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Celebrating Dr. Nina Kraus

By Samira Anderson, AuD, PhD, Marshall Chasin, AuD, and Steve Aiken, PhD

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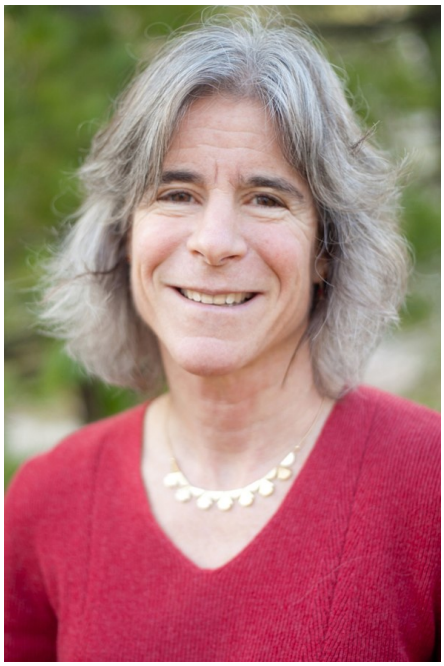

Dr. Nina Kraus is being celebrated in this special issue of *CanadianAudiologist*. To be fair, Nina's work is being feted, but it is almost impossible to separate Nina from her work. Nina's passion is boundless, and it would be naïve to think that we can separate Nina from her work, or for that matter, from the Brainvolts website or anything else in her life.

This *CanadianAudiologist* has many contributions from her previous students who have gone on and themselves have made significant contributions to the literature. But this issue also has an interview about Brainvolts, and even in that interview, it was impossible to separate Nina from her work. Indeed an amazing person, which the Canadian Academy of Audiology is proud to be able to recognize.

Nina Kraus absolutely insists on enjoying life. Her passion for life is evident in her work, relationships, and personal pursuits. She enjoys many genres of music ranging from Italian opera to rock and roll. In addition, she is a disciplined proponent of physical exercise, biking to work every day in all weather conditions (in frigid, snowy Chicago winters), and honing her boxing skills in the gym (check out the biceps). These interests have carried over to investigating the impact of life experiences, including music and sports, on auditory function. From her first days in her lab, Nina has also insisted that her students enjoy life or life in the lab. Lab dinners and outings encourage the sense of teamwork and collegiality that have led to > 400 publications on a wide range of topics, including music, concussion, reading, speech in noise, aging, bilingualism, neuroeducation, autism, and technologies.

Trent Nicol, Ann Bradlow, Bharath Chandrasekaran, and Dan Abrams in no particular order to this special issue featuring Nina's work.

ABOUT THE AUTHORS

Samira Anderson, AuD, PhD

Samira Anderson is an Associate Professor of Hearing and Speech Sciences at the University of Maryland. After practicing as a clinical audiologist for 26 years, she decided to pursue research to better understand the hearing difficulties experienced by her patients, and she obtained her PhD in December of 2012. Samira's current research focuses on the effects of aging and hearing loss on central auditory processing and neuroplasticity, and uses this information to evaluate efficacy of hearing aids, cochlear implants, and auditory training.

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Marshall Chasin, AuD, Doctor of Audiology, Editor in Chief

Marshall is the director of research at the Musicians' Clinics of Canada and has presented and published extensively on the topics of hearing loss prevention in musicians and hearing aids for music.

Other than being the editor in chief of Canadian Audiologist, Marshall Chasin writes a regular column in the Hearing Review called Back to Basics. Some of these columns are reprinted in this issue of Canadian Audiologist with permission of the Hearing Review.

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Steve Aiken, PhD

Steve Aiken is an associate professor at the School of Communication Sciences and Disorders and the Departments of Surgery, Psychology and Neuroscience at Dalhousie University. He received a master's degree in Audiology from the University of Western Ontario and a PhD in Medical Science from the University of Toronto. He is a past-president of the Canadian Academy of Audiology, founder of the Canadian Infant Hearing Task Force, associate editor of Canadian Audiologist, and co-chair of the Canadian Hearing and Auditory Research Translation group.

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Setting a Great Example

By Samira Anderson, AuD, PhD

Nina's work as a teacher and researcher has had a great impact on students and colleagues. Her mentorship was truly a gift as I transitioned from being a clinician to a clinician-scientist. I was an older student when I joined Nina's Auditory Neuroscience Lab at Northwestern in 2007, having worked as a clinical audiologist for twenty-six years in various settings. Because it had been over thirty years since I had taken any basic sciences courses, I was apprehensive about my ability to tackle the neuroscience classes needed as a foundation for pursuing research in Nina's lab. During those first uncertain years, Nina often checked in to ensure that I was managing the academic load. She was unceasing in her encouragement and helped me to appreciate the unique strengths I brought to research, both from a clinical background and from the perspective of being a non-traditional older student. Thus, it was fitting that I pursued the aging work in the lab!

While working as an audiologist, I was frustrated with my inability to predict my patient's everyday communication abilities from the audiological evaluation. Therefore, I was happy to work on the NIH grant entitled, "Neural correlates of auditory function and training in older adults," awarded to Nina and her colleague at Northwestern, Sumitrajit Dhar. Work from this grant led to several key findings. We were interested in the neural mechanisms that underlie speech-in-noise difficulties in older listeners, and found that neural responses of older listeners with better speech-in-noise performance were more resistant to the degrading effects of noise than listeners with poorer performance (Figure 1).[1] We learned that aging is associated with reduced phase-locking and response consistency in responses to speech syllables (Figure 2).[2] These differences appeared independent of hearing loss, as there were no significant hearing threshold differences through 2000 Hz between younger and older participants. Cognitive factors also make an essential contribution to speech-in-noise performance, especially auditory short-term and working memory, and auditory attention.[3] Given that these problems occur in individuals with normal hearing, it is apparent that hearing aid amplification alone may not be a sufficient remedy for speech-in-noise difficulties, motivating our desire to test the efficacy of an auditory-based cognitive training program in older listeners. We found that 40-hrs of this home-based auditory training improved performance on the Quick Speech-in-Noise test[4] and increased neural precision of responses to syllables presented in noise (Figure 3).[5] Some people have asked how Nina's lab can possibly be so productive. One big reason for this is that Nina's turn-around time reviewing our drafts is usually less than 24 hours. What a hard act to follow! Under Nina's guidance, I published 17 first-author manuscripts based on my candidacy project and my dissertation work. This body of work provided an excellent foundation for the aging and plasticity work that I have pursued as a faculty member at the University of Maryland.

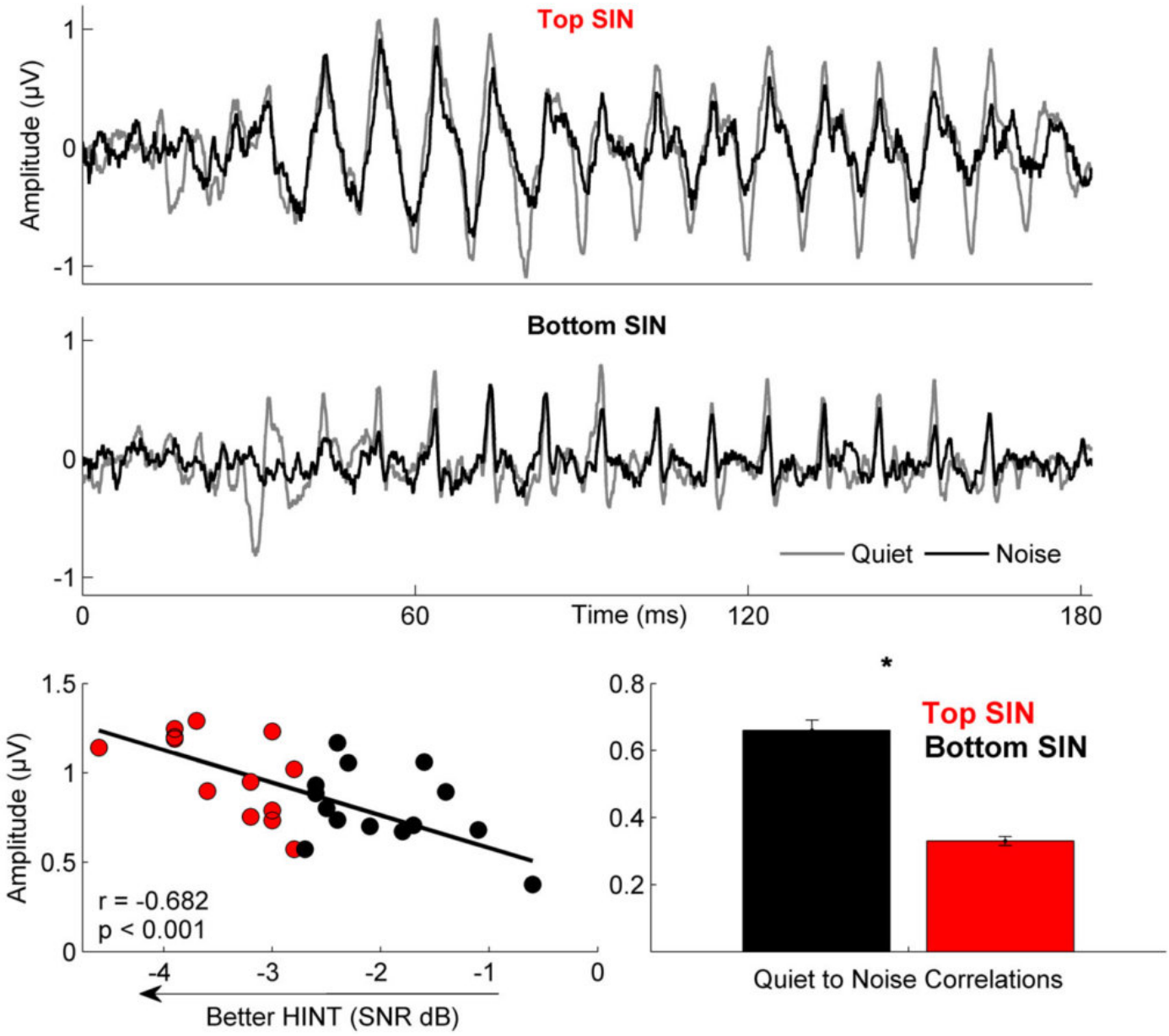

Figure 1. Top and middle panels: Individual waveforms to the speech syllable /da/ obtained in quiet and in noise (six-talker babble). The top panel shows waveforms from an individual with good performance on the Hearing in Noise Test (HINT), and the bottom panel shows responses from an individual with poor performance. Bottom panels. Quiet-to-noise correlations are higher in the listeners with good vs. poor HINT scores. Anderson et al. (2011) Ear and Hearing

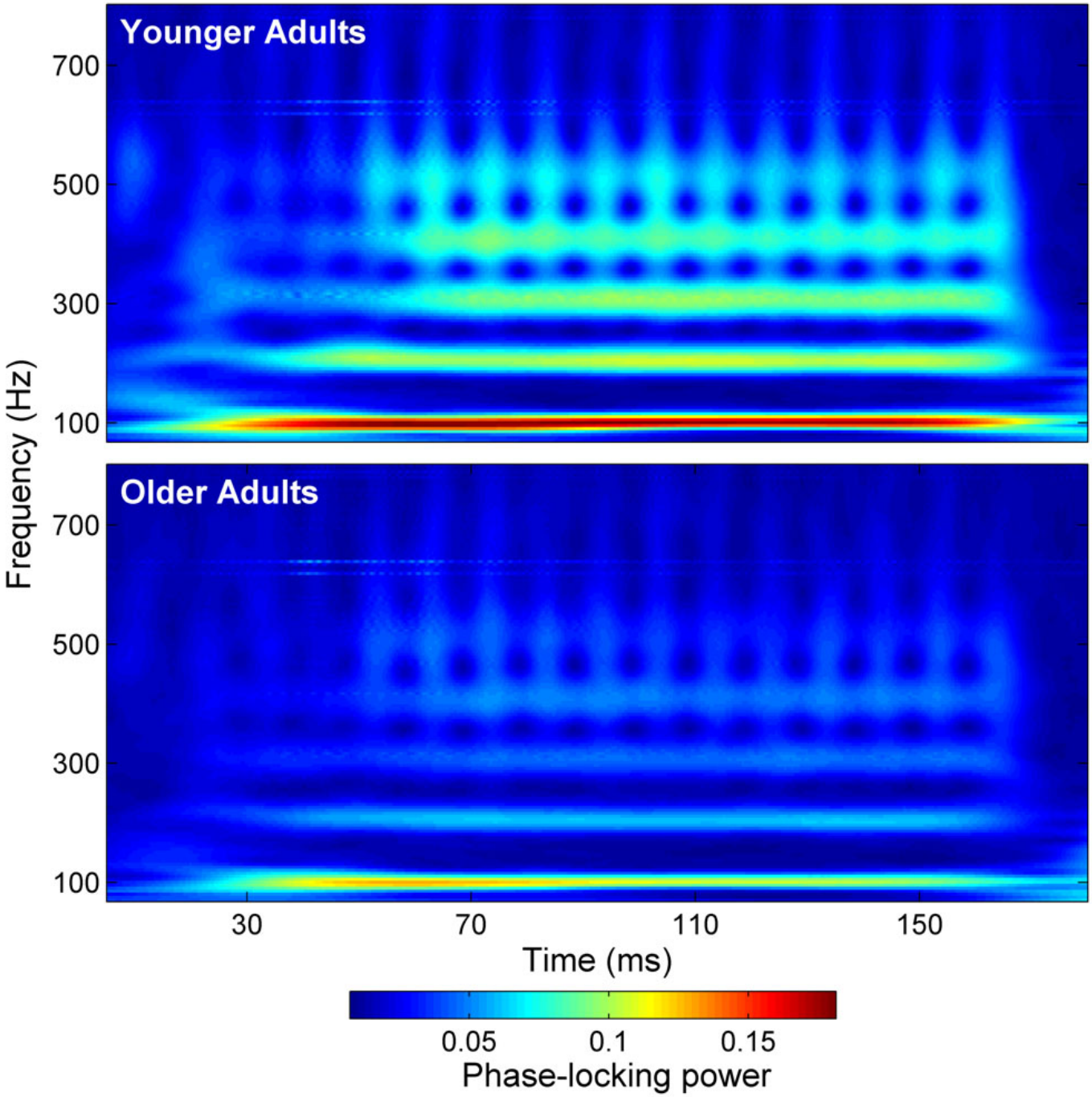

Figure 2. Compared to older adults with normal hearing, young adults have higher phase locking (deeper red colors) to the fundamental frequency and harmonics of the speech syllable /da/. Anderson et al. (2012) Journal of Neuroscience

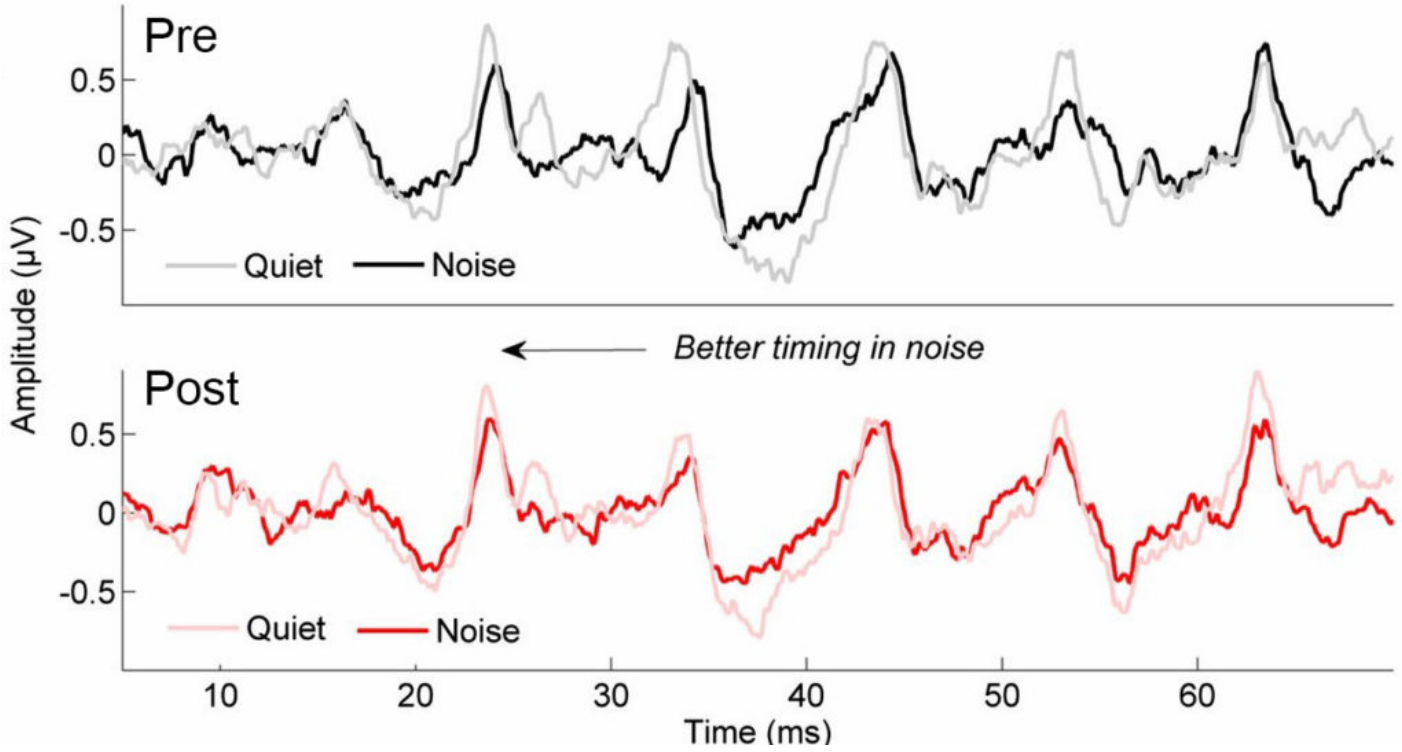

Figure 3. A comparison of an individual's responses to the speech syllable /da/ presented in quiet and in noise (6-talker babble) before and after 40 hrs of auditory-based cognitive training. Note that the noise-induced latency delays are reduced after training. *Anderson et al. (2013) Proceedings of the National Academy of Sciences - USA*

Figure 4. Lab dinner at my first conference – ARO Midwinter Conference 2009. From left to right: me (before my hair turned white), Nina, Karen Banai, Bharath Chandrasekaran, Erika Skoe, Jane Hornickel, Trent Nicol

In addition to publishing manuscripts, Nina encouraged me to present my results at many national and international conferences, including the Association for Research in Otolaryngology MidWinter meeting, the American Auditory Society annual conference, the Aging and Speech Communication Conference, and the International Symposium on Auditory and Audiological Research. Nina insisted that her students have plenty of presentation practice time during lab meetings. We were to pretend that we were presenting at actual conferences by standing in front of the group. Nina has spoken at hundreds of conferences, and those who have attended can attest that she is an engaging and dynamic speaker. I do not pretend to achieve Nina's level of engagement. Still, I appreciate that I have developed a high level of comfort when speaking to an audience because of Nina's guidance. Attending conferences with Nina and other lab members was always an energizing experience, and Nina took care to introduce me to leaders in the field. I particularly enjoyed the big dinners that Nina treated us to while at these conferences.

One-on-one time with a mentor is an important part of Ph.D. training. I most appreciate the way Nina welcomed me into her office for our meetings. She never made me feel that she was too busy to talk but was always delighted to see me. What a great example to follow as I now mentor my own students!

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TAGS: *Anderson, Kraus*

ABOUT THE AUTHOR

Samira Anderson, AuD, PhD

Samira Anderson is an Associate Professor of Hearing and Speech Sciences at the University of Maryland. After practicing as a clinical audiologist for 26 years, she decided to pursue research to better understand the hearing difficulties experienced by her patients, and she obtained her PhD in December of 2012. Samira's current research focuses on the effects of aging and hearing loss on central auditory processing and neuroplasticity, and uses this information to evaluate efficacy of hearing aids, cochlear implants, and auditory training.

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Memories of Times Past

By Trent Nicol, and Anu Sharma

As some of the first to have worked in Nina's lab at Northwestern, we thought we would reminisce about those earliest, seminal, foundational years which presumably shaped all that came later. Nina's lab moved from Michael Reese Hospital in Chicago's near south side to far up north in Evanston in 1990. Part of the Communication Sciences and Disorders department, the lab was housed on the second floor of Northwestern's famed Frances Searle building, widely regarded as a "communication disorder" itself for its labyrinthine layout and oddly situated doors leading to unexpected places. The first weeks were spent on hands and knees, with rags and paint thinner, cleaning the baseboards of spatter from the newly painted walls. Rugs, photos, and paintings on the walls soon brought additional cheer. Comfortable recliners placed inside the sound booths served the dual purpose of EEG testing and naps for hardworking graduate students. Oftentimes, astute graduate students combined the two, serving as EEG participants whose sleep stages were monitored for research examining MLR activity during REM and deep sleep.

In addition to rigorous science, Nina made sure food, conversation, and socialization were a focus. In those innocent days without ubiquitous internet, cellphones, or social media, lunch was always eaten together, often consisting of Michelini's salads and sandwiches delivered to the lab. In the days before vitamin water, we filled our humble water bottles at the water cooler, causing a brilliant statistician professor and beloved member of the lab to ask if we were *"bottling at the source?"* We all gathered around the 'conference' table, which was really more of a dining

table, dissecting and deconstructing all the relevant issues of the day. Another lab member was an eminent Audiology professor whose knowledge of Evanston eateries was legendary. When a constitutional crisis brought Russia to the brink of civil war in the early 1990s, we recall worriedly telling lab members, 'There's a coup in Russia and *Prof is in Hungary*', and those who heard this appeared terribly concerned since they heard '*Prof isn't hungry*'— an unprecedented situation indeed! Early lessons in speech perception thanks to our ever-loved gourmet professor.

Interesting characters would come and go regularly. A short-lived RA whose hair choices prompted one young subject to ask whether he was part poodle. And there was a post-doc convinced that Starbucks coffee contained a mind-control substance and adamantly refused to drink it. You can guess what was surreptitiously hidden in the Folgers can next to the venerable Proctor-Silex coffee maker.

In summers, at lunchtime, we would head down to the lake to eat on the beach. Sometimes Nina's then-small children (Nick, Russell and Mikey) would join us there. Winter celebrations around the conference table were especially looked forward to. In particular, I wonder what caused us typically shy folks to talk garrulously and giggle endlessly during Christmas parties while sipping eggnog? Nina (as always) was way ahead of her time and had created a lab environment where we all truly enjoyed working and being in that physical space. Perhaps today's high-tech trend of luring employees with food and games can be traced back to the original lab days when the lab was so comfortable and fun that no one wanted to leave.

Birthday celebrations were a must. When we wanted to get Nina into the lab for a surprise birthday party, the surest bet was to tell her that a certain NIDCD program officer was on the line. She dropped everything and rushed no matter how many times we used the same ploy.

One of the cutting-edge things about the lab in the early days was that Nina did an equal number of human and animal studies. While this was a terrific way to do neuroscience, it made for risky business as opening the wrong fridge at lunch could result in looking at histology slices or you might encounter R2D2 the autoclaver in the dark depths of the closet! There were aspects less than cutting edge as well. It may be hard to believe but Nina was late to embrace high-tech—when the internet became a thing in the mid-nineties, she refused for the longest time to get an email address! In the weeks before the annual ARO conferences, we all huddled together until the wee hours churning out data, creating poster panels by hand, making tiny slides (diazo process vs. black text on white was a recurring debate), all fueled by food, humor, and somehow no Powerpoint.

Famous scientists often visited the lab, and we got to accompany them shopping, listening to jazz and blues in Chicago's dive bars, and enjoying sushi dinners. And in one notable outing, searching every boutique on the Mag Mile for an elusive pair of red jeans, apparently in short supply in the visitor's native country.

Thank you, Nina, for the wonderful memories which remain fondly cherished and never forgotten.

TAGS: *Brainvolts, Kraus, Nicol, Sharma*

ABOUT THE AUTHORS

Trent Nicol

Trent Nicol is the manager of Nina Kraus's Brainvolts Laboratory at Northwestern University. For 30-plus years, he has been involved in all lab projects and lab minutia. He has been responsible for much of the instrumentation and software that led to Nina's many discoveries and has worked closely with many students who have moved on to careers in the auditory neuroscience fields.

Anu Sharma

Anu Sharma is Professor in Speech Language Hearing Science at the University of Colorado Boulder. She has the honor of being Nina's first Ph.D. student at Northwestern University many moons ago. An honor she is very proud of.

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Life Lessons

By Jane Hornickel

It's been almost 10 years since I earned my Ph.D. in Auditory Neuroscience from the Department of Communication Sciences and Disorders at Northwestern University. Four homes, two children, and three companies later, for this special edition, I reflected on the lessons I learned from my advisor, Dr. Nina Kraus. Not just those on how to run an electroencephalography experiment, how to analyze vector data in Matlab or the anatomy of the auditory system, but the life lessons I've taken to heart and integrated into my professional and personal life these last 10 years.

Take a Chance

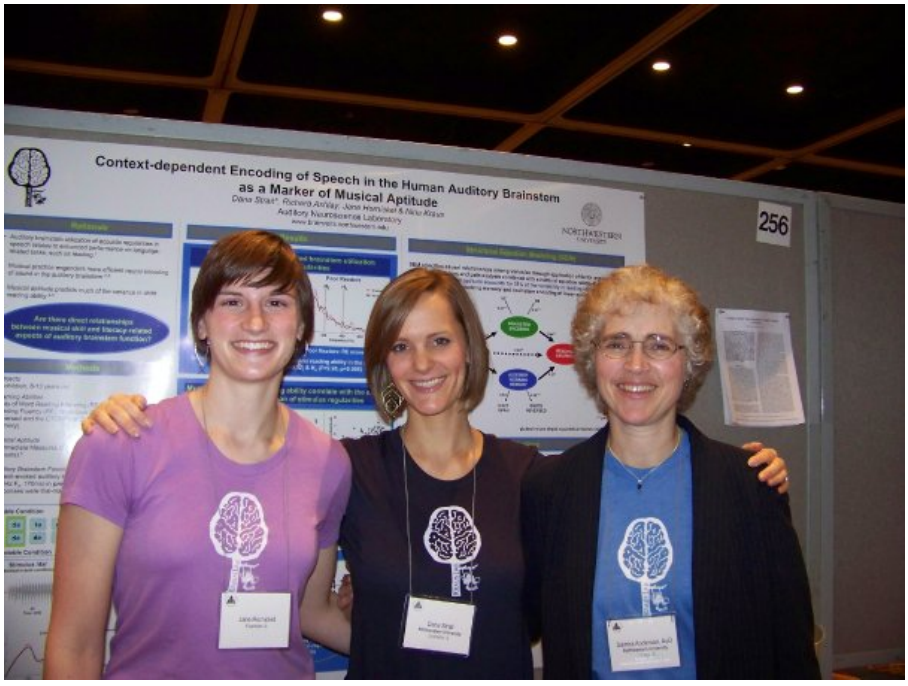
When I applied to graduate school, I was finishing my undergraduate degree in Neuroscience from Colgate University. Like other twenty-two year old's, I didn't necessarily know what I wanted to do as a career and was considering Teach for America and other education-based options besides graduate school. When applying to Northwestern University, I quickly identified Nina's research as an exciting opportunity for me, and, apparently, she did too! I learned later that she advocated for me with the admissions committee, encouraging them to take a chance on my potential. She helped craft that potential into collaborations on 23 publications and 19 conference presentations, supported by the sizeable

school-aged population study running at the time (Listening, Learning and the Brain). The experience she provided me in running a large-scale study was critical for developing project management, people management, and presentation skills. It's these soft skills that have been vital to my professional accomplishments since.

While her initial advocacy led the way to my opportunities in graduate school, she later advocated for me in a way that pivoted my whole career to its present direction. During my post-doctoral fellowship, I decided to start my own research company to support educators and learning clinics with research analysis and writing. Nina not only encouraged me to take that entrepreneurial step but was also my first client! Without her encouragement, I would not have started exploring educational research and technology as a career option. In addition to my small business, I also became the Director of Research at Hyde Park Day School. I then started my career at Schoolzilla (by Renaissance), where I have led customer support, customer setup. Customer account management as the Associate Director of Customer Success, using many of the skills Nina taught me.

Slides Should Have As Few Words As Possible

In my career so far, I've had many opportunities to teach: graduate student courses, lectures for parents of students participating in my studies, onboarding school district staff learning to use Schoolzilla – a critical skill I learned while in Nina's lab. Nina made sure that any student presenting at a conference or department lecture practiced their presentation at our weekly lab meetings. One semester as two students were preparing for their thesis defenses, I had to leave a lab meeting to take an exam, and she and the group were still helping prepare the students when I returned! Nina always emphasized that slides and presentations should be engaging, encouraging us to use few to no words on our slides, include audio and video clips, and not get stuck behind a podium while speaking. She was the only speaker to request a clip-on microphone at more than one conference and was famous for her laser pointer/slide advancer.



Given the exciting research we conducted in the lab, Nina received many invitations to speak worldwide. She recognized these invitations as opportunities for her students to create international collaborations. Through her generosity, I was able to speak at conferences across the US and in Germany, Hong Kong, and Egypt. I would never have traveled to those countries or learned from their cultures without the opportunity Nina provided. Those trips not only strengthened my communication skills but also my understanding of the world.

Be a Leader

Since I started my career in the educational technology industry, I realized how lucky I was to have a strong role model in Nina of who a professional woman could be and what she could accomplish. Seeing a woman like me be a respected, well-known world expert gave me a model of who I could become. Although I did not choose to follow her footsteps in academia, that confidence has carried me through my small business venture and entering a technology field, now taking on a new role as a technical product owner. Nina never takes no for an answer, always determined to support her research and her students in any way she can.

Cherish Your Family

Many of my favorite memories of my time in Nina's lab were dinners at her house. She would invite the entire lab over, cook her favorite Italian dishes, and end the evening with music. Nina created a family among students, staff, and post-docs through her caring and support and demonstrated the importance of family through her relationships with her husband and sons. It is abundantly clear they are the joys of her life. When I brought my then-boyfriend (now husband) to his first lab dinner, it was like I was bringing him home to meet my family. And in early 2020, at a lab reunion dinner, I was thrilled to have the opportunity to introduce her to my oldest daughter (also named Nina).

Through Nina's example, I learned that a woman can be an academic intellectual, a model communicator, a mother, and an adventurer, seizing the opportunities life presents. I am thrilled to contribute to this special issue honoring Nina by sharing some of the ways she has and continues to inspire me.

TAGS: *Hornickel, Kraus*

ABOUT THE AUTHOR

Jane Hornickel

After completing her Ph.D. with Nina Kraus, Jane was a post-doctoral fellow with Dr. Molly Losh. She became the Director of Research at Hyde Park Day School, founded her own company called Data Sense LLC, and served as an adjunct professor at Rush University. In 2016 Jane began working at Schoolzilla and led customer support, customer set up, and partnerships Associate Director of Customer Success. She has recently transitioned to a new role as the Senior Product Owner of Data Ops and Analytics, overseeing the product direction for Schoolzilla's data ingestion services. She lives in Fremont, California, with her husband and two daughters, where they enjoy gardening and visiting the ocean or the mountains in Lake Tahoe.

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Listening, Learning and the Brain of Nina Kraus

By Gabriella Musacchia, PhD

The brain of Nina Kraus is expansive, constantly searching and testing, but also demands the best and deepest work from her students. The Kraus lab was humming with activity and excitement when I joined. The main research project that all lab members contributed to, and drew data from, was called "Listening, Learning and the Brain." The LLB project focused on testing the hypothesis that auditory encoding of speech was related to childhood learning deficits. The project had just produced several critical papers showing evidence that supported this link.[1–3] When I look back, it seemed like we had children coming in and out all day, seven days a week. It was a constant stream of calibration, electrode application, electrode removal, audiometry, speech testing (with and without noise), and flipping standardized test booklet pages. Lab meetings were at lunchtime every week, and we were all on a rigorous diet of data collection and analysis. In my first years, the lab published two seminal papers showing frequency-following response deficits in children with learning problems[4] and a reduction of the speech-evoked FFR when presented in noise.[5]

I had come to the Kraus lab with a question. My experience as a professional musician prompted me to ask why people get more excited when they see live music than when they just listen? Nina, a musician and a music lover herself, paired the question with audiovisual methods to answer it. We set about to answer that and determine if musicians themselves had different FFR encoding compared to non-musicians. I learned everything about electrophysiology in Nina's lab from the ground up. Her philosophy was that I needed to know how to put the presentation systems together and take them apart if I could be a successful independent researcher. She and the lab manager, Trent Nicol, insisted that I read the manual before asking a question. There was tremendous support and quite a bit of fun, too. We had holiday parties, conferences, visiting scientists (including my other mentor, Mikko Sams), and even dodgeball playoffs. It was a family. In the end, Nina and I found out that auditory and visual information combines in the brain to create a supramodal FFR response that is larger than either the visual or auditory alone.[6] Nina and I also answered the musician question, showing, for the first time, that musicians have enhanced FFRs to speech and music stimuli, compared to non-musicians.[7,8]

Today, I still rely on the skills and culture I learned in the Kraus Lab. So far, I have started two electrophysiology labs from four bare walls. I have grown from post-doc to professor to department chair. I love to listen and learn from the people around me, especially students who have unusual questions. But, more than anything, I strive to create an educational environment that feels like family. I believe that is one of Nina's enduring legacies: inspiring generations of scientists to move hearing science forward and nurture the visionaries and leaders of tomorrow.

Figure 1. Holiday party in the Kraus Lab circa 2005. From Left to right: Beverly Wright, Erika Skoe, Judy Song, Erin Hayes, Marianne Cheatham, Brian Williams, Karen Banai, Steven Zecker, Anna Yermakova, Krista Johnson, John Seigel, Trent Nicol, Cynthia Warrier and Nina Kraus. Taken with an actual camera, but it was the best shot I got. Despite the poor photo quality, the feeling comes through.

Figure 2. A better, more composed shot of the Kraus Lab circa 2006. From left to right, bottom row: Nina Kraus, Gabriella Musacchia, Erika Skoe, Nicole Russo, Brian Williams, Krista Johnson. Top row: Catherine Warrier, Judy Song, Karen Banai, Trent Nicol, Steven Zecker.

Figure 3. Nina Kraus and Gabriella Musacchia, circa 2007, outside of the Frances Searle Building, home of the Communication Sciences Department at Northwestern University.

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TAGS: *The Kraus lab*

ABOUT THE AUTHOR

Gabriella Musacchia, PhD

Dr. Gabriella Musacchia, PhD, is an Associate Professor and Department Chair of Audiology at the University of the Pacific and a Research Scholar in the Department of Otolaryngology Head and Neck Surgery at Stanford University. Dr. Musacchia's area of scholarly expertise is in the central auditory nervous system. She enjoys sharing scholarly activities, experiences, and publications with her students and colleagues. Dr. Musacchia married Dr. Matthew Fitzgerald, fellow Northwestern grad and current Chief of Audiology at Stanford University. They have a beautiful son and live in San Francisco.

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The Dynamic Range of Nina Kraus

By Erika Skoe

"We are investigating speech perception from a neurophysiologic perspective." So begins the first article I read from Nina Kraus (Kraus et al., *Ear and Hearing*, 1995). Little did I know when I was assigned to read this article for a class in 1999 that four years down the road, I would begin a 10-year stint in Nina's lab and that this "we" would someday include *me.* When I took this class, I was a graduate student in Generative Linguistics who had become unsatisfied with the black-box nature of linguistic theory and started to turn to neuroscience to understand *where* and *how* it all happened in the brain. So, I traded in syntactic trees for axonal branches when I signed up for a course called *Neural Representation of Speech* with Drs. Keith Kluender and Bill Rhode at the University of Wisconsin. On the reading list were names like Eric Young, Xioquin Wang, Michael Merzenich, Christoph Schreiner, Bertrand Delgutte, Nelson Kiang...and Nina Kraus. A few years later, I moved to Chicago, and Keith Kluender suggested I reach out to Nina about opportunities in her lab. My luck could not have been better, as shortly before making contact, Nina's R01 grant "Neural Representation of Acoustic Elements of Speech" was renewed for another five years, and she had money to hire new staff. At my interview, she asked me how I felt about data pre-processing. Not entirely sure what she meant, I took my best stab at the question by responding, "It's a necessary evil." That must have sealed the deal.

My first tasks in the lab were to track down a copy of a movie on snake handling for the next lab meeting (a story for another day), organize the "backroom," and automate how the Mismatch Negativity data were being processed. Nina must have been impressed with my skill set, as a few months later, she agreed to allow me to work remotely for the lab doing computer programming after my husband and I moved to New York. We returned to Chicago in 2005. I continued to wear many hats in the lab: software developer, chief bottle washer, industry liaison, zookeeper, lab manager (alongside Trent Nicol), and eventually graduate student. Over the decade, I was fortunate to be part of a lot of amazing work on neural plasticity and development – work that has set the foundation for the rest of my career.

During my time in the Kraus Lab, I learned a few of Nina's favorite words: biologic, idiosyncratic, different (not to be interchanged with differential), and who could forget *ear condom.* I also saw many students come and go and witness the softer and louder moments of Nina's personal and professional life. I have been privileged to get to know her full dynamic range and experience the many dimensions of Nina.

Image 1: Nina Kraus welcoming the world with open arms while I look on. Taken in 2008 in front of Lake Michigan, steps from Nina's lab at Northwestern University in Evanston, Illinois.

Nina, The Force of Nature

Nina is unstoppable. Her prodigious career -- marked by some 400 publications, 20 plus grants, and countless talks – is showcased beautifully on her pride and joy, the lab's website (www.brainvolts.northwestern.edu). While Nina remains as productive as ever, sleep has become more important to her in recent years. Gone are the days of late-night emails, written in all small letters, that I had come to expect during my time in her lab. But even as she's mellowed (a bit) over the years, her energy is bountiful, and her physical fitness remains legendary. Few people can do one-armed push-ups, but yet few people are Nina Kraus.

Nina, The Pragmatist

Pragmatism is the necessity of productivity. Achieving all that Nina has achieved while keeping up with her highly-accomplished three sons has required uncluttering and uncomplicating other areas of her life. No place is Nina's *no muss no fuss* style clear than in her lunch choices. For much of the time I spent in her lab, Nina ate the same lunch nearly every day: a toasted bagel and a can of sardines. This limited lunch menu was not because Nina doesn't like food or can't cook. Quite the contrary. Her kitchen is always overflowing with mountains of colorful and delicious food, made with the love and care you'd expect from the Italian mother she is.

Image 2. Nina Kraus in her kitchen at one of the famous lab parties, 2012.

Nina, The Cheerleader

As a mentor, Nina brings out the best in me, and over the years, she has given me the resources, space, and safety net I needed to thrive. Today, now as I direct my own lab, Nina remains my biggest cheerleader, champion, and trusted advisor. In my 10 years in her lab, I cannot recall a single time that she forgot or canceled a meeting with me. Even on short notice, Nina managed to squeeze in a meeting or give feedback on a paper when I needed it. The same holds today – she always makes time for me when I need the kind of pep talk that only Nina can give. It was not until I transitioned to running my lab, and I found myself needing to be in two places at once, that I truly recognized and understood Nina's superhuman capacities as a mentor and the true generosity she shows the people in her lab.

Nina, The Teacher

Although I never took a class with Nina, she has taught me a great many things over the years, some directly and some indirectly. Many of these I now try to impart to my students:

- Surround yourself with "big brains" if you want to tackle big questions.
- Work is important, but so too is not working.
- Love your data. Treat it like a precious commodity. Study it from all angles using all your senses.
- Practice the art of science. Share and express the beauty of scientific data through sound and images. (Inspired by this, I've created a data quilt from Nina's publication and grant record history.
- Tell a story when communicating science. Engage your audience, write and speak in plain language, and by all means leave the lectern behind.

- Be prepared and get it done. If there was anything that I left Nina's lab knowing how to do, it was the skill of getting things done, not just *on time* but *ahead of time*.
- And most importantly…Be a human first and a scientist second.

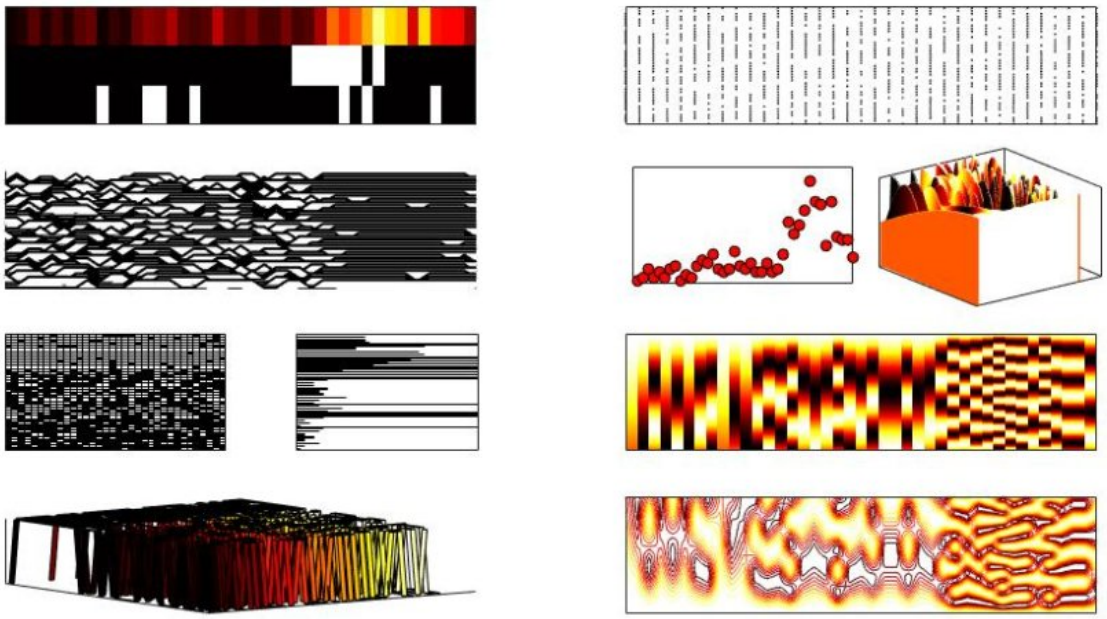

Image 3. A data quilt of Nina' Kraus publication and grant record, with color inspiration from our first publication together.

Through her research and mentorship, Nina has made a lasting impact on our field and our understanding of the neurophysiological basis of speech perception. I feel fortunate that she took a chance on me, and I thank her for her continued support and inspiration. It has been my honor to be part of her "we" for the last 18+ years.

TAGS: *Brainvolts, Kraus, Skoe*

ABOUT THE AUTHOR

Erika Skoe

Erika Skoe obtained her PhD with Nina Kraus at Northwestern University in 2012. She is currently an Associate Professor in the Department of Speech, Language and Hearing Sciences at the University of Connecticut, where she leads the Auditory Brain Research Lab and is the Director of the Cognitive Science Program.

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Nina Kraus and Individual Differences in Auditory Processing

By Karen Banai

University of Haifa, Haifa, Israel

It was in the late 1990s when I first encountered Nina's work.[1–3] I was studying auditory processing in dyslexia in Merav Ahissar's lab at the Hebrew University of Jerusalem. Our findings of large individual differences in basic auditory skills like frequency discrimination were met with skepticism. At the time, individual differences in sensation and perception were typically attributed to error – sampling error, measurement error, or "outliers." To the extent they were acknowledged, individual differences in auditory processing were used to diagnose auditory pathologies (e.g., with ABR tests). Nina's work on the links between auditory neurophysiology, performance in psychoacoustic tasks, and language skills were unique and exciting. It hinted at how individual differences in language and learning could be related to auditory perception and neurophysiology and how these could be studied non-invasively in human listeners.

Further, although I was unaware of it at the time, Nina was already developing more sensitive tools to study individual differences in the neural processing of speech (then termed "speech-ABR").[4] A few years later, when looking for a postdoctoral position, I met Nina in person for the first time. She was able to put me at ease immediately, even though I was stressed after a few sleepless nights dreading the interview. Then she

challenged me to explain my research in non-technical terms and its impact in the 'real world,' something she continued to do ever since. It was my first experience of Nina's effective mentoring style.

But it was really in 2004 when I finally made it to Evanston. I had planned to focus on auditory learning, but Nina managed to convince me to join the speech-ABR project. I had to first learn the ins and outs of ERPs, a rather painful process. I had no prior experience with the technique and did not realize how many "subjective" decisions were involved in collecting and analyzing "objective" measures. Specifically, the way peak latencies (e.g., of wave V) were determined at the time seemed arbitrary. Had it not been for Nina's patience and good humor, I would have probably quit before I even started. The fact that both Nina and Trent Nicol (her long-time lab manager) were incredibly consistent and reliable in their labeling and taught me that there was real data to uncover under all this noise. This would have never happened without Nina's graceful mentoring.

My main project in Nina's lab thus involved children with language-based learning disabilities and the speech sound [da]. We found that children with abnormal neural timing originating from sub-cortical areas (speech-ABR) also had less robust cortical processing of acoustic changes (MMN) and more impaired language and literacy than children with no timing deficits.[5] Later on, we established links between individual differences in the neural processing of speech sounds and reading-related skills.[6] Together, these and other works from Nina's lab served to establish the idea that indices of auditory processing can serve as biomarkers for literacy even though the underlying mechanisms remain elusive.[7,8]

In the years since, Nina and her crew continued to develop the measurement and analysis tools that now allow a nuanced analysis of the fidelity, integrity, and plasticity of sound encoding in the brain (the EEG-FFR).[9] These tools are based on evoked responses to speech sounds at the individual level and therefore can be used to study the behavioral relevance of different aspects of neural processing of speech sounds. Using this methodological and analytical framework, Nina's work touched on many areas, from the more traditional listening in noise, through language and reading development and the neuroscience of music all the way to autism and sports. Therefore, Nina's work not only helps us scientists deal with individual differences, but it also touches on the lives of so many human listeners, neurotypical and atypical alike.

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TAGS: *Banai, Kraus*

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Karen is an Associate Professor and director of the Auditory Cognition Lab at the Department of Communication Sciences and Disorders, University of Haifa, Israel. She completed her PhD in Brain Sciences at the Hebrew University of Jerusalem followed by post-doc in Northwestern University.

Karen's research focuses on auditory perception, cognition and learning across the lifespan in typical and atypical populations. Her current focus is on the role of perceptual learning of speech in speech perception and in hearing rehabilitation. Her work has been funded by several funding agencies, most recently the Israel Science Foundation (ISF).

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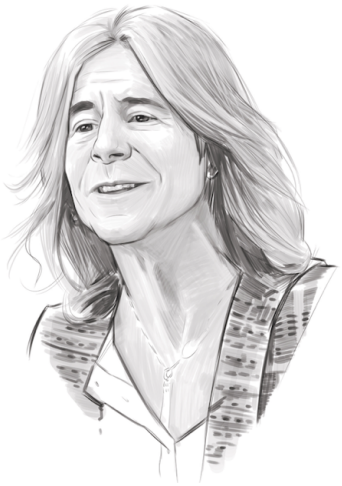
Nina's Passion for Science and Family

By Kelly Tremblay



Some people are quick to describe Nina according to her impressive h-index, a number that measures the productivity and citation impact of the publications in a scholar's career, or the numerous awards and accolades that have been bestowed upon her because of the impact she's made in advancing neuroscience. But I want to comment on Nina's passion – her passion for science and for family.

I had the privilege of being one of Nina's PhD students more than 25 years ago. I hadn't been exposed to many female Professors back in those days because there weren't many. In my eyes, Nina appeared as superwoman. She was someone who was, and still is, ahead of her time. She set the standard high by publishing in one of the most prestigious journals, "Science," while simultaneously chasing her three boys around the house and mentoring a team of scientists in the lab. How's that for multi-tasking? When you become a member of her lab, you become part of an extended family. I have fond memories of analyzing data at her home dining room table after being fed an amazing home-cooked Italian dinner.

Not only are you treated like family, but your family also becomes hers. When each of my boys was born, Nina was the first to send special hand-picked books with personal messages written within each one. We still have them today. She also makes an occasional unexpected appearance over the airwaves when we hear her on NPR or when her science makes the news. When that happens, and we hear her voice, we're all proud to shout out, "Hey, that's Nina!" One of her latest appearances came through a passionate pint-sized tween who proudly demonstrated the results of a junior version of a music perception experiment at my son's school science fair. At the end of her presentation, and at the bottom of the poster board, the junior scientist pointed to the scientific paper she cited by Kraus et al., and we pointed out and proudly shouted, "Hey, that's Nina!"

TAGS: *Kraus, Tremblay*

ABOUT THE AUTHOR

Kelly Tremblay

Kelly Tremblay is retired professor from the University of Washington in Seattle who currently serves as an Adjunct Professor at Dalhousie University and an Affiliate Professor at the University of British Columbia. She has a 30-plus year history of serving and advocating for people with hearing loss. As an audiologist and educator, she teaches graduate students how to prevent, assess, and manage hearing loss. As a neuroscientist, she studies the effects of hearing loss and hearing prosthesis on the brain in addition to the public health benefits of intervention for our aging society.

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Sound Impressions. Sound Guidance.

By Ann Bradlow

With her characteristic elegance and infectious enthusiasm, **Nina Kraus** often presents her extensive work on subcortical responses to sound in terms of a conceptual framework that focuses on three fundamental aspects of complex sounds: pitch, timbre, and timing.[1–3] I can think of no better way to celebrate Nina's research and mentoring contributions than through these three aspects of sound.

First is pitch, the sound attribute that allows us to place sounds on a scale from low to high. Nina seems to love huge pitch swoops. In her life outside the lab, she loves hiking up mountains and skiing down slopes. In her life with her research group, she always takes deep dives into data (of which there is always a huge amount in Nina's lab) and then challenges everyone to find the higher-order generalizations that make meaning of the data. Next is timbre, the perceived quality or "color" of a sound distinct from its pitch and intensity. Since timbre is quite hard to define, we usually appeal to adjectives that evoke some overall qualitative impression, such as *light*, *bright*, *rough*, or *smooth*. Within this descriptive tradition, I would describe the timbre of Nina's approach to scientific practice as *bright, fluid*, and, perhaps most of all, *joyous*. Those of us who are lucky enough to be associated with Nina's research group know that a major component of the Brainvolts group's unique quality – its timbre – revolves around communal feasts, including the legendary annual holiday party and the dissertation completion parties at Nina's house. The

third and final aspect of sound is timing, the sound attribute that describes event durations and relations. One of Nina's most remarkable scientific talents is her seamless integration of short-term patterns into long-term designs. Nina's work connects variation in short-term cortical responses (e.g., the frequency following response) to the variation in long-term experience with sound (e.g., by comparing musicians and non-musicians, monolinguals, and bilinguals). In Nina's Brainvolts research group, one can trace through-lines that connect series of studies over decades. As a prime example of this extended research timeline, consider the early studies on sound processing by children with learning disabilities from the *Listening, Learning, and the Brain Project* of the 1990s (e.g., Kraus, McGee, Carrell, Zecker, Nicol, and Koch, 1996) to recent work on rhythm, reading, and sound processing in pre-school children (Bonacina, Huang, White-Schwoch, Krizman, Nicol, and Kraus, 2021). Nina also has impeccable timing in selecting research topics, always managing to push the envelope of understanding current scientific and social relevance issues, ranging from learning disabilities to autism, sports-related concussion, access to music education, and bilingualism.

The world of sound is exciting and marvelous because it is a world with infinite combinations of pitch, timbre, and timing. In Nina's research group, this sense of endless possibility is the predominant strain. I was lucky enough to enjoy this wonder for three years in the mid-1990s, which turned out to be a pivotal point in my career as a linguist and speech scientist. Thank you, Nina, for all of the sound guidance (pun fully intended) that your life as a scientist, mentor, and friend represents.

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TAGS: *Bradlow, Brainvolts, Kraus*

ABOUT THE AUTHOR

Ann Bradlow

Ann Bradlow is the Abraham Harris Professor of Linguistics and Associate Dean for Graduate Studies in the Weinberg College of Arts and Sciences at Northwestern University. She received her PhD in Linguistics from Cornell University in 1993. In addition, she completed postdoctoral fellowships in Psychology at Indiana University (1993-1996) and Hearing Science at Northwestern University (1996-1998). Since 1998, Bradlow has been a faculty member in the Linguistics Department at Northwestern University where she directs the Speech Communication Research Group (SCRG). The SCRG pursues an interdisciplinary research program in acoustic phonetics and speech perception, focusing on speech intelligibility under conditions of talker-, listener-, and situation-related variability. A central line of current work investigates bilingual speech production and perception, with a particular focus on perceptual adaptation to second-language speech.

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Nina Kraus and the Art of Mentorship

By Bharath Chandrasekaran, PhD, and Daniel A. Abrams, PhD

> *"Mentoring is a **brain to pick**, an **ear to listen**, and a **push in the right direction**."*
> *– John C. Crosby*

There is much to consider and admire regarding Nina Kraus's incredible scientific accomplishments, which have been disseminated in hundreds of original research papers, book chapters, reviews, television and radio appearances, and guest lectures. While these accomplishments are available for most anyone to peruse, none of these communications provide any information about Nina's incredible mentorship to her students and staff in the Auditory Neuroscience Lab. We argue that Nina's mentorship is the crucial component for how her group has maintained such incredible productivity throughout her career. This brief paper will reflect on observations accumulated during our tenure in the Auditory Neuroscience Lab in support of this hypothesis. At the same time, we pursued our postdoctoral research (B.C.) and doctorate (D.A.A.) that speak to Nina's mentorship and how it has contributed to decades of innovative basic and clinical auditory brain research.

"A Brain to Pick...."

Nina has pursued excellence over a long and highly productive career. Trained during an era when the norm in neuroscience was hyper-reductionism, Nina stands out in her relentless pursuit of the big picture in auditory neuroscience. This search has allowed her to traverse across the auditory system: from the cortex to the cochlea, across levels: from single-neuron activity to systems-level function, across timescales: from rapid emergent plasticity induced via classical conditioning to lifelong music and language experience-dependent plasticity, and across translational tiers: from basic science leveraging animal models to translation to clinical practice and science/health/education policy.

Nina has a voracious appetite for science and is a firm believer in our ability to be lifelong learners. This broad and deep love for science has not only led her work to an unusually diverse collection of topics, including music, reading, development, brain injury, and learning, but also instilled in her trainees the importance of thinking about, and communicating, our science in the broadest way possible. A consequence of Nina's breadth as a scientist and keen sense of observation is that Nina's brain is fertile ground for a mentee to pick, and her encouragement of a "big picture" perspective is extremely important for her trainee's development. Consequently, her trainees are now influential across a broad range of fields. The ability to traverse across timescales, translational tiers, and systems to arrive at holistic perspectives has shaped the viewpoint that the ear is a critical doorway to the brain and cognitive function. This stems from intensive neuroscience training focused on the auditory system and an acute and keen observation of her world. As an example, her immense contribution to music neuroscience stems from personal insight and experiences rather than theoretical training in the music sciences. Unafraid to forego the path of least resistance to pave her own pathway and make it substantially easier for others to follow. A trailblazer in the truest sense.

"...An Ear to Listen..."

Nina's academic excellence is easily discernable by the scientific community as well as the layperson. As trainees with Nina, we had the opportunity to directly benefit from an underappreciated skillset, her ability to be an active listener, empathize, and discern others' perspectives. Nina's mentorship is underscored by a unique combination of leadership, intellectual curiosity, excitement for collaboration and exploration of new ideas, an infectious love of science, with a sprinkling of tough love. Nina has a unique leadership style: viewing herself as a member of the *Auditory Neuroscience Lab* who shapes rather than dictates terms. She typically eats lunch at the lab's conference table, where she makes herself available to talk with lab members and visitors about any number of scientific and non-scientific topics. Making herself available in this way enabled us to learn from her and experience her remarkable scientific mind in ways that might not be available otherwise. Her leadership style also makes her approachable to her trainees, which is critical for maintaining good communications throughout the scientific process. Nina worked hard to create a *collaborative* lab environment bonded by her passion for science and a focus on the big picture. Nina has an incredible

ability to protect trainees from the worst things about science and academia while preparing us in the best possible way to contribute to science. She is a lifelong mentor, lending a non-judgmental ear, offering sage advice ranging from mundane everyday academia to dealing with conflicts to work-life balance.

"...A Push in the Right Direction"

The process of designing and performing experimental brain research is a dance with the unknown, and the questions and anxieties surrounding this process are most pronounced in young researchers. Is this the right question to ask and the correct experimental design to address that question? Can we trust that the equipment is functioning correctly, the data is clean, and noise is kept to a minimum? Is the analysis sufficient to comprehensively test our hypotheses, and what claims can be made based on the findings? While young researchers thirst for immediate and definitive answers to their questions, the mentor's job is not always to simply provide this information to the mentee. Instead, it is often more beneficial if the mentor pushes their mentee in the right direction to think of ways to answer these questions themselves. A key aspect of Nina's mentorship is her incredible ability to direct her students in this way. Nina struck a perfect balance in mentorship, never too much into the weeds of a trainee's research project, yet never allowing trainees to lose track of the right direction, redirecting/aligning trainees whenever necessary.

To conclude, Nina has placed the highest emphasis on training future scientists, a fact attested by her impressive training record. She has served as the primary mentor for 14 postdoctoral fellows and more than 30 doctoral students and inspired countless trainees. While it is challenging to measure her training impact, we posit that it has left an indelible mark in the field of auditory neuroscience and has impacted how generations will think about how sounds profoundly shape our brains throughout our lifespan.

TAGS: *Abrams, Chandrasekaran, Kraus, mentorship*

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Bharath Chandrasekaran, PhD

Dr. Chandrasekaran serves as a Professor and Vice Chair of Research in the Department of Communication Sciences and Disorders at the University of Pittsburgh. He earned his Ph.D. in Integrative Neuroscience from Purdue University in 2008, completed a postdoctoral fellowship at Northwestern University with Nina Kraus and Patrick Wong before joining the University of Texas at Austin in 2010. He is the recipient of Regents' Outstanding Teaching Award in 2014, the Editor's award for best research article in the Journal of Speech, Language, and Hearing Research, the Psychonomics Early Career award in 2016, and the Society for Neurobiology of Language Early Career Award in 2018. Dr. Chandrasekaran currently serves as the Editor-in-Chief of the Journal of Speech, Language, and Hearing Research (Speech). Dr. Chandrasekaran's research examines the neurobiological computations that underlie human communication and learning, using an interdisciplinary, computational, and lifespan approach. His laboratory is currently supported by funding from the National Institutes of Health (NIH) and National Science Foundation (NSF).

Daniel A. Abrams, PhD

Dr. Abrams is a Clinical Assistant Professor in the Department of Psychiatry and Behavioral Sciences at Stanford University where he conducts research investigating the brain bases of social communication impairments in children with autism spectrum disorders (ASD). Dr. Abrams research focuses on understanding why children with ASD often "tune out" from the voices around them and how this impacts social and brain development. Dr. Abrams received his undergraduate degree from University of Arizona followed by a period in industry as an acoustical engineer in the San Francisco Bay Area. He subsequently completed his doctorate in Nina Kraus's Lab at Northwestern University and joined the Stanford University community as a postdoctoral researcher in 2008. Dr. Abrams joined the Stanford faculty in 2014 and was promoted to Clinical Assistant Professor in 2018. Dr. Abrams's research program has been supported by multiple funding agencies including the NIH, NARSAD, and the National Organization for Hearing Research Foundation.

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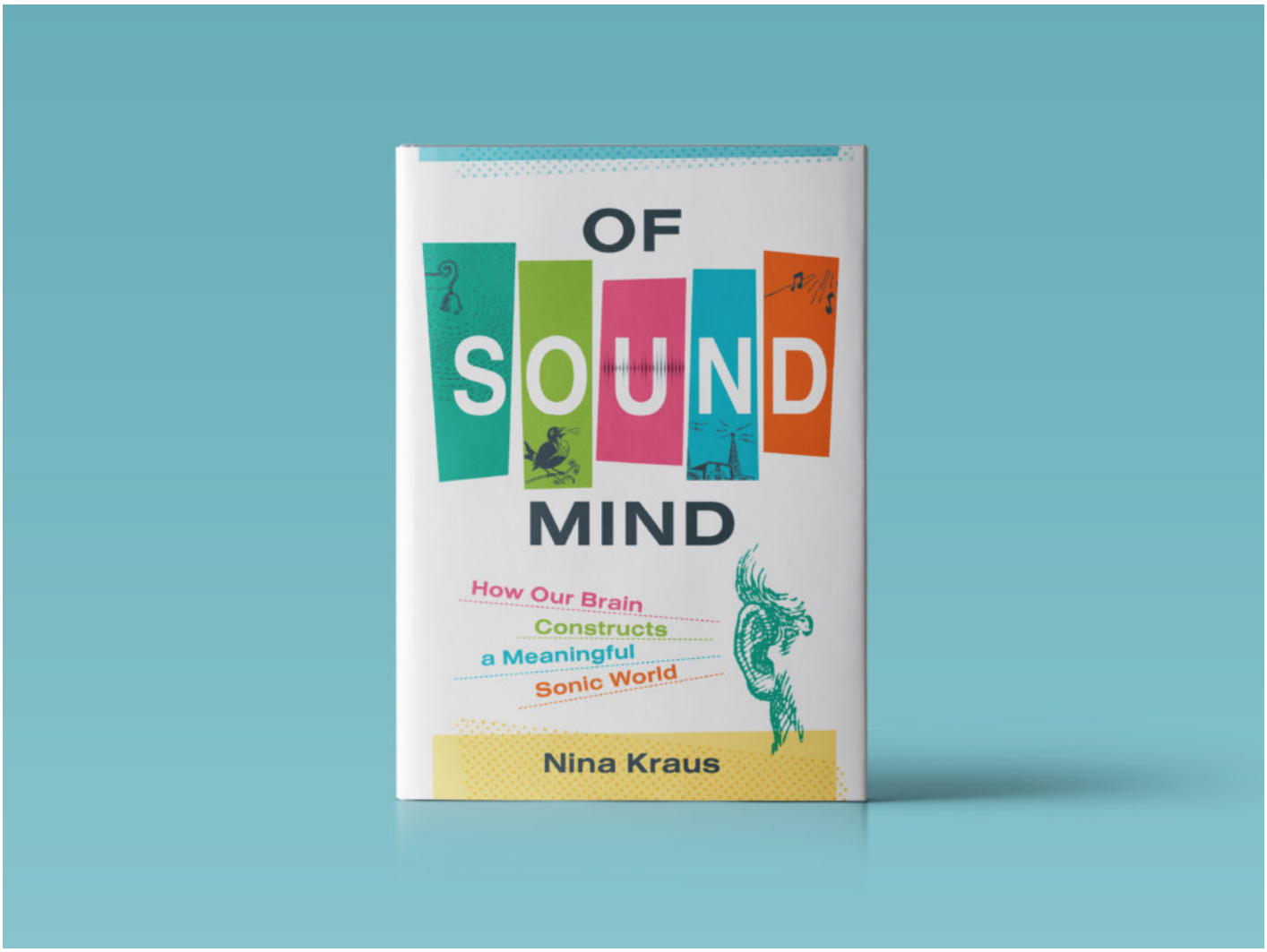
Book Review

By Amineh Koravand, PhD



Of Sound Mind. How Our Brain Constructs a Meaningful Sonic World

By Nina Kraus, Ph.D.

The MIT Press. Cambridge, Massachusetts | London, England. ISBN 9780262045865 (hardcover). This book has 368 pages, including the index.

Reviewed by: Amineh Koravand, PhD

Dr. Nina Kraus is the Hugh Knowles Professor at Northwestern University, exploring the neural encoding of speech and music.

Professor Kraus' *Of Sound Mind. How Our Brain Constructs a Meaningful Sonic World* is designed for anyone who desires an understanding of the long journey of sound, beginning with air vibrations outside of the ear to the neural pulses in the auditory brain. The book resembles a good story; Dr. Kraus effortlessly explains complex and advanced scientific concepts that can be easily understood by any reader and further develops these concepts with engaging art-based illustrations.

The book explains the nature of sound, the ways by which sound travels inside the auditory system, and the way we as human beings learn to make sense of sound based on our life-long experiences. It demonstrates that the act of "hearing" is multi-dimensional and actively involves sensing, moving, thinking, and feeling. Readers learn to appreciate that outstanding human achievement like speech and music result from deep connectivity between our sensory systems.

Dr. Kraus offers a clear and logical introduction to hearing mechanisms and the connection between "*signals outside the head*" and "*signals inside the head*." These mechanisms and connections are explored in detail, and Dr. Kraus expands on these notions to highlight both the positive and negative impacts that environmental sounds can have on our brains. For example, the partnership between music and language is introduced, exploring how an enriched sensory processing, such as might occur in bilinguals, can positively modify the way our brain processes auditory information. In contrast, the book presents the negative impact that noise, aging, and even brain trauma can have on how our auditory brain or "sound mind" processes sound. Having extensive (past) experiences with sound can positively shape the auditory brain. At the same time, a less favourable environment, such as having a language disorder, can have opposite or adverse effects.

Throughout the book, readers explore how the effects of our experiences on the "sound mind," whether rich or adverse, can be measured using highly sophisticated tests.

Brain electricity, in the form of positive or negative waves, can manifest differently in individuals based on their previous auditory experiences, and this is especially true of musicians, bilingual people, older adults, and individuals in clinical populations such as those with autism spectrum disorder, and concussion, etc. Moreover, Dr. Kraus identifies the importance of the Frequency Following Responses, or FFR, as one of the best neurophysiological measuring methods to record brain activities.

Of Sound Mind is strongly recommended to any reader, whether they possess extensive, little, or no previous background in this field. Every person who enjoys learning and expanding their knowledge of sound, hearing, listening, the adaptive auditory brain, how *"every sound mind is unique*", and how *"the sounds of our lives shape our brain"* will enjoy this book. It may also greatly benefit undergraduate and graduate students looking to gain insight into various neuro-audiology research possibilities. Dr. Kraus' narrative writing style and incorporation of personal experiences and anecdotes, including those from her childhood and travel, provide a refreshing perspective by exploring the scientific subject matter in a more approachable way. The information and knowledge presented in this book are highly valuable and will engage all readers.

TAGS: *Koravand, Kraus, Of Sound Mind*

ABOUT THE AUTHOR

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Amineh Koravand, PhD is an associate professor in the Audiology and Speech-Language Pathology program of the School of Rehabilitation Sciences, Faculty of Health Sciences at the University of Ottawa. Prof. Koravand's research deals with the relationship between the peripheral and central auditory systems in children. Her goal is to develop neurophysiological measures (biological neuromarkers) to assess the central auditory processing at subcortical and cortical level of children during early childhood, to prevent disorders while brain plasticity is still significant. Moreover, she is interested to investigate the effects of enriched auditory environment, such as musical training, singing lessons, bilingualism and/or multilingualism, on the auditory processing.