RESEARCH Blog

"Of Sound Mind": a Discussion of the Hearing Brain

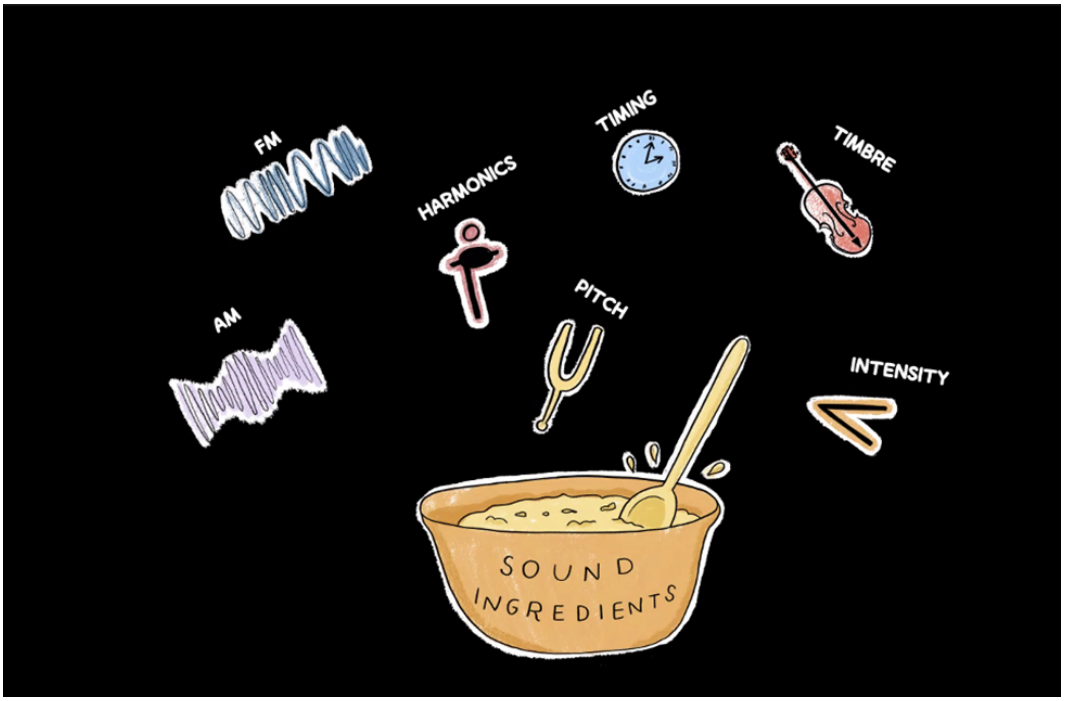
BY SOPHIE COX / ON OCTOBER 18, 2022

"To me [this image] captures the wonder, the awe, the beauty of sound and the brain that tries to make sense of it," said professor Nina Kraus, Northwestern University researcher and author of "Of Sound Mind: How Our Brain Constructs a Meaningful Sonic World."

Stop. What do you hear?

We might not always think about the sounds around us, but our brains are always listening, said Northwestern University professor Nina Kraus.

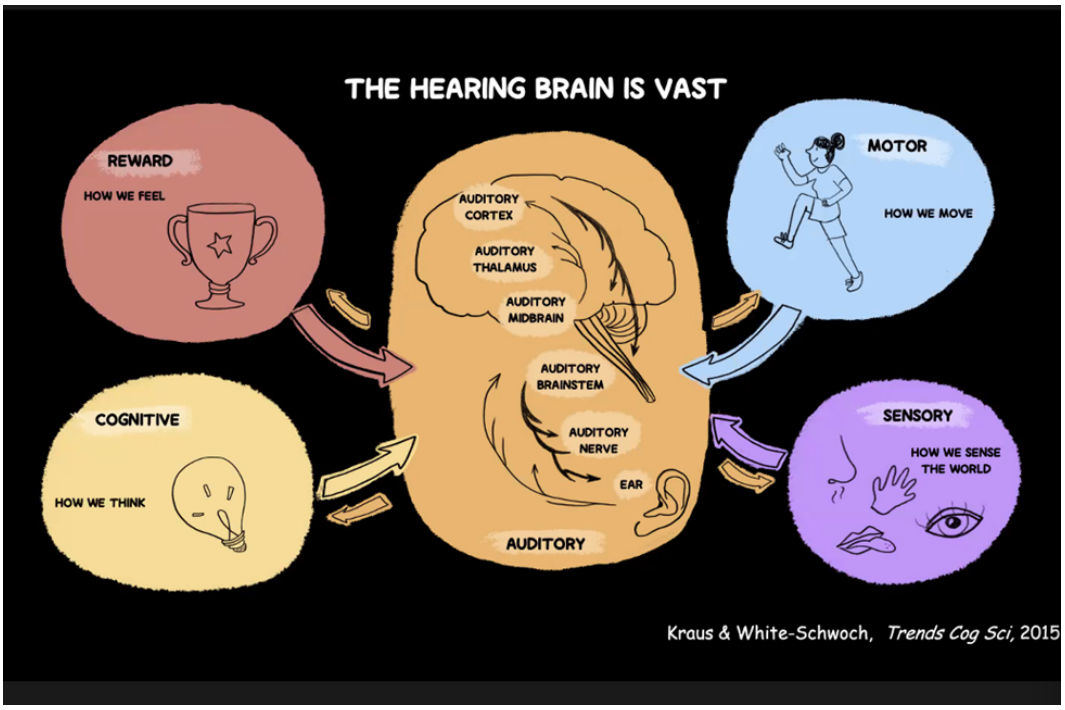
Kraus, auditory researcher and author of "Of Sound Mind: How Our Brain Constructs a Meaningful Sonic World," spoke via Zoom to a Duke audience in October. She has published more than four hundred papers on the auditory system in humans and other animals and how it's affected by conditions like autism, aging, and concussion. She discussed some of her findings and how "the sound mind" affects us in our day-to-day lives.



One of the slides from Kraus's presentation. We can think of sound as having many "ingredients."

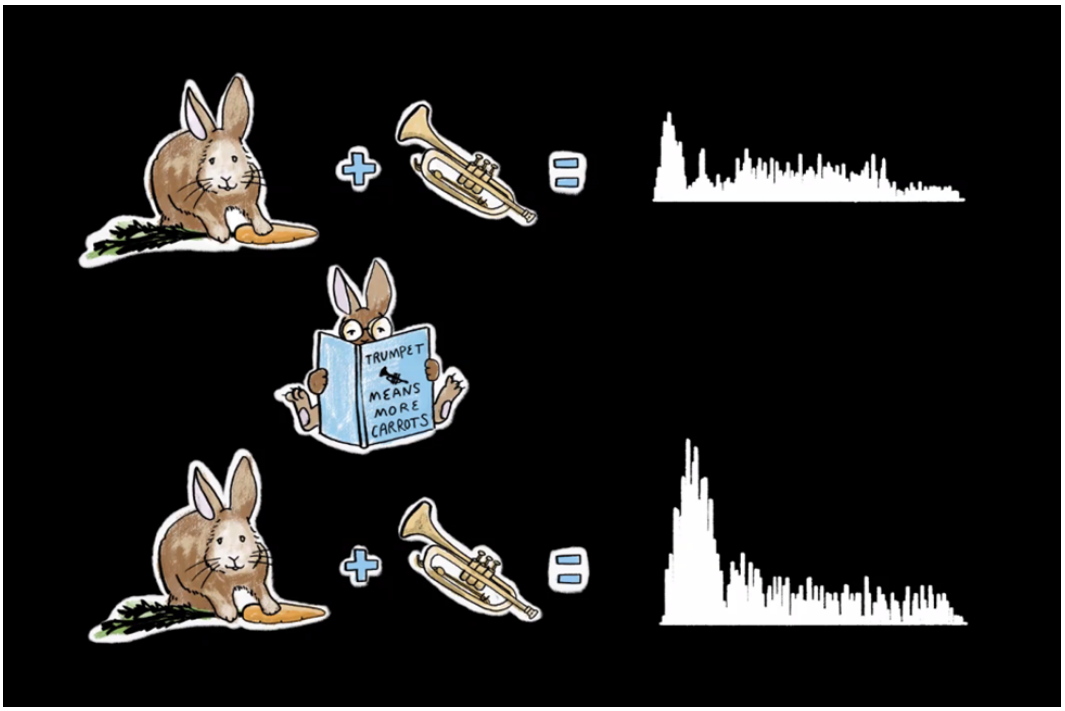
"I think of the sound mind as encompassing how we think, how we move, how we sense, and how we feel," Kraus said. We live in a "visually dominated world," but for hearing people, sound

plays an important role in language, music, rhythm, and how we perceive the world.



One of the slides from Kraus's presentation. The human auditory system involves not just the ears but also several regions of the brain. The "hearing brain" engages movement, cognition, and emotions along with interpreting direct sensory input from all senses.

Kraus discussed the auditory system and how much of what we think of as hearing takes place in the brain. We can think of sound as signals outside the head and electricity as signals inside the head (neural processing). When those two merge, learning occurs, and we can make sound-to-meaning connections.

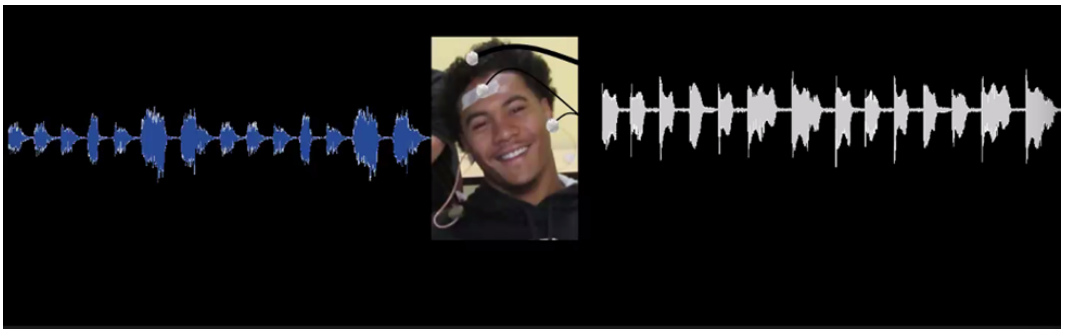


Another slide from Kraus's presentation. In an experiment, teaching rabbits to associate a sound with meaning (in this case, more carrots) changed patterns of neuron firing in the auditory cortex, even in individual neurons. "Same sound, same neuron, and yet the neuron responded differently… because now there's a sound-to-meaning connection," Kraus said.

Despite how sensitive our neurons and brains are to sound, things can get lost in translation. Kraus studies how conditions like concussions and hearing loss can adversely affect auditory processing. Even among healthy brains, we all hear and interpret sounds differently. People have unique "sonic fingerprints" that are relatively stable over time within an individual brain but differ between people. These patterns of sound recognition are apparent when scientists record brain responses to music or other sounds.

"One of the biological measures that we have been using in human and in animal models," Kraus said, is FFR (frequency following response) to speech. FFR-to-speech can be used to analyze an individual's auditory processing system. It also allows scientists to convert brain responses back into sound

waves. “The sound wave and the brainwave resemble each other, which is just remarkable.”



One of Kraus’s slides. Technology called frequency following response (FFR) can be used to convert brain waves back into original sound (like a song).

This technology helps reveal just how attuned our brains are to sound. When we hear a song, our brain waves respond to everything from the beat to the melody. Those brain waves are so specific to that particular song or sound that when scientists convert the brain waves back into sound, the resulting music is still recognizable.

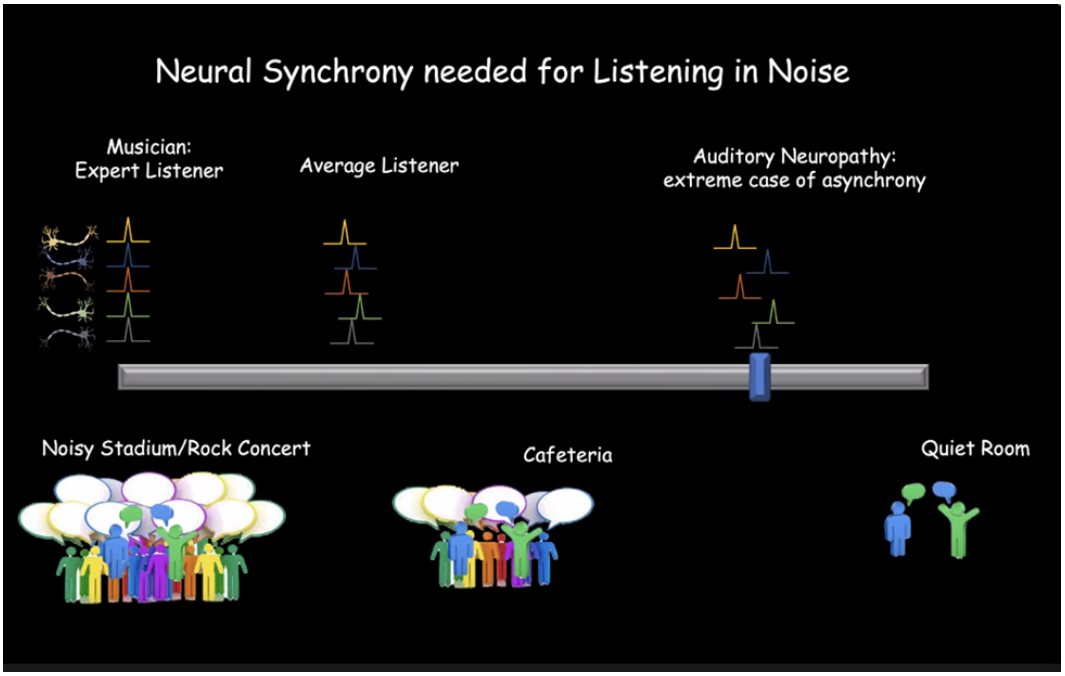
When scientists try this on people who have experienced a concussion, for instance, the recreated music can sound different or garbled. Experiments that compare healthy and unhealthy brains can help reveal what concussions do to the brain and our ability to interpret sound. But not everything that affects auditory processing is bad.

Musical training is famously good for the brain, and experiments done by Kraus and other scientists support that conclusion. “The musician signature—something that develops over time—” has specific patterns, and it can enhance certain components of auditory processing over time. Making music might also improve language skills. “The music and language signatures really overlap,” Kraus said, “which is why making

music is so good for strengthening our sound mind." Kids who can synchronize to a beat, for example, tend to have better language skills according to some of the experiments Kraus has been involved with.

Musicians are also, on average, better at processing sound in noisy environments. Musicians respond well in quiet and noisy environments. Non-musicians, on the other hand, respond well in quiet environments, but that response "really breaks down" in noisy ones.

Interestingly, "Making music has a lifelong impact. Making music in early life can strengthen the sound mind when one is seventy or eighty years old."



A slide from Kraus's presentation. Musicians tend to be better at processing sounds in noisy environments.

Exercise, too, can improve auditory processing. "Elite division 1 athletes have especially quiet brains" with less neural noise.

That's a good thing; it lets incoming information "stand out more."

In experiments, healthy athletes also have a more consistent response over time across multiple trials, especially women.

These benefits aren't limited to elite athletes, though. According to Kraus, "Being fit and flexible is one of the best things you can do for your brain," Kraus said.

Kraus and her team have a regularly updated website about their work. For those who want to learn more about their research, they have a short video about their research approach and an online lecture Kraus gave with the Kennedy Center.

Nina Kraus with a piano. “Science is a deeply human endeavor,” she said, “and I think we often forget that. It’s made by people.”
Photo courtesy of Kraus and colleague Jenna Cunningham, Ph.D.

Post by Sophie Cox, Class of 2025

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