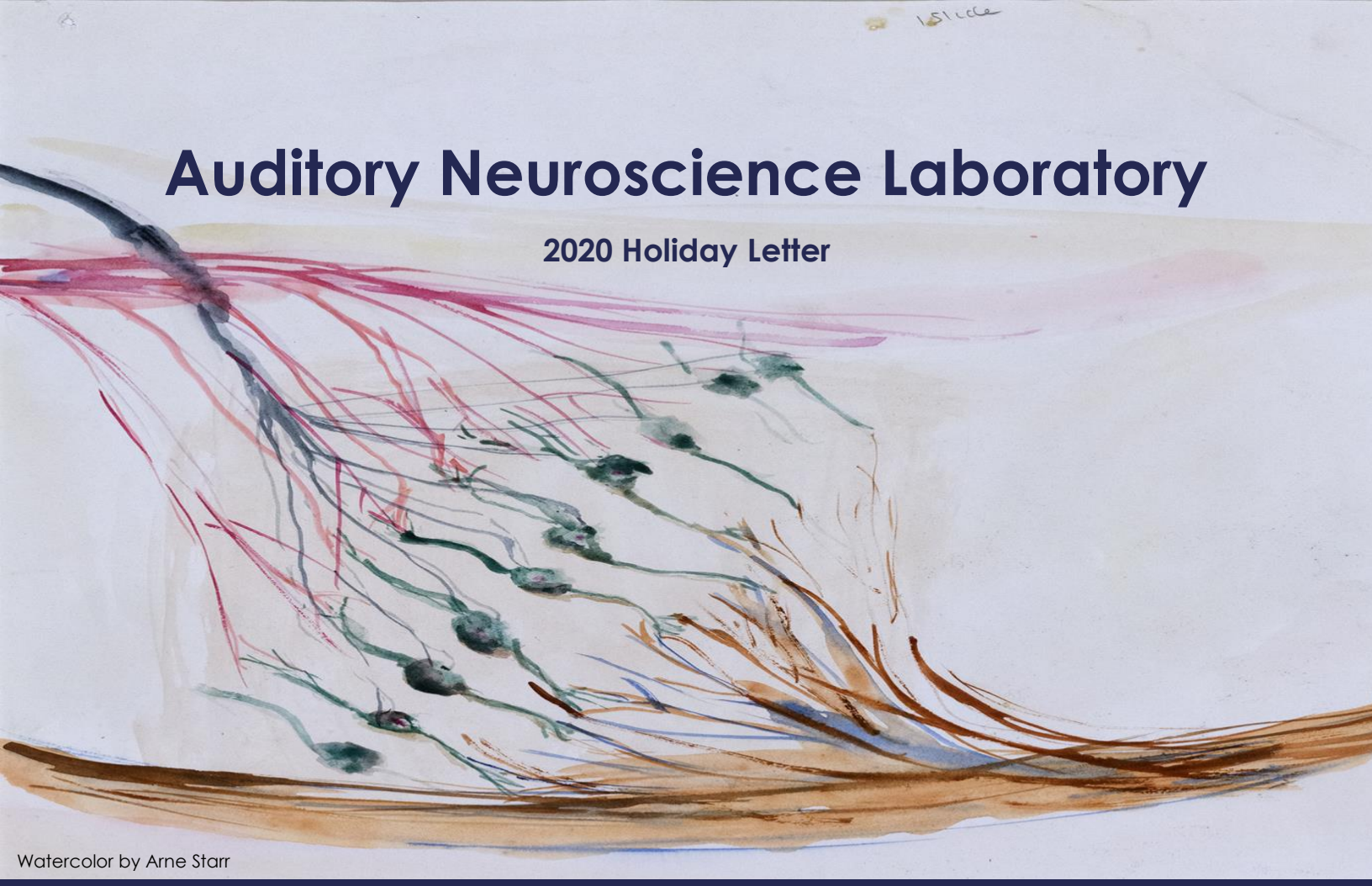
Auditory Neuroscience Laboratory

2020 Holiday Letter



Watercolor by Arne Starr

Nina Kraus, Ph.D.

Hugh Knowles Professor

www.brainvolts.northwestern.edu

Dan Abrams, Karen Banai, Bharath Chandrasekaran, Erika Skoe, Cindy King, Gabriella Musacchia

Jen Krizman, Travis White-Schwoch, Emily Spitzer, Samira Anderson, Nina Kraus, Jane Kazantsev, little Nina

A special year for Brainvolts and the world

Dear Friends,

This year is one we will never forget. At this time of reflection, we're grateful for our colleagues, collaborators, and advocates as we continue our work to understand the biological basis of sound processing in the brain and how it affects our lives. Thank you.

We are grateful we have been able to safely and responsibly continue our NIH-funded partnership with Northwestern Athletics to study concussions, sound processing, and brain health. And, we have re-opened our project in partnership with Sports Medicine at Lurie Children's Hospital to study concussion in adolescents.

During the lockdown, we were able to publish several findings. We've continued our emphasis on connecting with community audiences beyond science's conventional reach, including educators, policymakers, healthcare providers, and the general public.

Above all else, this has been a year of introspection. Grave and unusual times can create reasons for thanks. I am thankful because:

Packing less into our lives and slowing down can make us more present in the world

Reading more science and literature can make us better scientists and recover a sense of common humanity

We have more time to think

There is less noise

Plants and animals are healthier. Birds don't have to sing as loud, are heard at greater distances, and have energy to sing fancier songs

We are being reminded to honor our individual, local communities at a time when globalization reduces us to the same bunch of people, drinking the same coffee, listening to the same news

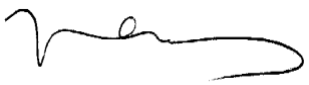
That said, Zoom helps keep us in touch

We can make music - the piano is on the way from the back porch to the kitchen

..of my quarantine roommate and his sense of humor

of YOU

With deep gratitude for your ongoing engagement with our work,



Nina,

Trent Nicol, Jennifer Krizman, Travis White-Schwoch, Silvia Bonacina, Rembrandt Otto-Meyer

Kayla Byrne, Yohan Eskrick-Parkinson, Omkar Prabhavalkar, Erik Mueller, Braeden Heald, Jacob Wild

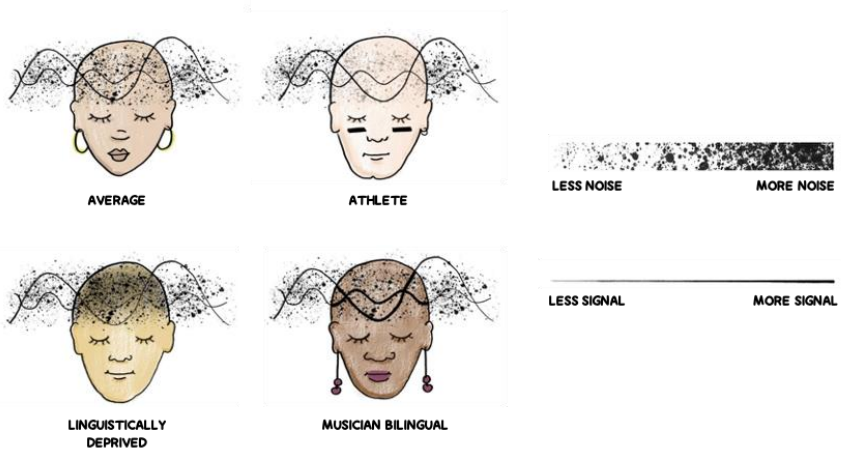
2020 by the numbers

- **16** publications
- **12** scientific talks and posters
- **5** podcasts sharing our science with the general public
- on Renée Fleming's Music and the Mind LIVE
- **7** students graduated, 1 with an honors thesis
- **13** students pursuing original research
- **9** news features
- **1** book under publication

DONATE TO SUPPORT OUR WORK

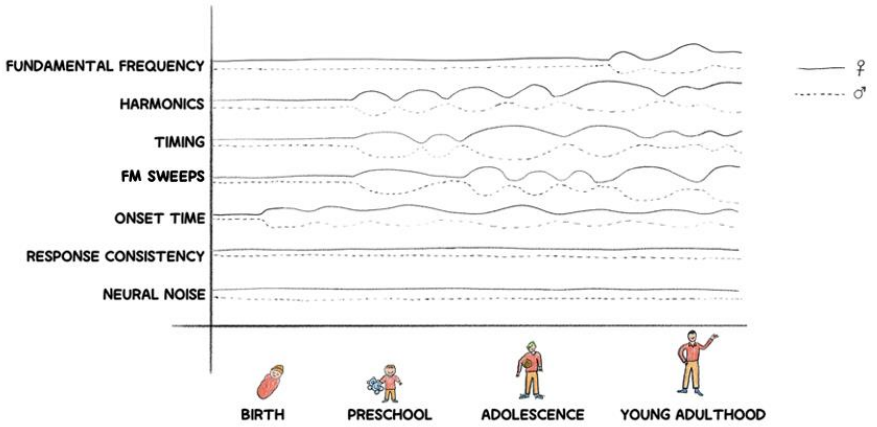
Research Highlights

How to achieve a clear sound signal



To process sound, we want to have the best brain signal possible. Signal clarity comes from how well the brain processes sound ingredients like pitch, timing, and timbre. Clarity can be obscured by neural noise, like the static of a poorly tuned radio. Brainvolts has identified brain differences in signal clarity among certain groups. Linguistic deprivation, common in children raised in poverty, tends to lead to both a reduced signal and increased brain noise. Musicians' and bilinguals' brains tend to "turn up the volume" on the signal. And, elite collegiate athletes clarify the incoming sound not by "turning up" the signal but by "turning down" the noise. We are fascinated to discover the different tuning strategies our brains use to achieve the goal of a clear auditory signal. Krizman, Lindley, Bonacina, Colegrove, White-Schwoch & Kraus (2020) Sports Health; Krizman, Skoe, Marian, & Kraus (2014) Brain and Language; Skoe, Krizman & Kraus (2013) Journal of Neuroscience; Musacchia, Sams, Skoe, & Kraus (2007) PNAS.

Vive la différence!



Males and female brains process sounds differently. Do sound processing differences exist at birth or do they emerge over time? It depends. The processing of some sound ingredients already differs at birth. Sex differences emerge during adolescence for other sound ingredients, possibly due to hormonal influences. There are no sex differences at any age for other aspects of sound processing. We speculate that processing differences may partially account for boys being more vulnerable to language disorders than girls. The very components of speech that are processed less distinctly in males are closely tied to language ability. Krizman, Bonacina & Kraus (2020) Hearing Research; Krizman, Bonacina & Kraus (2019) Hearing Research.

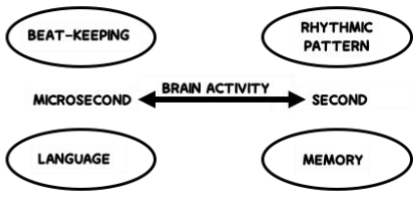
The argument for music education

Making music changes sound processing in the brain. Frequently asked about our stance on the topic of music education, we decided to write an opinion piece in *American Scientist* that makes three arguments for music education. The *indirect* argument: music training sets up children's brains to make them better learners through language. The *incentive* argument: a child who plays music in school is a child who does better on educational outcomes. The *intangible* argument: music making leads to gains in hard-to-measure areas like confidence, discipline, satisfaction, and social engagement. Kraus & White-Schwoch (2020) American Scientist.

Another chapter in the rhythm story

Silvia Bonacina

Brainvolts continues to investigate the link connecting rhythm ability, cognitive skills, and the hearing brain. Timescales are a key to understanding this three-way link. Rhythms unfold on different time scales; think of how you can clap out the rhythm of the notes of a song while simultaneously tapping your foot to the beat. Likewise, the hearing brain simultaneously organizes sound into shorter or longer streams of processing from microseconds to seconds. We are discovering that the ability to produce a rhythmic pattern aligns with a longer timescale of auditory-brain processing which, in turn, aligns with better performance on certain cognitive skills such as memory. On the other hand, precise beat-keeping aligns with short-timescale brain processing and language skills. Our most recent publication in our rhythm series reveals rhythm's role as a precursor to reading in children between the ages of five and eight years. Bonacina, Krizman, White-Schwoch, Nicol & Kraus (2020) Cognitive Processing.



Grant to study how we understand accents

Jennifer Krizman

Individuals, businesses, and societies that are far apart can now be connected. With these connections, more people are communicating in non-native languages. There are nearly twice as many non-native English speakers as native speakers. Understanding accents is something that many of us must do every day and is something that some struggle to do well. Currently, it is not known what makes someone good at understanding accents. Lab member Jennifer Krizman was awarded the prestigious Birtman Grant from the American Hearing Research Foundation to understand why some people excel and others struggle to understand accents.

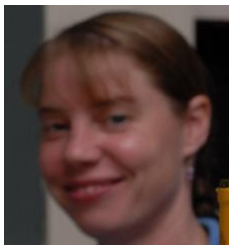
Visit us online!

Our website, www.brainvolts.northwestern.edu, remains a point of pride. Please visit us to learn more about our ongoing research, download publications, and find out about our next talk. Be sure to check out the *video tour* on the homepage so you can find what you're looking for.

… and find us on social media!

HIV and the Hearing Brain: A Dartmouth/Brainvolts collaboration in Tanzania and China

HIV patients, even if they are quite healthy, are at increased risk for neurologic problems, such as difficulty concentrating or remembering. With Jay Buckey and his colleagues at Dartmouth School of Medicine, we are exploring whether the auditory system might offer early clues of neurological problems in this population. We showed that HIV patients have weaker neural responses to the subtle features of speech sounds that distinguish phonemes -- for example, was it a "b" or a "g"? Sound processing in the brain may offer an objective strategy to track brain function in HIV patients. White-Schwoch, Magohe, Fellows, Rieke, Vilarello, Nicol, Massawe, Moshi, Kraus, Buckey (2020) Clinical Neurophysiology.



Abigail Fellows

Jay Buckey

Insights for Hearing in Noise

Long term outcomes. Auditory Neuropathy is a vexing disorder caused by abnormalities in neural synchrony leading to inordinate difficulty hearing speech in noise. Along with Samira Anderson, a Brainvolts alum, we published one of the first long-term follow-ups, tracking an individual with neuropathy for nearly 30 years. We showed that hearing was relatively stable over this time period. The beginnings of a high-frequency hearing loss were evident, however, which may reflect early presbycusis or the consequence of insufficient protection from loud sounds due to the neuropathy. White-Schwoch, Anderson, Kraus (2020) JAMA-Otolaryngology.

Timing expert of the brain is subcortical. The hearing brain is vast and involves how we think, feel, sense, and move. While this vast network is affected by auditory neuropathy, our observations suggest that subcortical dysfunction is predominantly responsible for the poor neural synchrony which is the hallmark of auditory neuropathy. White-Schwoch, Krizman, Nicol, Kraus (2020) Journal of Neurophysiology.

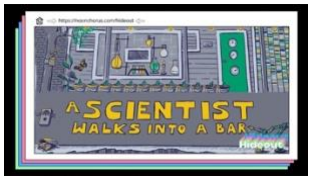
In the News

Increasing awareness of sound and athlete health

Rembrandt Otto-Meyer

We hope this New York Times coverage increased awareness for the role of sound in athlete health - as a biological marker for concussion and index of brain health. Our lab continues to study concussions, with Rembrandt Otto-Meyer working with student-athletes.

***Interview* by Field Museum writer Kate Golembiewski**



In Memoriam

This November we lost a dear friend. Dr. Steve Zecker has been part of the Brainvolts family for all of our 30 years. He was a thoughtful and inspiring collaborator and a mentor to our graduate students. He was also a smiling face and a ray of sunshine for many people on many dark days. We miss him dearly. He and his family are in our thoughts and prayers.