Hear Here Podcast – Season 1, Episode 1: Dr. Ruth Litovsky

Introduction

[Music]

Karen Gordon

Hello and welcome to the Hear Here podcast. I'm your host, Karen Gordon, I'm an audiologist and senior scientist at the hospital for Sick Children in Toronto, Canada, and a professor at the University of Toronto. Our goal with these discussions is to explore new ideas that may help people use devices like cochlear implants to hear. Transcripts of these discussions are available alongside the recordings.

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It's Dr. Sharon Cushing, Dr. Blake Papsin, and me, Karen Gordon. We'd like to welcome you to our first episode of the Hear Here podcast.

[Music]

And we're really happy to um be speaking with Doctor Ruth Litovsky, who is a professor at the University of Wisconsin in Madison. We know Ruth for many, many years, right, Sharon?

Sharon Cushing

Absolutely, and, and you know, I, I think I'd described Ruth as a great communication partner, and I got to meet her and she's just such an approachable human being. I saw - I met her first when I was a trainee and you know, we went on walks together, um had dinner at your house and she is just a really great human.

Karen Gordon

Yeah, she studies something that we're really interested in, which is binaural hearing and the use of bilateral cochlear implants. So, um, let's get into it. We'll hear from Ruth about uh that main interest, and where it came from.

[Music]

Ruth Litovsky

Good morning and thank you for having me. It's such a pleasure to be here with you today.

Karen Gordon

It's really wonderful.

Karen Gordon

So, your lab is called binaural hearing and speech lab?

Ruth Litovsky

Correct.

Karen Gordon

It's a great name and, uh, I know it well but tell me a bit about why you chose the name.

Ruth Litovsky

Well, certainly at the time that I joined the faculty at the University of Wisconsin Madison, uh, this is now in the year 2001, so we're coming on 20 years, uh, from now, I was focusing on those two questions. I wanted to understand how the brain uses and integrates information from the two ears to be able to allow humans to localize, to segregate speech from noise, and to suppress echoes. And those are the benefits of binaural hearing.

And in addition, I was studying speech understanding. I was still in Boston at the time, and I was having a great time studying normal processes but we had already, uh, my-my students and uh collaborators and I, had already moved into the space of creating, uh, in the lab, complex auditory environments, and in these environments, we simulated what might be going on in the real world.

For example, you might have uh to listen in the presence of multiple talkers, and they might be positioned to your right or to your left or both, and so we started to investigate how well can we segregate speech from noise in all of these complex situations?

[Music]

Karen Gordon

We hear from Ruth about the importance of binaural hearing. A hearing loss in one ear can make listening very challenging so we are trying to improve the situation by making sure to provide people with hearing loss access to sound in both ears. I think it does surprise people that we used to only give a cochlear implant in one ear even when deafness was in both ears.

Blake Papsin

I gotta be honest um... the single sided cochlear implants uh for bilateral deafness are still more common than bilateral, most people on Earth only get one, we're pretty lucky to be able to even think about testing this.

Sharon Cushing

I think it speaks to like where we've come from, right? Like the first idea was like let's give them access. And, you know beyond access, then you want better access and um less effortful access. And that's why I think where we get into binaural hearing, if you ask the, you know, the individual walking down the street or a friend who's not in science or academia and say like, you know, “how does binaural hearing help you?”, they kind of look at you funny and um it's not something that you ever think about 'til you don't have it.

Karen Gordon

That's absolutely right, the idea that we'll need, we need to hear what's going on around us, and the world is a 3-dimensional space, it's happening all the way around us.

Blake Papsin

Yeah, the interesting thing that people think, they..., just it's a plug and play system, you put two in and it goes. We think it's naturally done. It's only when you see it break down, that we realized, oh my God, this is a huge problem, and it becomes a new experimental paradigm.

[Music]

Karen Gordon

It gets interesting to hear some of the early work that Ruth was doing. Um, just what's happening, um when you give two Cochlear Implants, I think that first work she's going to describe it, um was done in adults

Ruth Litovsky

They wanted to measure the outcomes in these adults, “how, how do we know if having the second implant really helps?”, “how to (we) do clinical studies?”.

I designed a set of experiments that would take them 40 hours to get the data from each subject [laughing]... I didn't know that really, you might have two hours with each uh, participant. But we'd had a great time uh thinking through what were the most important parameters and how to bring it down to about 2 hours. We designed these great studies, and I got very deeply involved with helping to get that work done and then publishing it.

At the same time, when I was moving my lab to Wisconsin, they asked me if I could help to run the studies in my lab with the first few children that were getting bilateral implants here. They were between 8 and 12 years of age. And so, we set up this loudspeaker array that was one of the very first generations of what we then moved forward with for many years, and we flew children in from Dallas through a wonderful collaboration with a-a terrific surgeon named Bob Peters and did those very first studies.

It was a longitudinal 2-year study and initially we did not find much benefits for the children, but with time we saw that there's emergence of these abilities and eventually, I sort of turned my own lab into a more uh cochlear implant research lab.

Karen Gordon

Somebody’s listening to this podcast right now and they took out one earphone, or made it just a little bit off, in their ear, then they would start to get the sense of “OK that's kind of a little bit of imbalance between my ears”. But imagine that one is noisier on one side than the other.

That's, I think, a way of thinking about this where we try to understand what is actually the problem. When we think about kids with bilateral cochlear implants, we're trying to push the system to do something it's never done before, it's-it’s got to take these two inputs and create something out of those, that it's never done well.

Ruth Litovsky

And, as you and I have talked about a lot over the years, the interesting thing about people who have implants, uh, in both ears, is that, as you already said, each implant was designed by the cochlear implant manufacturer to capture speech cues and to represent those cues to somebody who's born deaf or who is trying to get their hearing back after having become deaf. And the goal was to integrate into society so you can gain access to language and to-to be a-a spoken language person.

Nobody really thought, at the time, about the fact that if we were to give people 2 cochlear implants, we have to think about what the brain is doing in a normal natural system to gain access to binaural cues. And the thing about binaural hearing, is that it relies on these exquisitely timed, and well synchronized arrival of inputs to the two ears.

So, imagine, for example, that a sound is arriving from directly in front of you. When it reaches both ears at the same time, with the same intensity, it will activate the neural circuits in a very particular way, and there's a sort of online computation, kind of like a little computer in your brainstem that is comparing the inputs and telling the brain there's a sound coming from in front. Now, if the sound moves over to one side of the head, it will reach that ear that is closer first, it will also have more intensity in that ear.

So, those differences in timing and in intensity are computed by the brain online and the ears, or the cochlea, rather in the ears, have a traveling wave, and there's phase locking that goes on and then there is this beautiful phase locking at the level of the auditory nerve.

Now, all of that, is not exactly reconstructed as well as it should be with cochlear implants, because children and adults are fitted with two independent devices and they operate with their own time clocks. They might be inserted into the cochlea with different, slightly differing depths of insertion in terms of the electrode array depending on what the surgeon is able to achieve and uh some of the fine grain information in the frequency space is not uh maintained or is not represented with fidelity. So, all of that just means that there really is not good binaural hearing in bilateral cochlear implants.

But, let's not throw out the baby with the bathwater. There is some very good restoration of access to sound in both ears, and there is some terrific reliance on bilateral hearing, which we know has provided some strong, strong, significant benefits for improved sound localization, being able to hear speech in noise, awareness of sounds in the environment, etc.

[Music]

Karen Gordon

So, in the next part, um Ruth really talks about some of the limitations of bilateral cochlear implantation, specifically about matching the two cochlear implants. And, it's really interesting to think about this because our ears are normally so well matched, we can't even really tell which ear is listening. We need the auditory brainstem and brain to hear sounds coming into each ear at perfect matches uh in pitch, for example. So, Ruth is going to tell us a little bit more about that.

Ruth Litovsky

So, instead of the entire array of many electrodes, we can pick one or two electrodes, we can move up and down the cochlea, and start to ask the patient to tell us which of the electrodes are perceived to have the same pitch.

When we do this pitch matching experiment, we discovered that a patient might perceive a sound to have the same pitch across the two ears. And, it turns out that pitch matching is very important because if I start to take away the pitch matching, for example, move the electrodes further and further apart, then the patients lose the ability to even hear one fused image in the head.

Imagine that when you put on headphones and you hear a stereo sound that's beautifully in the center of your head and you say to yourself, “ah-ha that sounds like something stereo”, right, think about a stereo sound that's in the middle of your head and now, think about the stereo sound slowly fading away and you hear a mush, in your head.

That's what it sounds like when you lose binaural synchronization or true binaural hearing. And what we've learned, is that if you take away that fusion, or that binaural perception, it also goes along with not being able to localize the sound as well, or not be able to hear the speech sounds across the two ears together as well.

I think that clinicians, when programming devices are going to ultimately want to be able to give this fused binaural perception of a stereo sound.

I don't think the clinician needs to measure pitch matching but I think if the clinician can measure the actual outcome, “do you hear stereo sound in the head?, “does it move to the left or right easily?”, “is the signal to noise ratio improving?”. Behind that, under the hood, I think that the cochlear implant manufacturers will probably have to implement some tools that vary a whole bunch of parameters, and probably make some very smart signal processing decisions along the way.

Music

Karen Gordon

I don't know if you guys have any comments, further, on pitch matching between 2 cochlear implants?

Blake Papsin

Impossible, yeah.

As soon as we get dendrites growing out from the spiral ganglion to the electrode, and we can discretely uh stimulate, uh at thousands, of the electrical um, uh stimulation we're using today. And right, right now, we stimulate, especially with anti-modiolar electrodes and even with peri-modiolar electrodes. By the time it hits the spiral ganglion, it's spread into some wide arc and, and it's just it's, it's not natural.

So I, I don't think it's applicable yet. So that's why I remain hopeful that one day um we become more discrete with our stimulation.

Karen Gordon

I think for me, one of the questions about matching is, maybe we have some potential for using this massive spread of excitation on ei-either side. Maybe if we're using multi-channel um implants it it doesn't sound as discordant between the two as we might think.

And, and I think it's also important to note that Ruth doesn't think that it's necessary do the pitch matching. So, there may be some things that are more important about, um, getting bilateral cochlear implants programmed right, if we're gonna, um, make some improvements here.

Sharon Cushing

We ask the-the-the child to respond, or to tell us, or to pitch match, but there's gotta be a better way and we just don't know it yet, in terms of using neural signals, in order to, to do a better job of actually matching these than what we're doing today. I feel like that's the-the nut to crack.

You know, I went to the optometrist recently, and every time I go to the optometrist, they have a new diagnostic tool that they put me through, that got to imagine that one day, we're going to put a sound in through that implant and then the res - neural response, we're going to measure that back and, and we're going to get both ears matched like, I just feel like that's what we need.

Karen Gordon

When we're talking about what kinds of tools might work, um can you think of something that would be better in adults uh and more challenging in children?

Sharon Cushing

I think adults you can expect behavioral response, whereas in kids you often can't, or it's unreliable, and so I think you know a move, again, towards objective measures can be really helpful, not in isolation, but certainly you know objective measures that allow us to do all these fancy things with programming and making the best out of what the system's got.

Karen Gordon

Totally reminds me of um our early experiment where we just wanted the kids to tell us where do you hear the sound and they kept pointing to both of their cochlear implants, not even in their ears. They would touch the coils on both sides to say "yeah, I hear it here". And, that gave us a clue that they're giving us um an answer we didn't even expect, so sometimes we don't know what to even ask children to do.

So, that is where the electrophysiological measures could help. At the end of the day, from a binaural point of view, you do want input coming in from each ear to really be processed in the auditory system. And there's some hopeful um evidence that it is actually detected in the brainstem. Less positive in the cortex, where we see lots of evidence we put information into both ears, and it doesn't look that much different in children receiving 2 cochlear implants, as just putting sounds into each ear alone, um not as different as it should be, as we see in children with normal hearing.

[Music]

Karen Gordon:

This move from in your lab toward this clinical focus and, and your relationships over time with these patients. So, I want to talk to you about um the inclusion of adults and children because not a lot of people um will spend the time to think about how scientific tests, paradigms or how questions could be answered in adults versus children.

Ruth Litovsky

Well, that's a beautiful question. Thank you for that. I think of my work as uh spanning the lifespan, so I'm interested in babies and toddlers, as much as I am in adolescents, as much as I am in very active young adults, and of course, people who reach um older age. And so, we've studied patients who vary from, you

know, two years old to people in their mid to late 80s, and that's been such-such a fun experience. In part, it's also because I'm interested in plasticity, or how does the brain change its ability to use information that reaches the two ears. So, obviously the challenges are, are very different.

My Ph.D. was in developmental psychology and my PhD dissertation was on toddlers, children, and adults because I wanted to understand how binaural and spatial hearing matures and what are the changes. And my challenge to myself at the time, was to design some tasks, some behavioral measures that everybody could do, and then to change the stimulus to make it harder and to appreciate where children can no longer do what adults can do. And I think it's a very important take home message to myself about how to do developmental research. You have to find something that everybody's doing that you know they should be able to do.

For example, a simple task like "can you tell if the sound is to the left or to the right?", now how do you get a very young child to tell you that? Well in the clinic, of course we have uh the head turning paradigm, but now when you start to bring in toddlers who are much more active, about two years of age, they're not very interested in sitting around and you know, telling you with their head where things are happening, they're using more of their body language.

So, so we adapted, some measures have to do with body language and then we got them to actually do something that they love to do, which is to physically reach for sounds that were hidden behind a curtain. We call that the "reaching for sound" paradigm, and that was a way to get them engaged with their whole body in terms of telling us where they thought a sound was coming from and that's very important for a young child who has been deaf for the first year or two years of their life. Now you give them cochlear implants and you're asking them to do a new task, you're asking them to engage with the world in a way they haven't learned how to do yet.

We also wanted the parent to learn from sitting in the room with us, was how to encourage the child to repeat those behaviors in the real world. So, when you could figure out where the sound was coming from and you found that sound and you got a toy or a reinforcement or a piece of food, you know to, to tell you "Great job, you found that sound!", the parent is watching. And so, they're learning to take that home and use games as part of their home therapy.

Well, of course, the adults are much more nuanced and, and very interesting to talk to because they have made certain decisions clinically about whether to get cochlear implants. When I first started to do this, h this research and I didn't know much about cochlear implants, we learned about a whole story that had to do with plasticity by talking with the adults about their experiences. By learning about when they used hearing aids, when they transitioned to getting cochlear implants. And it turned out that the earlier that they became deaf during life, the harder it was for their brain to retain the ability to use those fine-grained time differences but everybody was able to retain the ability to use level differences.

[Music]

Sharon Cushing

It's the beauty and the risk of children, right? Because you've got this relatively blank canvas and what you do and what you don't do is going to impact their development. And so, it's a big responsibility on us in terms of making sure that we're doing the right things and guiding that development with the best of our knowledge.

Karen Gordon

So, here I want to give a plug to the importance of research, so that we have some way to guide our decisions um for this treatment that we're providing in the clinical world. Um, and also, a plug to clinical research because I think that whether this is somebody in a lab or somebody in a clinic, or you know a parent or a child or a cochlear implant user themselves, um we're all after the same thing. And that is to to-to make life the best it can be for each person.

I think that Ruth does do a really good job of expressing that connection to the participants who come to her lab from all over uh the US, and maybe other parts of the world. Um, they give their time, um, and I think that is something that we should really celebrate- That they're part of a community both and they're volunteering their time.

[Music]

Blake, you did a lot of community building in, uh, some of the earlier days of our program. Remember just north of the city, we had a day camp where we brought families to enjoy the day and there were times that we went skating all as a program. And, uh, those opportunities really helped us connect with the children and the families outside of the hospital.

Blake Papsin

It was a miracle. It's sort of in, in like the closest thing I'll probably ever see to one, seeing these kids' uh families trust us and then uh develop language and I, I think um selfishly, I just wanted to be with them and part of them I felt they were my own family so if that built a community then that's good.

Karen Gordon

I think it extends out to you know everybody who's on this team, whether it be in the lab, the clinic, but also to the, to the students, residents, fellows, etc. And um I think that's a good segue to what Ruth discusses next, which is, you know, the importance of mentorship um in a program like hers and like ours.

Sharon Cushing

I can tell you I've had some pretty amazing mentorship, and it's, you know, it's been one of the, the best parts about my education and my career, and you know both Karen, yourself, and Blake have been those mentors. And it's an incredible amount of work and effort, um and I only recognize that now that I'm, you know, older taking students to meetings, introducing them, uh doing all these things, um you know, showing them what they can do, asking them what they're interested in. It really opened so many doors for me, so um it's immensely impactful. So, so thank you both.

Blake Papsin

Well, you're welcome.

Karen Gordon

I think maybe one part of being mentored is being allowed to go forward, ask the question and have somebody saying “yeah do it, you know you're doing it the right way, do it”.

To get back to Ruth, she is so like-minded and really wants to support this discussion to allow people to uh to have confidence to ask what they want to do in science.

Sharon Cushing

I think to go out and take those leaps, you have to feel safe, and Ruth makes you feel safe. She's accessible, you-you know you're not worried about her judgment, and I think that is, you know immensely important cause great things happen when you allow people to be vulnerable.

[Music]

Ruth Litovsky

I think of my lab as a family, as a place where I want students and postdocs to come in and bring their best self to the situation, and to dig deeply inside their hearts and their minds and figure out what they want to understand and who they want to be when they leave the lab and moving forward.

Mentorship is about the process of self-discovery and it's about thinking through what tools are in the lab to help you reach those goals. So, one of the beauties of of having a group of people that work together, is that they actually build community with each other, they rely on each other for different strengths and so people bring different skills to the table.

But to me, mentorship is about helping people figure out what they want to do and how they want to get further along in their own careers, what are their careers goals, and how can I help them achieve those goals. And of course, there's a combination of helping people develop hypotheses and questions, helping people learn about which techniques are most important, mentoring them to interact with patients and then there's the productivity part which is about self-motivation. During Graduate School, there was no training on how to be a mentor.

Karen Gordon

I think that the innovation you've had from mentorship is to really bring um this to the forefront, even in places where we didn't talk about it that much.

Ruth Litovsky

So, what I decided to do was to take some of the best practices that I witnessed in my own PhD advisor Rachel Keen, and in my postdoc advisor Tom Ian, and in my post postdoc advisor when I was uh becoming an independent researcher, Steve Colburn. And each of them offered me very different but unique experiences with some excellent mentoring opportunities.

I think this started uh sometime around 2006 or 2008, when, in many conferences, there were many more men than women, and women were sort of gathering in these small groups and talking about what it's like to be a woman in science, what it's like to be a woman who's a clinician but doing research, what about women who are engineers and how do we form community for women in science and clinic and in research.

So, the very first workshop that that we ran, and I ran this uh with a couple of colleagues uh at a clinical meeting, was very well attended. There were hundreds of people who showed up on a Friday evening when you think that people would be exhausted from the conference and just want to go out and grab a drink.

They showed up to this stuffy room in a hotel to talk about mentoring and community building and the other interesting thing that happened was the men asked “what about us?”, we can use some mentoring too.

So then moving forward, both at the uh ARO and at the conference on implantable auditory prostheses, we started um to have mentoring workshops and my goal there, was to think about what are the questions that are burning for people, what-what are the issues that people feel like they really want to come into a safe space and talk with other people, and who can we get to facilitate these conversations?

And so, the conversations have been very, I think, helpful and deep and steady but it's really about people who share concerns and ideas and feelings and thoughts about their lives and the challenges and the directions that they want to take, getting together in a safe space to talk. And so, the conversations have ranged from work-life balance, to writing a grant, to deciding between being a clinical researcher and an engineering type researcher, or transitions in your career, how to publish. All of the concerns that we have, need to be aired out and need to be considered and thought about and discussed in an open space. I think that now there's such synergy across the fields in terms of appreciating that mentoring and these open conversations are very important and I don't want to take credit for that. I think that, that folks have really embraced this in many fields and across the world in-in really beautiful ways.

Karen Gordon

I-I really appreciate that and it was, as you're speaking, it reminds me so much about how important communication is. The connection um that we have to each other and the pandemic has just reinforced how much we miss these interactions. Just the simple act of communicating your thoughts and hearing other people's thoughts and back and forth and I think that maybe why you're such a good communicator is also why you are interested in communication, I really want to thank you for doing this podcast with me.

Ruth Litovsky

Thank you, Karen. Thank you so much, it's always so much fun to talk to you and uh it's always fun to have you ask me questions and have me think about the work that I've done and-and the way that I've been able to engage uh with researchers such as yourself.

[Music]

Karen Gordon

That concludes our first episode of the Hear Here podcast, I hope you enjoyed it. Um, I want to thank again our wonderful guest Dr. Ruth Litovsky and my co-hosts Dr. Blake Papsin and Dr. Sharon Cushing.

You can catch other episodes of the Hear Here podcast. There’s a link on our website, search Archie’s Cochlear Implant Sickkids Research Institute or wherever you get your podcasts.

The Hear Here podcast is put together by me, Dr. Karen Gordon, with my colleagues at the hospital for Sick Children in Toronto, Canada, Drs Blake Papsin and Sharon Cushing with a tremendous production and advisory team, Sofia Olaizola, Rachel Bedder, and Maria Khan.

The wonderful music was composed and performed by Dr. Blake Papsin.