

# Hearing <sup>THE</sup> Journal

THE MOST RESPECTED PUBLICATION IN HEARING HEALTH CARE

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## HJ PODCAST MAY 2021: Dr. Fan-Gang Zeng

### MAIN SHOW

Dr. D' Anne Rudden: We've seen the movies. In the 1960s, 2001: *A Space Odyssey*, HAL, a sentient computer controlling the operation of an interplanetary spaceship, turns on the crew in an act of self-preservation.

Later, it was the Terminator movies. Arnold Schwarzenegger's character walks in the door...leather jacket, sunglasses, guns blazing.

He turns out to be living tissue over metal endoskeleton that has returned from the future on a mission to terminate humans standing in the way of machine learning.

And if you remember your Terminator opening scene trivia, machines ultimately achieve self-awareness and initiate a nuclear war, obliterating much of humanity.

While the death and destruction unleashed by Artificial Intelligence in the movies is not quite the current reality, it IS understandable why the very concept of A.I. makes some of us uneasy...especially when it comes to our job security.

Right now, however, very few subjects in science and technology are causing as much excitement as A.I.

Some of the world's brightest minds have said that A.I.'s potential to revolutionize all aspects of our lives is unprecedented.

I think what worries some of us is that the advent of A.I. in the audiology realm is coming with some pretty significant change attached to it.

But, my friends, let's not jump into our doomsday bunkers just yet. As with anything, A.I. in the audiology clinic has earned itself more than a few myths that need clearing up.

Luckily, on the podcast this month, we have an incredible guest to help us navigate the technological water of AI, and dispel some inherent fear that may come along with the rise of the machines.

Dr. Fan-Gang Zeng is a Professor of Anatomy and Neurobiology, Biomedical Engineering, Cognitive Sciences, and Otolaryngology and Director of the Center for Hearing Research at the University of California at Irvine. Dr. Zeng is a leading researcher in auditory science and technology, unraveling brain mechanisms in loudness coding and speech recognition while translating research into two commercial products in deafness and tinnitus treatment (Nurotron and SoundCure). He has published more than 100 peer-reviewed journal articles and he also serves as the Chairman of the Editorial Board for *The Hearing Journal*.

Dr. Zeng, thank you so much for being our esteemed guest on *The Hearing Journal* Podcast. It is an honor to speak with you today.

02:58 Dr. Fan-Gang Zeng: Thank you D'Anne for the introduction. It is my pleasure to be with you today.

03:05 Dr. D' Anne Rudden: To start us off, what exactly is A.I. in your mind?

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03:13 Dr. Fan-Gang Zeng: In my mind, A.I. is a way to help people improve or enhance their brainpower. That means the things that we do, we do for a minute and you got tired, and the machine will be able to learn and help you do that.

03:33 Dr. D' Anne Rudden: How do you take that definition and apply it to hearing science and hearing aids?

03:42 Dr. Fan-Gang Zeng: Some low-hanging fruit. We have seen the hearing aid industry picking up. For example, if you walk into a noisy restaurant versus going into a concert, and your A.I., an assistant downloads a program through a microphone, detects the environment you are in, and changes your hearing aid setting so that you can enjoy your conversation in a noisy restaurant or when you listen to music.

04:16 Dr. D' Anne Rudden: Would you say that anything occurring in a hearing aid technology that occurs automatically is using a kind of A.I. feature?

04:29 Dr. Fan-Gang Zeng: Yes, in a very primitive form on what an A.I. can do for you classify your sound environment into different categories, then you will change your fitting, your hearing aid parameters so that you can get the most sound environment. That is the very first step.

04:53 Dr. D' Anne Rudden: How some of the things that you describe like going into a noisy restaurant and things like directional microphones kick in, or how it may sound can classify into a different algorithm parameter? That has been around for a while. Why is it only now that we are starting to hear about A.I. in hearing aid technologies that doing something different is new and improved?

05:48 Dr. Fan-Gang Zeng: I would say yes. If you can recall, the number one complaint by hearing aid users or by people with hearing loss is to understand speech-in-noise. That has been a problem since day one, and we haven't really solved the problem. All the noise reduction algorithms you heard about except for directional microphones, didn't seem to really work in improving speech understanding in noise. Only recently, A.I. came on board. The kind of algorithm developed by A.I. algorithm, we called Deep Learning, started to show that they can help hearing-impaired people to understand speech-in-noise. I think this is revolutionary, and it is going to change the game. Maybe for the first time in history, people with hearing aids or cochlear implants can understand speech-in-noise. The noise doesn't have to be a static noise. Noise can be another speaker, or another competing speaker in a noisy restaurant.

07:10 Dr. D' Anne Rudden: Tell me about some things that we already know about in the world that are using this type of technology so that we can put it in a kind of frame of reference for people who might be listening.

07:47 Dr. Fan-Gang Zeng: The interesting part is, the revolution started in automatic speech recognition in language translation. We call it "Natural Language Processing." The other big arm in artificial intelligence is computer vision, but two of the three things that we talked about are related to hearing.

Recently, we started to utilize better technology and all were applied to hearing aid audiology-related research.

We started it early on but did not utilize it until people in Automatic Speech Recognition and Natural Language Processing showed us that they can do it for other things and people in the hearing aid industry are saying - if they can borrow a little bit of what they have learned and their technology, and apply to help the hearing aid users, then that would be really wonderful.

08:55 Dr. D' Anne Rudden: What I am hearing you say is that we pioneered a lot of this research, but then other

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industries were able to take what we started in the audiology realm, put it to use and ways we haven't thought of. And now, we are like trying to put these back on what we're doing and started in the first place? Is that what you are saying?

09:19 Dr. Fan-Gang Zeng: Yes. At one time, hearing aids were at the forefront compared with consumer electronics technology. Hearing aids had the first to digital form hearables. The word "Hearables" only came on board in 2013 or 2014, but we can't locate where they are now. The comparison is just unbelievable. Last year, all the hearing aids or cochlear implant companies, - their total revenues were about 12 billion dollars. If you look at it, one company-one product (AirPods), their revenue was about 15 billion dollars which was greater in all the hearing aid/cochlear implant companies combined.

Companies like Apple, Microsoft, Googles, Facebook, they are the ones who pushed A.I. technologies to the extent that now is the time for us to learn from them.

10:28 Dr. D' Anne Rudden: Absolutely. When you think about hearing aids in the grand scheme of things, what is a small percentage of the population that we're dealing with? In the big picture, if we get that type of technology that can be expanded into a much greater reach, then we are taking advantage of things that can help people with hearing loss, and people with normal hearing.

11:02 Dr. Fan-Gang Zeng: You pointed out something very important. For a long time, we have been complaining about low penetration rates in the hearing aid business. We have presumably 500 million people with hearing loss that could potentially benefit from hearing aids or cochlear implants. If you've read the most recent work from the World Health Organization report, then why we don't get more people interested or invest in utilizing hearing aids or cochlear implants that can help them?

There are several factors involved. One, it cost too much. Second, no awareness of the potential benefit of hearing devices, and the third factor is stigma. If you wear a pair of hearing aids, people think you are disabled.

But, I think with A.I. technologies and all these hearables, maybe in five years, everybody will have something in their ears and there won't stigma...Not just hearing-impaired people who will wear something in their ears, but also normal hearing people that will enhance their normal hearing.

12:29 Dr. D' Anne Rudden: I think that is happening now. I've felt when I walk around, there are people with all kinds of things hanging out of their ears. It definitely helped a normal person coming to a regular clinic to have less of that stigma. When I started out in the 90s it was a much bigger stigma, but I think it has gotten better as time has gone by.

12:59 Dr. Fan-Gang Zeng: Imagine everybody down the road. Probably in less than five years, we will have something in their ears. It is not only to help you hear better or enhance your normal hearing but it can serve as a monitoring device. Some of the recent hearables coming to the market can monitor your heart rate and your respiration. The Airpods and Google have also joined the game. They are going to monitor the sweat and analyze your glucose, and potentially monitoring your diabetes status. Imagine the realm of possibilities. We are in a very exciting time.

13:55 Dr. D' Anne Rudden: In your mind, is there a potential that A.I. will replace us as professionals involved in the hearing health equation? As a private practitioner, that is always something that I couldn't help but come into my mindset.

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14:29 Dr. Fan-Gang Zeng: Yes. It will replace some of the routine tests we are doing today, like audiograms and probably the fitting of hearing aids and cochlear implants. I think 90 percent of that job will be replaced by A.I., but no machine will ever replace the human aspect—the empathy. We will be required for the communication, for the fitting, for the rehabilitation to be effective. The audiology role will never be replaced by a machine.

Not to mention, it will liberate us from dealing with routine things. We can get into more interesting stuff, complicated cases or things that go beyond just an audiogram and a fitting. For example, how do you deal with hidden hearing loss, auditory neuropathy, autism, people with tinnitus, hyperacusis, and other kinds of neurological disorders? These kinds of things will require more than just a simple "pushing of a button" and open up more opportunities for audiologists down on the road.

15:55 Dr. D' Anne Rudden: I love your optimism and the word you used—that it will “liberate” us. That is where I am going to hang my hat. It is liberation for the future rather than the destruction of all mankind, and the rise of the machines. I love to think that we will be liberated from pushing buttons and get to do the work we are trained to do.

16:28 Dr. Fan-Gang Zeng: That is how technology is supposed to do. Repetitive routine stuff—let the machine take care of it, and let us do more interesting and creative stuff. And, have more time talking to your patients.

16:46 Dr. D' Anne Rudden: That sounds spectacular. I am so grateful to have had the opportunity to chat with you and for you to share with us some of the things that are coming down the line. We are going to dive in more deeper in the *Aftershow*, so don't go away.

Dr. Fan-Gang Zeng: Thank you so much for your time today. Thank you for sharing your knowledge, your excitement, and your expertise.

17:13 Dr. Fan-Gang Zeng: Thank you. It is my pleasure.

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## AFTERSHOW

17:20 Dr. D' Anne Rudden: We are back on the Hearing Journal Podcast Aftershow with Dr. Fan-Gang Zeng from the University of California Irvine, also known as Frank to his good friends.

We were talking in the first part of the Podcast about Artificial Intelligence and its role in Audiology. You are optimistic, which is always something that speaks to me, there's enough doom and gloom to go around in the world. It is very nice to speak with someone who is actually looking at the rise of A.I. in Audiology, as something for us to be excited about.

I want to circle back with you to connect with something we had talked about in the first part. And that is... how A.I. is going to replace the mundane part of what we do as professionals? How is this happening?

18:28 Dr. Fan-Gang Zeng: There are two components about A.I. One is the algorithm, which we call deep learning which has been applied to all sources of applications from beating the best chess and Go players in the world to someday automatic driving or self-piloting.

The second part is the big data. We need to accumulate the data that will be able to train an algorithm so that they

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can accomplish something for you. The difficult work or sometimes the challenging tasks, like understanding speech-in-noise. That part is already happening.

The interesting part is the third component. It is the miniaturization of the device that you can place in the ear. Whatever is inside the ear canal is not just a sound amplifier. It can be a monitoring device or a sensing device, which can be super powerful. Imagine, whatever you put in your ear canal not only can amplify the sound, but can monitor the activities or record (someday) auto caustic ignition, your auditory brain stem responses, and your cortical responses. Just think how powerful that would be?

20:06 Dr. D' Anne Rudden: I have read somewhere along the line that having these in your ear in the amount of potential it has for the neural interaction that it can get to know where your eyes would tract to and looked at from that activity and picked up the sound it is associated with.

20:35 Dr. Fan-Gang Zeng: There are several groups in the U.S. and Europe who are applying it to hearing aid applications.

Right now, the A.I. algorithms can separate different streams even two or three competing talkers. Which stream or speaker do you want to focus your attention on? A.I. will read your mind, and know whether it is a female or another male talker you want to pay attention to. Automatically, it will pick that stream for you so that you can understand speech, not in the presence of other competing sounds, but just the one that you want to pay attention to.

21:29 Dr. D' Anne Rudden: I hope it doesn't read my mind too much because that could be very scary.

21:36 Dr. Fan-Gang Zeng: I agree with you. I don't want the A.I. to do too much. We just give them limited access.

21:41 Dr. D' Anne Rudden: What are the opportunities we need to embrace when it comes to A.I.?

21:55 Dr. Fan-Gang Zeng: It is a tremendous opportunity for audiologists to allow to go beyond their traditional scope of work which is limited to people with hearing loss. We can go to special populations that may have other disabilities or think of it in the future to people with normal hearing but who want to enjoy and enrich their hearing experience. I think audiologists are in the best position to help people with normal hearing to enhance their listening experience.

22:49 Dr. D' Anne Rudden: At some point, we will see a broader scope of patients than what we see right now. For me, it is very exciting.

How did you get interested in working with A.I.? Who inspired you?

23:14 Dr. Fan-Gang Zeng: I got interested in these as I was trained as an electric engineer. No wonder why I have been following this trend.

In 2011, I wrote an article for *The Hearing Journal* about personalizing listening experience. I remember going to a couple of meetings which are not audiology related, like micromachines or consumer electronics. I vividly remembered the computer chips doing the same as a hearing aid was supposed to do, and it got my attention. Maybe, consumer electronic companies like Apple, Samsung, and Qualcomm, will invade our space. And I thought they will come because they are the ones who have the marketing power, they have economic power to change the game. And sure enough, they did.

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Talking about enhanced normal hearing experience...I remember in the 2013 article for *The Hearing Journal*, it talked about LeBron James's experience going full speed from one side of the court to the other wearing a camera and a microphone in his headband. It allows you to hear and to see exactly what LeBron sees down the court. This is the kind of personalized experience we can provide potentially for our user whether you are hearing impaired or not. This kind of experience is where an A.I. can give you.

In five years, half of an audiologist's job is to help people with hearing loss, and the other half is [to help those] who want the best personalized hearing or listening experience. We can provide and charge that person.

25:30 Dr. D' Anne Rudden: Who are your gurus? Not necessarily in the realm of Audiology but who are those people who inspire you? Who do you look up to?

25:53 Dr. Fan-Gang Zeng: I have a couple of people's names come into mine. Early on, I worked with Bob Shannon and Blake Wilson. They are pioneers in cochlear implants. They are the ones who not only understand the signs but also the technology, and make their technologies and inventions in the public domain.

If you look at a cochlear implant these days, people can understand 70-80 percent speech. Thanks to these guys who really inspired me. They led me to become the kind of person I am. I am forever grateful.

26:42 Dr. D' Anne Rudden: We all are. There are people out there doing this work, and setting the bar for what eventually trickles down to people like myself in the clinic who are using now daily that was in someone's dream years ago.

27:03 Dr. Fan-Gang Zeng: You are right. If you look at the cochlear implant, when Bill House invented his single-channel cochlear implant nobody thought it would ever work. From physicians to basic scientists to people in deaf culture, said it will never work. But look at how many people who lasted years the number of cochlear implant users worldwide passed one million. That's a huge number. Thanks to the people like Bill House, Bob Shannon, Blake Wilson—people who insisted, persisted, and made sure that it would work safely, and actively. That's where we are today. We thank them.

27:58 Dr. D' Anne Rudden: Now we are connecting those to our phones and other bi-modal solutions.

28:11 Dr. Fan-Gang Zeng: Exactly. This is the next wave as what A.I. can bring to us. It is a seamless connection between people and the crowd that allows you to have access not just speech sound but anything in the world that you can get instantaneously.

28:42 Dr. D' Anne Rudden: Hopefully with better connectivity than the current Bluetooth situation.

28:46 Dr. Fan-Gang Zeng: The Bluetooth is evolving, too. In earlier days, it is power-consuming, it has a long latency, and not that reliable because sometimes you lose your signal. But I think the technology has gotten so much better. Now you have 5G, and people are now talking about 6G technology. It will give you a less than millisecond delay while consuming a load of power. That is why I am so optimistic about hearing aids will not be called hearing aids anymore, but it is something in your ear that everybody uses that will connect you to the outside world.

29:34 Dr. D' Anne Rudden: What name do you think we have in store? Can you give us a little glimpse into your crystal ball?

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29:43 Dr. Fan-Gang Zeng: That is a great question. We are on the move from hearing aids to hearables, or a brain connector, or ear-brain connector. It is a very exciting time.

30:01 Dr. D' Anne Rudden: You have already talked about where you see us in 5 years, but go further down the road for us. In your wildest dream, the dreams of people like you are doing research and pulling us into futuristic direction...where do you see Audiology in 10 years? In 25 years?

30:24 Dr. Fan-Gang Zeng: To the extent that we allow the technology to get inside our body, I think we would need a port that will connect human beings to the outside world. Right now, we utilized our cellphones as the port into connecting our bodies to the outside world. In the future, it can be or maybe the ears are the place to hide it, you don't see it. I look at my boy who always has his phone in his hands. It doesn't matter where he goes, or what he is doing. I think it will free our hands from holding cell phones, a natural place to hold a piece of equipment that connects us to the outside world is our ear canal.

31:23 Dr. D' Anne Rudden: Somebody have said a few years ago in a conference that the ear is the new wrist.

31:30 Dr. Fan-Gang Zeng: I agree with that. I can see that happening. The Google glasses tried hard but it didn't work out. We are talking about Google Ears.

31:42 Dr. D' Anne Rudden: I will look for that on the horizon. Before we close our podcast today, I want to give you the opportunity to share a little bit about you personally. You are such an engaging person. When us regular clinical folk think about you in research, we don't think about you as a normal human being doing normal human things. You are in the lab doing research and all the amazing things. What do we not know about you?

32:22 Dr. Fan-Gang Zeng: During the pandemic, I couldn't play basketball anymore so I gained about 15 pounds. My new year resolution was to lose it. What I did, instead of driving to work every day, I started to walk to work every day. As a result, I shredded whatever pounds I gained during the pandemic. I am so grateful.

32:50 Dr. D' Anne Rudden: What you are saying is, brilliant researchers are just like us. They gained the "pandemic 15" just like us.

32:59 Dr. Fan-Gang Zeng: Absolutely. No exemptions.

33:04 Dr. D' Anne Rudden: Now I understand your reference to LeBron James even more. When I think about me having a LeBron James experience, it is going to bring me right back to you.

Thank you so much for sharing your expertise, your wisdom, and especially your humor. You are a delight. Thank you for taking your time to speak with us today.

33:30 Dr. Fan-Gang Zeng: Thank you very much for the opportunity. You are wonderful.

33:37 END