm going to talk about. So, with that being said, I'm going to start this discussion in an unusual way. As Donna mentioned, I am a physician, I'm a cochlear implant surgeon, and so I want to start off with a story that I think really illustrates, illustrates what I'm going to talk to you about today, the first clinical trial in medicine. And before you all say, oh, no, I'm going to tell it as a story, because I think it is an incredible example of the power of not just research, but the power of understanding the mechanisms behind what we do and why it's so important, not just theoretically, but from a real world lens.

So I'm going to bring you back all the way to 1747, when another surgeon, not Dana Suskind, but a surgeon named James Lind, who was a British sailor and surgeon, was desperate to find out the cure for a devastating illness that had killed thousands and thousands of people throughout the years. That disease was scurvy. It actually killed more people than on the battlefield. It was a horrific condition that I'm sure many of you all heard of, that the body cells break down, the nervous system stops working, people start bleeding out, teeth falling out. But basically, it is what killed so many sailors at sea, though now we know what the cause of scurvy is, vitamin C, not having enough of it.

Back then, they didn't know. And it was a really particularly tragic scenario for sailors. And believe it or not, it was so devastating that most ship owners assumed that 50% of their sailors were going to die at sea and had to account for it. And some of these sailors were shipmates of James Lynn, the surgeon, and he was distraught by their suffering. So he asked the captain to be able to conduct an experiment to try to find a remedy, because that made sense, right?

And so how did he do this? Lyn divided up twelve sailors from the ship that he was on into six different pairs and gave them each a different remedy. Two of them he gave cider, two sulfuric acid, another vinegar, another seawater, another orange and lemons,

and another one, a putrid, unnamed concoction. And believe it or not, after a week or so, his trial ended because he ran out of fruit. But it was pretty clear what was making a difference.

Nothing worked. The cider maybe worked a little bit, but lo and behold, the citrus, the oranges and lemon completely cured the sailors. And you'd probably say, wow, eureka. James Lynn cured scurvy. And from then on, no other sailors died.

But that wasn't what happened. It would take another 200 years and thousands of hundreds of thousands of deaths before his finding actually could change the world. And you may ask, well, why he knew it was oranges and lemon.

And the reason why I'd like to propose is because James Lind didn't understand the mechanisms of why lemons and limes worked. And you could say, well, why does that matter? Well, because he didn't know the mechanism. He was like, oh, you know, oranges and lemons, that works. He couldn't provide accurate recommendations.

So, for example, they started saying, oh, well, this is great. Let's boil the lemon juice because it's a long voyage, and use it. But when you boil the lemons and the limes, it actually kills the vitamin C. That heat destroys the vitamin C's curative powers, and the sailors would still die. And, you know, and so this took 200 years for them to figure out that it was actually the vitamin C and that they could actually then accurately treat and prevent scurvy as a result.

This is a really great example, I think, of why you need to understand, even at a deeper level, why things work and why those mechanisms are important. Yes. This clinical trial that I share from hundreds of years ago, I think is both illustrative of the power of science. I am a researcher as well, but also the critical need, scientific understanding of

mechanisms, and that there's often more than meets the eye. In this case, vitamins were the missing link.

But let's bring it back to present day. At first blush, we all, I assume, everyone in the audience, we take care of children with hearing loss, with other disabilities. We want to optimize their early development in skill formation. But the truth is, while we know at some level the different things that we need to do to support children, I believe that there are so many underlying mechanisms that we haven't uncovered, and it's crucial to be able to really understand this so that we can understand how to best develop our programs and our technologies to help each child at the individual level. But even more importantly, how we scale up these programs at a policy level, because we know that while we have helped many children at the individual level in the last 50 years, it's what Donna was talking about the ACI working on.

How do we make sure that all children can benefit from the science that we've learned, and how do we improve the scaling up of these programs so all children can get the necessary input and we can reduce disparities. And fortunately, though, I believe that we are actually on the cusp of rapid transformational advances in our knowledge and understanding of how human beings develop, and advances that are really fueled by emerging technologies that will help us identify what inputs allow the optimal development of all children. In other words, we will soon be able to discover the vitamins of foundational brain development. But before we dive into how and why, I think we will soon be able to identify these mechanisms, I'd like to talk a little bit about the existing literature on early brain development, because it is really incredible. Now, as I said earlier, the truth is my career path has been a little bit unconventional.

So I first came across the science of foundational brain development in a pretty unorthodox mechanism. But like I said, I owe everything to my roots. 20 years ago, as I was just beginning my career as a pediatric physician and as a surgeon, I specialized in

giving children born deaf cochlear implants, helping them access sound, hearing, and spoken language. But early in my practice, I started noticing dramatically different outcomes in my patients. Some of my patients who got cochlear implants excelled developmentally, others, not at all.

Some learned to talk, others did not. This phenomenon that I'm sure many of you are familiar with, the ability to hear, it turns out, doesn't always unlock the full capacity of children to thrive and learn intellectually. But why? I asked. And so I set out to find out the answer to this question.

But my search for clinical, physical, and technological explanations for my patients disparities and outcomes came up short. And so I followed my line of inquiry out of the operating room into the world of social sciences, where, in fact, I did find an explanation.

The first thing. And I really, you know, we don't use the term 30 million word gap, just to be clear anymore. But one of the first research studies that I found was a research study that showed a stark variation in the amount of language, the actual number of words that children were exposed to. That difference often, although not always, fell along socioeconomic lines, with more language occurring in more affluent homes and less language in less affluent homes. Those researchers calculated that by the time a child reached their fourth birthday, there was a gap of roughly, and I put air quotes around it, 30 million words, between those who heard a lot of language and those who heard very little.

This research was far from perfect, but it was really a first sentence. What has become a robust and evolving literature, a body of literature around the powerful role of talk and nurturing interaction in promoting healthy brain development. I always say it was compelling enough to pull a surgeon out of the operating room. But as I mentioned, the

research that inspired me wasn't perfect, far from it. But it did give me, as a surgeon, a critical place to start.

I think of this as just a first sentence in what has become an extensive literature, a body of literature that includes cutting edge research that has revealed the ways in which language input stimulates every part of an infant's brain.

And this literature demonstrated, as many of you all know, the more language a child is exposed to in the early years, the more nurturing interaction, the more securely the foundational connections of a baby's brain is built. It reveals that those connections are formed at a dizzying pace during the first three years of life. Nearly a million new neural connections are formed every second, and the brain grows 85% of its adult size. And the literature is pretty clear. It tells us to capitalize on this formative time.

What do babies need most? They need nurturing, rich conversational interaction. This is often called serve and return, and relatively recent advances in neuroscience more incremental additions to our understanding of human brain development have identified it as particularly powerful. And you know, this is just one of the many research studies by researchers like Rachel Romeo or Kim Noble at Columbia and other leaders in the field that have combined language recordings with sophisticated brain imaging and have found that these conversational turns are correlated with more activity in relevant parts of the brain. With children's scores on standardized tests, skills tests of language skills, these studies have found that the effect of conversational turns is greater than even just the effect of number of words heard.

Serve and return interaction has been found not to even not only impact language development, but math and spatial ability, literacy skills, self regulation, reaction to stress, perseverance, etcetera. It is an essential catalyst in determining the strength and permanence of certain neural wiring, and the rich body of science helped me to

understand what was happening with my patients. Some of them were receiving robust language input, be it spoken language or sign language that they needed. Others were not. I also realized that what I was observing in my patients really mirrored what was happening at the population at large.

Far too many children failing to reach their full intellectual and emotional potential, entrenched gaps in opportunity that hadn't budged in decades and cost individuals and communities a tremendous amount in the form of lost wages, productivity, health outcomes, other long term consequences. The mechanisms that largely explain this issue, it turned out to be the importance of caregiver nurturing interaction in the early years. Ultimately, the scientific literature helped me realize two critically important things. Number one, we need to start much earlier if every child is given the chance to thrive. And number two, all parents and caregivers possess the power to shape their children's foundational brain development.

But in far too many cases, that increase incredible potential remains untapped. And that is the focus of the TM center for Early Learning in Public Health, an interdisciplinary research center that I founded at the University of Chicago that leverages and advances the science with the goal of ensuring healthy development for all children. We strive to make sure that every child has the ability to reach his or her potential intellectually and emotionally. Our approach is rooted in a commitment to children, to their families, and to rigorous science. As such, we have developed a suite of evidence based behavioral interventions that empower parents and other caregivers, such as preschool teachers, with knowledge and skills to support their healthy brain development.

Most of our programs are in English and Spanish, even Haitian Creole, and it really translates the brain science into strategies that parents and caregivers can use in everyday settings. At the heart of each program is our flagship teaching tool called the

three T's, which is based on the science that reveals the particular power, as I mentioned, of serve and return interaction. This simple behavioral toolkit reminds parents and caregivers to tune in by being in the moment with your child. Talk more by using a variety of words, and take turns by engaging your child in conversation. At the end of the day, everything we do is rooted in the power of parents and caring adults.

We believe that they are a crucial untapped resource with the incentive and capacity to make a significant difference. And I want to be very clear that leveraging the science of early brain development is not just about telling parents, hey, go talk to your baby. Because when we advocate for the power of parent talk, we must also advocate for parents and caregivers. We need social policies that invest in parents and communities so that they can invest in their children. And that's why I wrote my second book, *Parent Nation*, to make sure we made it clear that this is not just on the shoulders of parents and caregivers, but society to support them in this important endeavor.

Because we understand that true population level change can only happen when we come together to support parents and families. And thus, we designed our programs so that they can be embedded at a community level in maternity wards, pediatric well child visits, overlaying into the universal newborn hearing screen, classrooms, and behind. And of course, you know, I am a translational researcher. You know, it's not enough to just say, oh look, these sound great. We must show that these programs work and we are committed to evaluating and pushing forward the rigorous science.

So, for example, our randomized control trial of our home visiting program showed significant impact on the parents use of the three t's and use of praise and explanations and open ended questions. We've developed all of our programs and tested them in rigorous trials to make sure that we not only support parents in providing the nurturing interaction and can look parents have more conversation when they learn about these different strategies and underlying science, but importantly, that

we can show impacts on children's language skills. And this is just one example of how the home visiting study that we trialed impacted children's language skills in the longer term. While this is not a research talk, I just wanted to share that I'm incredibly proud of the research that we've been able to put out there to show that parents have the power not only to internalize this brain science and the strategies to build their children's brains, but are really able to advance their children's language and brain development. We've worked very hard to deploy them widely.

We always welcome collaboration and work together. We have implementation partnerships around with communities across the US and research partnerships across the world. But the truth is, even this is not enough to achieve the type of population level change that we envision. A population level shift in the way we foster Children's foundational brain development. We know from day one that we needed to be committed to effective scaling.

You can impact one child at a time, which is incredibly important, but we really want to push forward a population level shift. But the truth is just simply scaling and putting it out there without knowing if we're making a positive impact isn't our goal either. And while it would be easy enough to just put it out there, put these videos out there, we have learned that most programs in almost any realm, any policy, often lose impact at scale, no matter how many great interventions that show impact in the smaller randomized control trial, that when you do scale them, they lose impact. And so this graph, and I won't go into it too much, but I just want to share with you this graph that shows what happens when you try to replicate successful programs. So you can see Perry preschool and abecedarian, which are some of the most famous early childhood research programs out there, and you see the arrows to them, they have huge impacts.

One point over a standard deviation impact, which is a lot of impact on children's development. But you can see the little bubbles below them where they tried to

replicate them, which really did not show the same impact. Towards that end, you ask, why is this and what can we do to address it? I think one of the major things is the difficulty in being able to measure at scale as you're implementing these programs. And towards that end, our team is developing technologies that we hope will support providers and teachers and parents to go even further in understanding how to implement programs and how to foster healthy brain development.

Think about this. What information do parents, teachers, you all, policymakers, researchers have about children's cognitive needs and the potential gaps in their learning environments? We know that learning environments are critically important, but how do we measure it at scale? There really are very few out there. I'd like to share just a little bit about some of the new tools that we're developing that are very much on the research side of things at this moment.

But I'm very excited to help with personalized guidance to help parents and caregivers optimize the impact they have on children's brain development. I'm hoping that these will help tailor and target interventions and allow impact at scale. Let me share just a little bit about each one of them. But first, before I dive in to share more about the Speedcat, which is a computer adaptive tool that measures parents and teachers knowledge of different facets of child development, I want to share why understanding this is important.

Why does it matter what parents and teachers and caregivers know about child development? Because our research and other people's research have found that knowledge of early development is predictive of two things, how much brain building behavior people engage in and children's future skill formation. We have even. We found that, believe it or not, what parents know about child development at one week of their child's age actually predicts their sensitive responsiveness at nine months of age. But despite the importance of knowing, you know, of being able to of parents

knowledge is that there are really no really population level tools that can measure what adults know about the different facets of child development, particularly ones that are technology based, scalable, and easy to use.

And that's why my team and I have built something called the speak cat. It's a computer adaptive scale that measures parental knowledge and beliefs about our early child development. The survey adapts to the individual responding to the survey and issues new questions based on the level of knowledge that they've displayed and a smart app powered by the computer adaptive technology. Ultimately, we're building this, will deliver personalized guidance that you can provide if you're providers or teachers or therapists, or can provide it directly, sharing the information and tips that are tailored based on the individual's demonstrated knowledge and stated beliefs based on their child's age and stage of development.

And this tool will be powerful in multiple ways. The feedback it provides will help enhance individuals knowledge in the moment. Depending on where it's administrated the research, the results can also help clinicians or providers understand what kind of supports and guidance they should be providing. I always think it's very hard to know where to start because we don't know what people know. And so that is why we often go with sort of a one size fits all approach, either assuming parents know nothing or they know everything.

And this will allow a better personalized approach. And on the aggregate, the results will shine lights on the prevalence of disparities in parent knowledge and caregiver knowledge, which we can know drive disparities in child outcomes. And we've been finding some really, really interesting findings about what people know and different assumptions. So many people, it's very interesting, think that educational tv is good for children under the age of two, which we know is not even gender differences. We're finding that women as a whole know more about child development than men.

It's not universal, but we've found that as well. Not only will the results reveal overall levels of understanding, but they can also be broken down in many different domains. Right, because we know that understanding of math and spatial learning, socio emotional development, the importance of dual language, et cetera, are critically important to building the entire brain. This is about building, obviously, children's language and literacy formation. But the truth is, in the early years, you're building the entire brain, and parent talk and interaction is critically important towards that end.

In addition, we're pushing forward another AI driven device that measures in real time a child's acoustic environment and provides in the moment feedback. It will allow us to observe the unobservable without having to record language. So on the device, it will measure nurturing interaction in the real time so that parents and caregivers can optimize their early brain development without the issues of recording their language. Ultimately, the use of these new technologies, I hope, will lead to the creation of large, anonymous data sets that can really advance our understanding of child development. That will be sort of like census data that allows both at the individual and population level for us to help all children thrive, and will ultimately help us not only scale existing programs and policies in effective ways so we don't lose impact at scale, but importantly change a shift away from a one size fits all approach to early childhood education that we often take into a much more efficient and effective personalized approach.

It will allow a society to finally provide a prevention versus a remediation strategy to build a system that connects and aligns parents and early educators, health systems, family facing organizations and policymakers. The insights that will be made possible will be transformational. And really, I hope that they will provide you all and different organizations the power to understand the sources of inequality. Spot warning signs help ensure all children reach their potentials, and all families and caregivers are

supported in an asset based way. And it's a very, you know, obviously it is the big dream, but in my opinion, these tools will help us advance our deeper understanding of human development and uncover what I call, you know, new biomarkers or predictors of endpoint surrogates for children's future success.

And, you know, while, you know, although all surrogate endpoints are biomarkers, not all biomarkers are useful surrogate endpoints. The truth is that we will learn so much from what we know about things like parents that sing songy voice that is so important for early brain development. But what are the different aspects of it? These are the things that we'll need to learn to really allow children to thrive.

Because when we go back to thinking about why it's important to understand these mechanisms, I want to go back to that slide that I shared about the difficulty in scaling and the slide that showed we can have a really perry preschool in abecedarian that has huge impacts, but we can't replicate it despite 50 years of trying. And the truth is that understanding the power of these endpoint surrogates will allow us to take all these little bubbles of different programs that have tried to replicate and really ensure that they are replicated so that they have positive impact on children.

And, you know, going back to other research, a recent study by the American Economic Review, when we're talking about the importance of defining these endpoint surrogates, the vitamin cs, in a different realm, in the world of, let's say, cancer, they showed that being able to identify the power of endpoint surrogates, the vitamin C, actually not only leads to live save, basically, they showed that the authors estimated that around 890,000 lost lives could have been prevented from understanding these endpoint surrogates. The truth is, surrogate endpoints for healthy brain development will be just as powerful. They will help us identify the vitamin C that fuels the healthy brain development, and it'll equip us with this knowledge where we can prevent and alleviate cognitive disparities, just as vitamin C prevented an alleviated scurvy, or the

social and economic dividends that will make the \$89 billion per year look like pocket change in the cancer world. So I want to share just a little bit about how. I'm thinking about how these technologies can help us identify these biomarkers or surrogate endpoints in early childhood.

Because I know, you know, I've talked at a high level, look, it's about the power of talk and interaction, but how these technologies will allow us to dive even deeper. How does one identify biomarkers or surrogate endpoints in early childhood when the catalyzing factor for brain development is nurturing talk and interaction? Thankfully, now I'm going to get into a little bit of machine learning. Thanks to the advances in machine learning in artificial intelligence, I believe that we've reached a moment in time when that discovery is possible. I think that the tools that my team and other teams around the world have developed will help us uncover those.

So I'm going to give you an example that I briefly mentioned before in the world of parents, because you all know about this. I'd like to tell you about some exciting work that we've done that helps us uncover the power of parent tone as one such mechanism.

In order to begin exploring what's happening below the surface of conversational turns and why this matters for brain development, we decided to utilize the hundreds of thousands, the hundreds and hundreds of hours of recordings that we had from our home visiting program that I mentioned from those big studies. So in this study, we leveraged machine learning advances in audio signal processing to determine, well, what are the features of this parent talk and interaction that we had collected that really mapped into the cognitive and non cognitive skills. I'm sorry, because remember, I had told you before, the research had showed, look, our programs work to help get parents, you know, help parents talk and interact more, and their children's. Their children, you

know, had higher language development. But this was a moment to try to look under the hood here.

We knew, you know, there was more talk and interaction, but what was, could we find the different vitamin C components that were mapping into the positive impact? So rather than pick the qualities that we thought would likely impact it, we approached the problem sort of agnostically and let algorithms detect the different features. What was the data driven approach to understanding? What are the facets of this conversational turn that was powerful?

And what we found was very interesting. Now, I want you to think about what are the features of predictive, what are the predictive features of parent tone in these conversations that made a difference? And remember, I presume, since we're, since I can't see all of you all, you know, the power of parents that sing songy voice that we talk about with parents, the baby talk, the child directed speech that we know is so powerful for children. What we did is allowed our algorithms to pull them out and try to understand what were the features that were so powerful. And the results were really, really interesting.

And what we found is a model that identifies what features of the parent's speech and tone that enhanced skill formation? And importantly, what are the features that hindered skill formation. Our algorithm examined 200 separate frequency features, such as pitch, volume, even more to test their predictive power. Then, the algorithm created tone indices based on the mapping of those features with child outcomes related to language skills, socio emotional skills, executive function, and these indices were incredibly telling. We see across all three sets of skills, similar features of tone that are associated with higher skill, and similar features that are associated with lower skills.

Specifically, we find that a tone comprised of a broad harmonic range, high clarity, contrast of voice against background noise, and bright voice is associated with greater scale formation. On the other hand, tones comprised of a loud voice and a high pitched range, monotonous tone and speech features associated with sadness are associated with less scale formation. And so with this creative use of machine learning, we've identified a novel mechanism to find out or to reveal the underlying relationship between the adult child interaction and child development. So now we have a model of the different aspects of positive and negative tone that we know are related to child skill formation. And it's obviously, it is very much in the beginning, but I wanted to share some of this cutting edge research with you.

The truth is, as excited as I am about this new work and the potential for the tools broadly, I want to be clear that I also recognize the risks associated with introducing artificial intelligence and machine learning into this world. In fact, I believe that if we are not careful, AI has the potential to fundamentally alter, rather than support the foundational wiring of the human brain. The truth is, it's only a matter of time, likely a short one, before parents turn to this technology to help lighten the load that the overwhelming load that parenting of young children often brings. That's why there is an urgent need to unlock the secrets of foundational brain development, because we need to understand what is the way that children's brains need to be fed and developed before we start feeding artificial language nutrition, as Donna said. And so, yes, I think that there's great opportunity, but also great risk, because you see how responsive technology that is already happening in the world could be harnessed in ways that are not scientifically sound to alleviate the load on parents and caregivers with AI nannies engaging in babies back and forth.

That's obviously why I wrote this op ed in the Wall Street Journal, both delineating the risks and opportunities, because without more fully understanding the nuances of human development, as I mentioned, we risk using AI to double down on the wrong

kind of input or provide the wrong dosage, or in some ways, fail to meet children's and infants true needs. We risk, you know, using, you know, cider instead of lemons and limes or lemons in building healthy brain development. And just as the british navy thought that they were providing sailors what they needed to stay healthy when they boiled the lemon juice, there's every possibility that AI nannies might provide not what children need and somehow miss the mark. So that is why we must be careful and thoughtful. Fortunately, we have an opportunity to avoid that fate.

The insights generated by my team and teams across the country can play an enormous role in this rapidly advancing space, in our ability to identify the most powerful and predictive biomarkers of future success. And really, with this knowledge, we'll be able to ensure that humans and the technologies they use provide the input that will help individual children, with or without hearing loss, thrive and help society flourish, will enable the creation of technologies that are truly supportive, because the impacts of such technologies are tremendous. But even more, ensuring that children have more exposure to the right stuff is going to be critically important to both. Allowing all children to thrive, to close opportunity achievement gaps, and what society would benefit from will be incredibly important. And, you know, with that, just as AI's rapid integration into the life sciences is expected to accelerate advancement in medicine, potentially leading to groundbreaking treatments for various diseases, I believe that it will advance our understanding of human development as well, so that we are not only better equipped to treat, but to prevent a variety of cognitive delays and disparities.

In this way, we'll really build a future that is ripe with opportunity. We will unleash the full power of parent child interaction, caregiver child interaction, and we will unlock the promise of every child by better understanding it. We will, at long last, stop the squandering, the spectacular evolutionary gift that the universe has given us, that short window of time in which children can be set up for a prosperous life. And with that

being said, I wanted to say thank you. Thank you for listening and for hearing the power of parent and caregiver talk and interaction and the opportunity for technology to support them.

It looks like there's a question, Deana, from someone who says it looks like positive speaking women instill intelligence. I love that comment. Is there a response that you'd like to provide on that? Dana?

I am so thankful to be around so many positive, inspiring women on this call. I wish I could see all the people in the audience, but thank you. Thank you for listening.

See, I don't see. I don't see any other questions. You know, I think in the conversations that I was involved in over the past couple of days with educators who work with children with hearing loss and are really encouraging early, early, early with the families that they work with. They struggle sometimes with the dilemma that we have in this country, where families are encouraged to not necessarily use the language of the home, to use another language. And that's really different from what we know is the best thing to do.

So do you have any commentary you can make about that, whether that the language they're using is English or Spanish or polish or ASL? The benefits of using the language of the home and not learning another language? Yeah. No, I think that, I mean, that really goes back to understanding the science. I mean, the science is so clear that, you know, children learn best from being exposed to their parent and caregiver, native tongue.

And it's because the language that is transmitted is just not words. Right. Emotions. So much comes through the native language of the parent and caregiver. And it's amazing.

I mean, Donna, you and I have been doing this for quite some time, and this has been a continuum conundrum that parents are hearing that they should be using a language that is not their native language. And we know, and it's a real problem. And I think that I had mentioned the tool, the speak cat. Right. The speak cat, which measures people's understanding of child development.

This is an important question in domain that we ask questions about to see. Do they realize that using their native language is the key for healthy development? And that's why I actually think the speak cat could be a powerful tool, not just for parents. I mean, obviously parents, it'll help them understand the different ways their language can build their child's capacity. But even providers, right?

I mean, who are the providers who are saying, look, you know, use English, even though the parent's native language is Spanish, they, too, could probably benefit from leveraging the Speedcat to have personalized understanding of how children develop as well, maybe even policymakers. So, yeah, I think those are all really important lessons. And, you know, I think people are starting to pay more attention to this. Dana, I'm really excited that so many different disciplines within hearing loss and outside of hearing loss have captured this, including governmental entities and foundations. And I'm so grateful to you personally for having popularized this notion and encourage more people to get involved in this.

Two years after your book came out, it was the pediatric nursing community that came up with the term language nutrition. I love that they were inspired by your work, as all of us were. And so I. I think it's fantastic that all these different disciplines are now getting it and are encouraging children of, with and without hearing loss to pay attention to parent power. Yeah.

Well, you know, it's so funny, Donna, is that really. I was completely inspired by the hearing loss community they've known forever. Right. The power of the early years, the power of parent talk and interaction. So I think the fact that I crossed over into the early childhood, I mean, I was really just taking the message that is from the world of hearing loss, the power of parents and caregivers.

We've known that for forever, for a long, long time. So. And I don't think that in, I think really in the hearing loss communities, where you can see most powerfully the impact of early language environments on children's development. So, no, I feel very thankful. It looks like we've got some great new comments here.

Someone asked, do you need to pay for speak cat? Yeah. Oh, no, no. Speak cat. And you have to pay for it.

Yeah. No, no, no. It's a research tool, so we're always looking for people who are interested in finding ways to leverage it to support parents or providers. So feel free to shoot me an email if you are interested in exploring. That sounds great.

That sounds really great. Let's see if we have any more questions here. Everybody's just saying, thank you, Dina, for really fantastic talk. And I'm exuding the dynamics that you. That you have and exciting us all to move forward with these tools.

So I thank you personally, and AC alliance thanks you for the inspiration that you have given to us for our own initiatives that are built upon the work that you've been doing for so long. Thank you so much. It's my pleasure. Thank you. So I think with that, we can turn off and everyone who's on come again next week with our next speaker, Carl White, who's been really an advocate for early intervention for as long as I've been in this field, and he's going to talk a bit about the impact of early intervention on children's ability to learn language and also the role of parents months.

So thanks, everyone, for attending today. Thanks again, Dana, for being with us. My pleasure. Thank you guys so much. Just a quick note to everybody.

The exam will be available in about ten to 15 minutes following the webinar. Have a great rest of your day, everyone.