brainvolts

Auditory Neuroscience Laboratory 2023 Holiday Newsletter

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Dear Friends of Brainvolts,

2023 has been a year for reaching out and bringing in - the reciprocity, the back-and-forth embodied by sound itself.

Noise recurs as a theme. We want to do the right thing as we live our lives, but we often need help recognizing what to do. Science can guide us.

Our outreach this year focused on taking every opportunity to let people know about the under-recognized effect of moderate-level noise on our biological and mental health.

Pulling a brain response to sound out of the electrical noise that surrounds it is an ongoing challenge to Brainvolts' biological approach. We are developing noise reduction algorithms to enable more discoveries about the power of sound for brain health.

Hearing aids do a notoriously poor job processing music despite exceptional results for speech. Using our brain keyboard (measuring the brain's response to each note on a 3octave keyboard), we are working to understand this better.

Another challenge is understanding accented speech in our multi-lingual world. Brainvolts Professor Jennifer Krizman's ongoing project is beginning to reveal how brain mechanisms employed in understanding accented speech differ from other impediments to speech recognition such as the noise coming from an air conditioner.

Beyond scientific disciplines concerned with music, athletics, bilingualism... Brainvolts is expanding its reach to ecology, the humanities, and philosophy.

Nina

Trent (rock-of-the-lab) Nicol, Jennifer Krizman, Silvia Bonacina, Anoop B. J., Chaitra V., Joseph Luetkehans, Joshua Sevier, Blaise Malisch, Jenna Cunningham, Charlie Culbert

Students: Courtney Baker, Kaitlyn Burkamper, Anika Kaushikkar, Maggie Powers, Lane Herbert, Johanna Endres

Artist collaborator: Katie Shelly

Brainvolts 2023 by the numbers

7 publications

Journals include Exercise,
Sport, and Movement,
Journal of Concussion,
JAMA, AIDS

- 32 science talks including 21 keynotes
 - Around the world from Hong Kong to Stockholm, Lisbon, and Rome, New York City to Orlando, Florida
 - 17 podcasts & interviews
 - Including conversations with NPR, BBC, and Scientific American
 - promotions
 - Jen promoted to Research Associate Professor

Publications

Kraus, Colegrove, Otto-Meyer, Bonacina, Nicol, Cunningham, Krizman. Subconcussion revealed by sound processing in the brain. Exercise, Sport, and Movement.

Bonacina, Kraus, Krizman, Farley, Nicol, LaBella. Concussion disrupts brain synchrony: Evidence from Interactive Metronome on young children with persisting symptoms and prolonged recovery post-concussion. Journal of Concussion.

Bonacina, Niemczak, Lichtenstein, Magohe, Fellows, Nicol, Massawe, Buckey, Kraus. Pre-literacy assessment in children living with HIV in Tanzania: comparison to results from children living without HIV in Tanzania and the US. AIDS.

Ealer, Niemczak, Nicol, Magohe, Bonacina, Ziyin, Rieke, Leigh, Kobrina, Lichtenstein, Massawe, Kraus, Buckey. Auditory Neural Processing in Children Living with HIV Uncovers Underlying Central Nervous System Dysfunction: a Tanzanian Cohort Study. AIDS.

Niemczak, Ealer, Fellows, Magohe, Gui, Rieke, Nicol, Massawe, Kraus, Buckey. Peripheral auditory function in Tanzanian children living with HIV with clinically normal hearing. JAMA.

Kraus. Peter Dallos - A Renaissance Man. Hearing Journal.

Kraus. Guest essay: Leaf blowers - a small part of a larger movement Evanston should lead. Evanston Round Table.

Subconcussion Revealed by Sound Processing in the Brain



In 2023, we published "Subconcussion revealed by sound processing in the brain" in Exercise, Sport, and Movement. Injuries to the brain that are insufficient to cause the acute symptoms of a diagnosable concussion can cause subconcussion, which is thought to contribute to chronic traumatic encephalopathy (CTE), a progressive degeneration of the brain that leads to mood instability and problems with memory, focus, and thinking.

Our NIH-supported partnership with Northwestern Athletics has uncovered a biological measure of subconcussion in our study of more than 700 male and female athletes. This finding was specific to male contact-sport athletes, for whom more years spent playing a contact sport involving player-to-player or player-to-ground contact led to poorer biological pitch processing. This likely reflects reduced synchrony across multiple brain regions that should be highly coordinated.

Brainvolts is doing its best to foster awareness of the effects of concussion on hearing to the public and to the sports medicine community. That said, being physically active continues to be one of the best things we can do for our overall health. By discovering this proverbial canary in

the coalmine, we hope to increase player safety by identifying what is 'too much' for an individual player, without compromising the sports we love.

The Brain Keyboard

We've been recording brain responses to musical notes with the goal of assessing how factors such as sex, age, and hearing loss affect neural activity arising from music. On the strength of our biological approach, we can convert these musical brain responses back into sound. Our new Brain Keyboard program, designed by resident sound wizard Charlie Culbert, allows us to play, listen to, and compare our brains' unique responses to music. The program includes a tagging and filtering system for efficient exploration of our expanding library of brain responses, fine-tuned denoising algorithms to enhance the sound quality of the keyboard, and an intuitive interface that expands the potential for artistic and musical exploration and collaboration. This new listening-based strategy for assessing neural processing of sound provides us with a deeper understanding of how our brains represent musical details. Doctoral student Joe, postdoc Anoop, research audiologist Chaitra, AuD student Kaitlyn and consultant Joshua are investigating how hearing aids influence the way our brains encode speech and music.



College Athletic Trainers' Society Conference

In May, Jen, together with our Northwestern Medicine collaborator, Matt Nerrie, spoke about our concussion work at the College Athletic Trainers' Society Conference in Las Vegas. Their talk on the effects of concussion on the auditory system helped raise awareness about the under-recognized effects of concussion on the hearing brain and the ability to make sense of sound in noisy environments.



Frequency-Following Response (FFR) Workshop

Brainvolts will be hosting the next FFR Workshop. The FFR is a method to capture the brain's response to sound. Brainvolts helped pioneer this biological measure, which has since become widely used around the world. This event will bring together an international community of FFR researchers.

The conference will take place at Northwestern's downtown Chicago campus in the beautiful Wirtz building, located steps from Chicago's Magnificent Mile, and with terrific views of Lake Michigan. The workshop will be June 12-14, 2024. In addition to talks by our fabulous keynote speakers – Brainvolts alum Samira Anderson from University of Maryland, Fuh-Cherng Jeng from Ohio University, Rachel Reetzke from Johns Hopkins University, and Srivatsun Sadagopan from University of Pittsburgh – and two full days of science, our final day will include an architectural boat tour along the Chicago River. Registration and abstract submission will open on the workshop website in early 2024. Email Jen (j-krizman@northwestern.edu) if you'd like to join the workshop's mailing list.



Tom Petty and Cade Museum



Eight years ago, Nina spoke in Gainesville about the effects of music education on the nervous system. This year she was invited back to speak at an event celebrating the life of rocker Tom Petty, who died in 2017. The event was catalyzed by Tom's daughter Adria, who donated memorabilia to the museum. The event included remarks from State Senator Keith Perry who signed a bill supporting music education in the state of Florida,

partially on the strength of what he had heard

eight years ago. The event was held at the Cade Museum for Creativity and Invention, which has thoughtful hands-on displays, currently including an exhibit called "Playing With Sound" featuring sound, waves, and oscillation. Nina's favorite was a fun demonstration that there is no sound in a vacuum.





The Cade Museum was founded by Phoebe Miles, daughter of Dr James Cade, the inventor of Gatorade. It was touching to be at an event featuring two daughters honoring their fathers.

Concussion Disrupts Rhythm Skills in Children

Our discovery that concussion disrupts rhythmic skills – the ability to synchronize and interact with a beat – was published this year in the *Journal of Concussion*. This is the latest finding to emerge from our collaboration with the Lurie Children's Hospital Institute for Sports Medicine led by Dr. Cynthia LaBella. Data collection and recruitment continues to expand our longitudinal dataset and address new questions about the auditory and cognitive mechanisms supporting speech in noise recognition following a concussion and how these mechanisms change once the child has recovered. Silvia continues to lead data analysis and the publications of our discoveries achieved within this collaboration. We're delighted to welcome Blaise Malisch to the team who has taken over data collection from Jacob Farley, who is now in medical school.

In July, Nina and Jen shared progress with the National Operating Committee on Standards for Athletic Equipment board which partially supports this work. They had the opportunity to discuss current findings and future goals.

HIV and Language Development



Our collaboration with the Space Medicine Innovations Lab at Dartmouth, headed by astronaut Jay Buckey, and the Muhimbili University of Health and Allied Sciences in Dar Es Salaam Tanzania led to two publications. We found that Tanzanian children living with HIV struggle at Rapid Automatized Naming tasks, the simplest preliteracy assessment a child can perform that predicts future reading skills. In addition, these children revealed less robust, more variable, and less accurate neural encoding of speech sounds when compared with children without HIV. Several environmental influences affecting lan-

guage outcomes were taken into account to disentangle the effect of HIV infection from other potential confounding factors. Ongoing analyses, led by Silvia, are exploring the relationship be-

tween HIV status and literacy using an internationally validated measure (EGRA) to assess progress toward learning to read.



Accented Speech



As we wrap up the third year of our accented-speech project, headed by Jen, we have begun to make some exciting discoveries about the different skills we rely on to understand accented speech compared to the

challenge of listening to speech in noise. We are continuing to

recruit participants (ages 30-65 years) and are looking for monolingual English speakers with hearing loss (or suspected hearing loss) and native Spanish and native Mandarin speakers who also speak English. Please email us at brainvolts@gmail.com if you would like to participate in this paid (\$100) research study.





Stop that Noise - It's Hurting my Brain

Greener Glenview has been raising awareness of the ecological effects of disruptive lawn care practices. Nina spoke to this group at a local library about the damaging effect of moderate-level noise on our health. The Rotary Club asked for a similar talk. In 2023, gas-powered leaf blowers were banned in our community of Evanston. <u>Read more about it</u>. A feature of noise, unlike other pollutants, is when you turn it off, it's GONE.

International Outreach

In May, Nina delivered a few lectures in Italian on "Music and The Brain: The Biological Foundation of Sound Pro-

cessing" within a conference held in Rome in collaboration with University Roma Tre and the Minister of Education and Merit. We are awaiting the forthcoming translation of *Of Sound Mind* in Italian, *La Mente Sonora*, with great anticipation.

Of Sound Mind has already been translated and published in Chinese and Russian. Japanese and

Korean translations of Of Sound Mind are in progress.

Nina spoke to audiences in Hong Kong, Portugal, Italy, Brazil, and at a virtually presented Global Conference with listeners joining from across Europe and the States.



Nina will be speaking at the Brain Listening Enhancement Webinar hosted by Taiwan's National Women's League Hearing Health Foundation, a non-profit organization dedicated to helping

people with hearing loss on April 27, 2024. Traditional Chinese subtitles will be added to the pre-recorded lectures.

Music and Hearing Loss

Hearing aids do a good job helping us amplify speech, but music does not sound especially good through a hearing aid. In fact, people with a hearing loss often choose to listen to music without their hearing aids. We are trying to understand this better by measuring the brain's response to music in the same person with and without a hearing aid. We can see and hear how a hearing aid creates noise and distortion. New technologies to improve music through hearing aids, while also protecting the ear from damaging levels of sound, are emerging; we're looking into them with our collaborators at Widex and Sensaphonics.



Music - Healing and the Humanities

Brainvolts has always drawn inspiration from the arts, literature, and humanities. Nina spoke at the **Philosophical Society of Texas** about the biological effects of music for healing and strength. Other speakers included Rosanne Cash and the presidents of the Ford and Mellon Foundations. *Abraham Verghese* - physician and author of some of Nina's favorite works of fiction - spoke of the value of touch and *talking* in patient care. Talk is *sound*! And it is a crucial part of healthcare. This refocusing on what a patient's story can tell is part of a larger narrative medicine effort founded by our colleague Rita Charon at Columbia University.

Brainvolts partnered with the **Jerusalem Youth Chorus**, an ensemble comprising Jews, Christians, and Muslims from East and West Jerusalem who sing together. Unfortunately, the performance was scheduled to occur a few days after the Hamas attack cancelled all flights from the region. We are hoping to reschedule in the Spring of 2024, together with Chicago's Uniting Voices; we will keep our Friends of Brainvolts informed.

The Good Athlete Podcast

How can athleticism benefit our lives in sound, and how do concussions disrupt how we process the sounds around us? This past September, Jim Davis and Joe Lim of the Good Athlete Project sat down for a conversation with Nina where they discussed these questions including the future of sound in concussion treatment and rehabilitation and, more generally, the role of sound in promoting and disrupting health.



The Good Athlete Project uses lessons learned from sports to pro-

mote education through athletics and support athletes, coaches, and learners around the globe. Listen to their conversation with Nina <u>here</u>.

Celebrating Heroes Past and Present

Arne Starr

This year we lost Arne Starr, one of the first people to use the physiologic responses we measure at Brainvolts and put them to clinical use in the treatment and understanding of the neurological bases of listening disorders. He brought his insights as a physician, scientist, and artist (including the Page 1 image). Nina wrote a short piece in the Hearing Journal honoring Arne a couple years ago.



Peter Dallos

Peter Dallos, arguably our foremost living auditory neurosci-

earlier this year.



Hugh Knowles

I am encouraged and inspired to have the title, 'Hugh Knowles Professor.' Who is Hugh Knowles? Hugh S. Knowles was an engineer who held 50 patents and pioneered the miniaturization of microphones—an advance that jumpstarted the hearing aid industry in the nineteen-fifties. His microphones also went to the moon during the Apollo missions and, less wholesomely, were used in the Watergate White House bugging. His love of sound was exemplified by his fluency in several languages and his love of the violin. The Knowles Hearing Center, formed in 1988, has supported Brainvolts' 'high-



risk, high impact' projects over the years through its mission to advance prevention, diagnosis, and treatment of hearing disorders.



Peter Narins

Every few years, the Knowles Hearing Center honors a deserving individual with its Distinguished Achievement Prize. In 2023, Peter Narins was so honored. Sound, at its core, is vibration; yet little attention has been devoted to the world of vibrations that bypass the ear drum. Peter found that blind moles detect the movement of dune grass by dipping their head and shoulders into the sand. Another notable discovery, which fits this year's newsletter's theme of noise, is that a frog species in China produces ultrasonic com-

tessential Renaissance man. His autobiography "I Was Here: Life, Science and Art in Turbulent Times" paints a picture of his childhood fleeing Nazis from his home country of Hungary and his journey to the basement lab here at Northwestern where he made discoveries about the function of cochlear hair cells that are foundational to the hearing sciences. His metal sculptures abstractly commemorate his memories of war and other significant topics. Nina also wrote a piece about Peter in the Hearing Journal

munication calls to avoid competing with the loud waterfall in its environment.

Connecting Fine People



Homecoming



We celebrated the return of several lab alumnae as Jane (Hornickel) Kazantsev and Erika Skoe visited the lab on separate occasions. Since graduating from the lab, Jane has been Senior Project Manager for a company that provides educational data for U.S. schools and Erika has been running her own lab at University of Connecticut. It was great to reconnect with them both!

Serendipity brought Bob Conway back into our lives. Bob built, fixed, and designed custom carpentry and electrical circuitry for everyone in the building where Brainvolts is lodged until he retired a few years ago. Now Nina sees him once a month at a community open mic where he regales the group with his songs and edgy lyrical inventions.





Silvia's little percussionists, Pietro and Filippo, enjoyed a visit to Mommy's work where they happily banged on the drums, as she told them stories about her testing days on the Biotots project. Who knew a workplace visit could be such a blend of creativity and fun?

Family Music

When Nina's grandbaby Otto was born this year, he had some difficulty breathing. New dad Mikey sang to him, and the effects were immediate. He could feel his baby relax and the monitors in the neonatal intensive care unit told the story in numbers. Babies in intensive care have long been studied, as they are hooked up to sen-





sors scientists can utilize. It was beautiful to see the well-documented effect of singing on physical health firsthand.

Nina's other grandson Juli has made many appearances as an ambassador for music in her talks in 2023.

Musicians and cochlear-implant users, Jon Taylor and Richard Reed, got together at one of Rich's gigs last month.



Meanwhile over in Paris, Charlie collaborated with Nina's son Russell on a video artwork that centered on recording the unique sounds of wind moving through trees.

Disney Adventures

Over the first weekend of January, Jen kicked off 2023 by running the Dopey Challenge at Walt Disney World in Florida. This event involves running a 5K on Thursday, a 10K on Friday, a half marathon on Saturday, and a full marathon on Sunday. She got to meet many characters along each course, including Daisy and her personal favorite — Goofy! A month later, Jen was back in

Orlando, along with Nina, Silvia, and Jenna, for the Association for Research in Otolaryngology MidWinter Meeting and they took a break from science to spend a day at Disney. They rode everything from the Tomorrowland Transit Authority People Mover to the Seven Dwarfs Mine Train and felt like celebrities as they had their picture taken by every Disney photographer in the park.

Northwestern University provides Brainvolts with its lab space and provides Nina's salary as a tenured professor. Absolutely everything else - our equipment, computers, supplies, and most importantly, our people - must be funded by grants and philanthropic gifts. Please consider supporting Brainvolts this year. Thank you.

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