A Consumer-friendly Recap of the HLAA 2018 Research Symposium: Listening in Noise

Webinar

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Augustana University
Sioux Falls, SD
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Listening in Noise

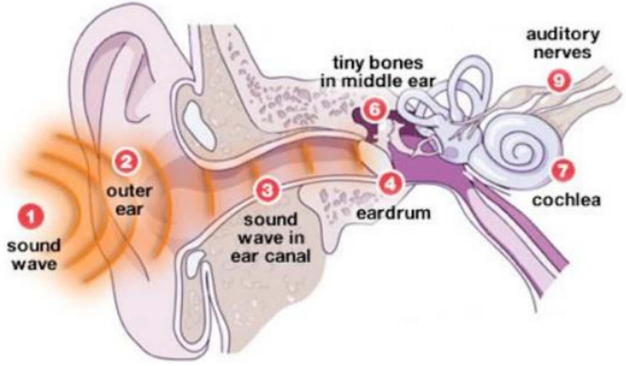
Cocktail Party Problem

One of most common problems

Hearing loss

Normal hearing

Hidden hearing loss



Cocktail Noise/Party Problem

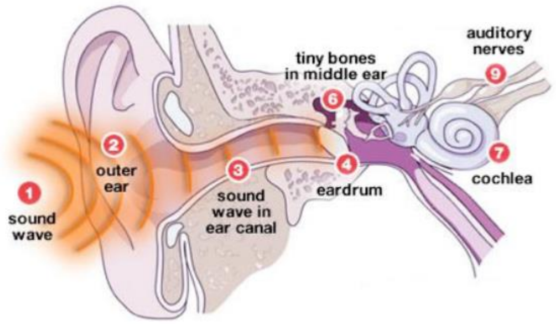
Listening in noisy situations is extremely difficult if not impossible for many

Parties filled with voices, background music, and other sounds is challenging for all

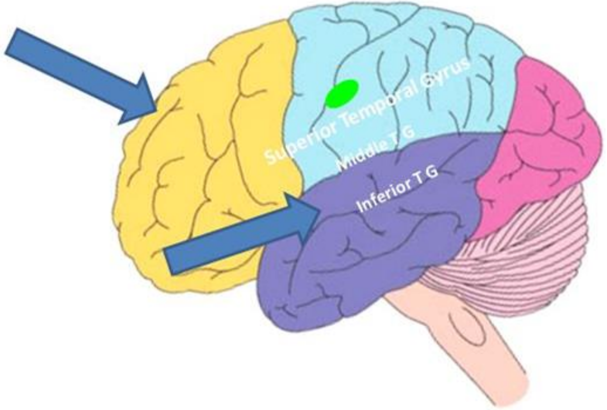
For most, the brain’s natural ability to filter out background noise makes it relatively easy to focus only on what we want to hear

Processing Speech in Noise

We have good understanding of how the hearing mechanism processes sound



Incomplete understanding of how the human brain processes sound including speech and conversations



Research Symposium Presenters

Andrew J. Oxenham, PhD, University of Minnesota

Director, Auditory Perception and Cognition Laboratory

Evelyn Davies-Venn, PhD, University of Minnesota

Director of the Sensory Aids and Perception Lab,

Norman Lee, PhD, St. Olaf College

Postdoctoral fellow in the Department of Ecology, Evolution, and Behavior, University of Minnesota - now Professor - St. Olaf College

DeLiang Wang, PhD, Ohio State University

OSU Perception and Neurodynamics Lab

Nima Mesgarani, PhD, Columbia University

Andrew J. Oxenham, PhD

Peripheral hearing mechanism function

Encoding sound / acoustic information for the brain to interpret

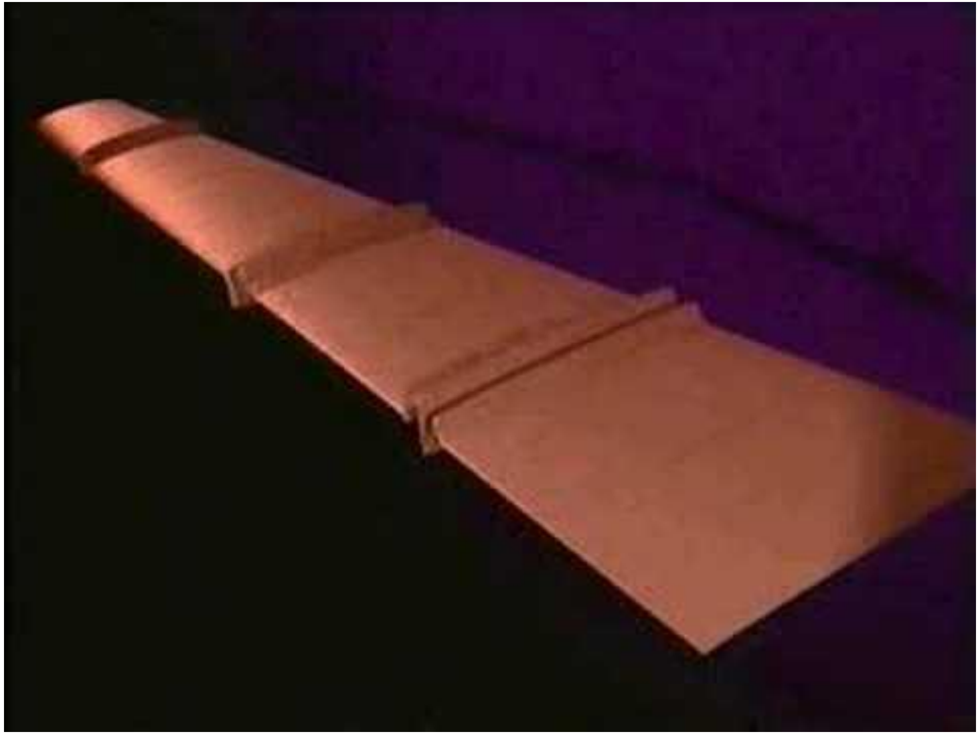
Hearing loss resulting in cocktail noise problem

- Cochlear hearing loss (inner ear)
- Hidden hearing loss

Andrew J. Oxenham, PhD

Basilar membrane in inner ear (the cochlea)

Much like piano keyboard tuned to specific sounds, it is part of process of the ear to code information for the brain to interpret



Andrew J. Oxenham, PhD

Atop the basilar membrane are inner and outer hair cells

Outer hair cells amplify soft sounds

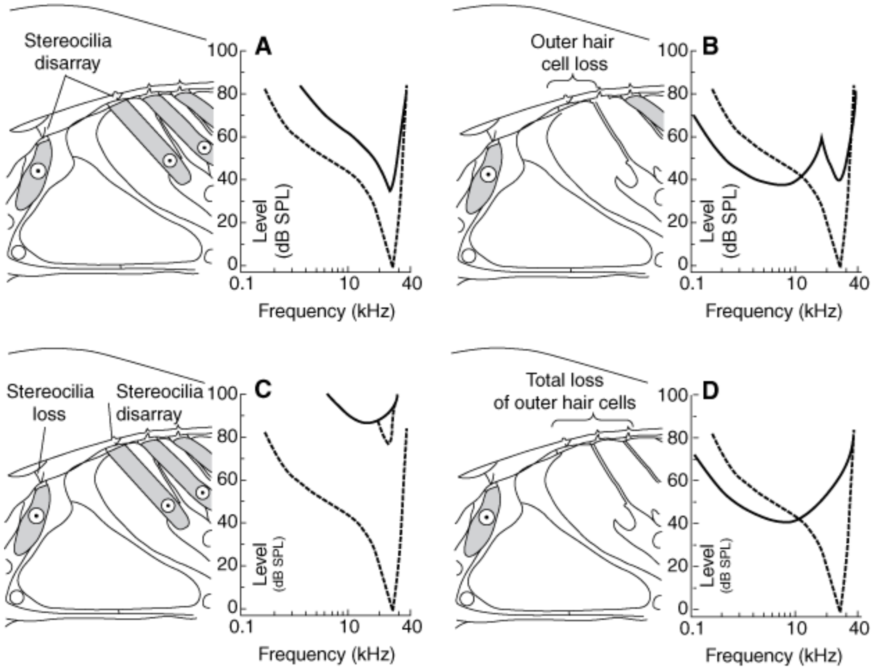
Inner hair cells transmit electrical code to brain

Andrew J. Oxenham, PhD

Fine tuning of normal hair cell in cochlea

Damaged hair cells lose fine tuning ability

Loss of hair cells also alter coding of sound to transmit to the brain



Source: Lalwani AK: *Current Diagnosis & Treatment in Otolaryngology—Head & Neck Surgery*, 2nd Edition: http://www.accessmedicine.com

Andrew J. Oxenham, PhD

Hidden Hearing Loss (Synaptopathy)

Loss and damage of hair cells results in loss of connections (synapses) to and function of some auditory nerve neurons

Occurs from noise exposure

Occurs in aging

Affects ability to listen in noisy environments

Evelyn Davies-Venn, PhD (Audiologist)

Unable to attend and present at HLAA - recorded

Research focused on hearing aids, implants and hearing in noise

Primarily improves audiblity

Evelyn Davies-Venn, PhD (Audiologist)

Directional microphones

Digital signal processing

Digital adaptive signal processing

Remote microphones and hearing assistive technologies

Smartphone apps

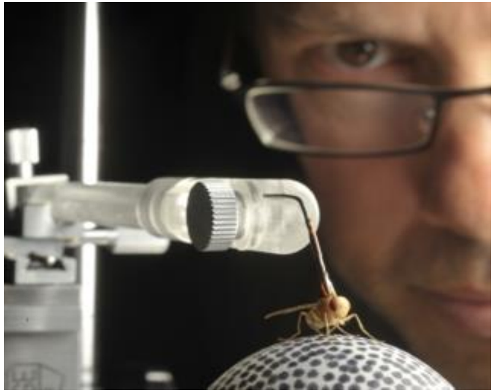
Norman Lee, PhD

Parasitic fly study

Has most acute directional hearing of any animal which inspired directional microphone

Has two hearing mechanisms but both eardrums are connected together

Noise distracts fly from target



Norman Lee, PhD

Discovered how Cope’s gray treefrog female on a spring evening listening in the din of noise to calls of countless male frogs and other noise finds her perfect mate

Male calls include high and low frequencies changing in loudness simultaneously

Females are able to detect the simultaneous changes in these frequencies from noise

DeLiang Wang, PhD

Engineers tried and failed to achieve remove noise from speech

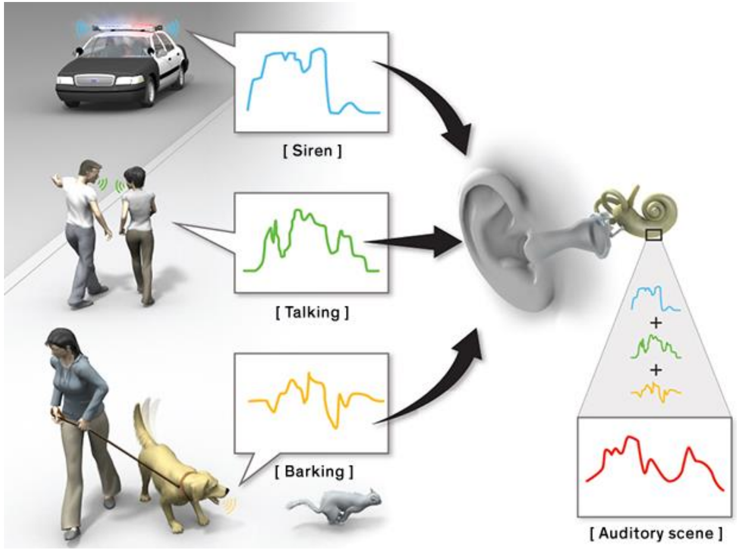
Used a voice-activity detector to identify gaps between people’s utterances

Sounds captured within those gaps considered “noise” and an algorithm subtracts the noise from speech—leaving, ideally, noise-free speech

DeLiang Wang, PhD

Spectral subtraction, used in hearing aids can remove too much speech or too little noise

Dr. Bregman, a psychologist, proposed in 1990 that the human auditory system organizes sounds into distinct auditory streams



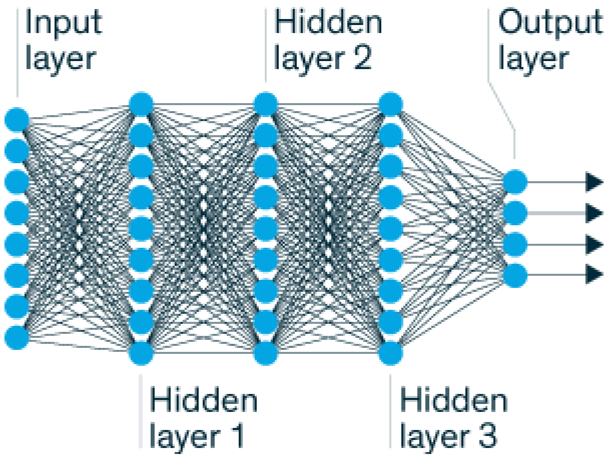
DeLiang Wang, PhD

Created a speech filter, designed on principle of auditory scene analysis (detects speech stream from noise)

Was successful for increasing the speech signal from noise in the lab

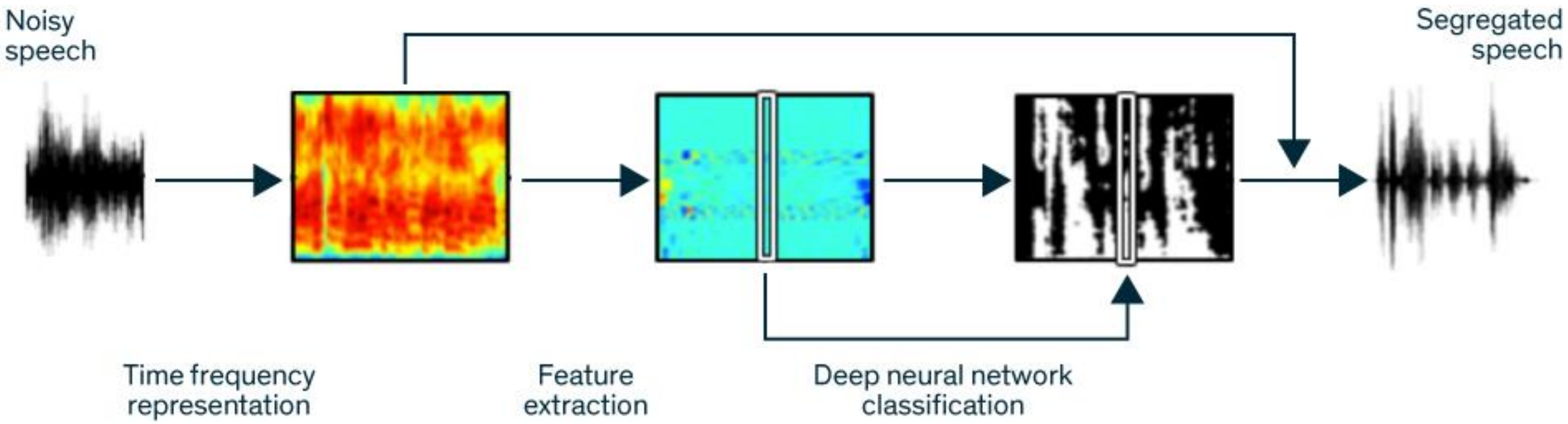
DeLiang Wang, PhD

Built a machine-learning program that would run on a neural network to separate speech from noise after undergoing a complex training process



Alexa, Google Assistant, Siri, and Cortana

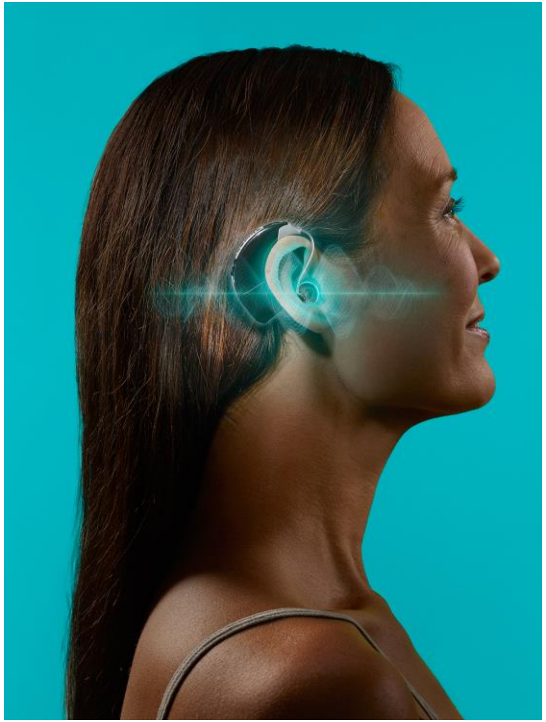
DeLiang Wang, PhD



[Deep Learning Reinvents the Hearing Aid]

Article summarizes Dr. DeLiang Wang’s work

Includes sound samples from Deep Learning



Nima Mesgarani, PhD

Research is about how the brain processes acoustic signals.

Attempting to reverse engineer human sound processing in the brain in machines/computers

Potentially develop new systems and devices to help persons with hearing loss hear better

Nima Mesgarani, PhD

Initially devised a method to reconstruct which sounds the brain listens to and which it ignores by measuring human brainwaves

Nima Mesgarani, PhD

Using volunteers undergoing brain surgery, they listened to a sentences spoken by different people simultaneously while measuring their brainwaves

Fed brainwaves into a computer algorithm his lab developed

Computer was able to reproduce the words the patients were payed attention to ignoring the other speech spoken simultaneously (brain able to filter message listened to)

Nima Mesgarani, PhD

His computer program could essentially translate a person’s auditory brainwaves into real words

The ear codes sound and speech into electrical impules the brain can interpret

His lab was able to decode this brainwave coded sound and speech back to the original sound

Laid foundation for brain-machine interfaces

Nima Mesgarani, PhD

Using speech samples listened to by persons undergoing clinical evaluation for epilepsy surgery, he discovered how vowels and consonants of different phonetic categories are encoded by recording the brainwave activity from the temporal lobe

Paved way for a hearing device designed to help solve the cocktail party problem

Nima Mesgarani, PhD

Based on his research understanding of how the brain processes speech and how the brain can pay attention to specific sounds, he has developed a cognitive hearing aid

Similar to Dr. Wang’s device, the cognitive hearing aid uses neural networks and machine learning to decode the speech heard by the listener

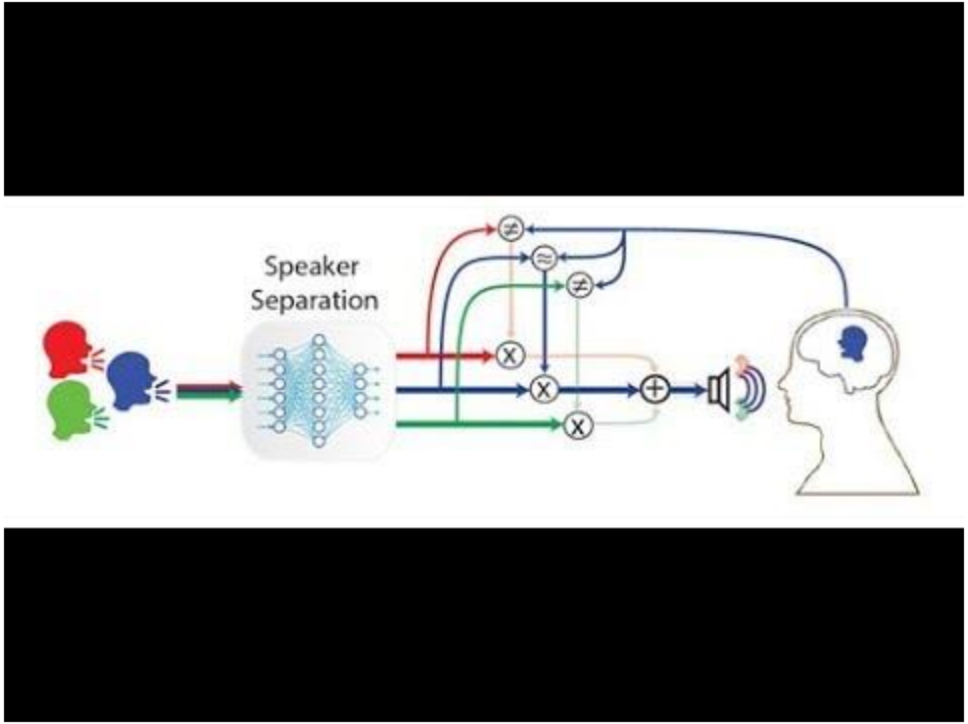
Nima Mesgarani, PhD

It first automatically separating out the voices of multiple speakers in a group

Next, compares the voice of each speaker to the brain waves of the person wearing the hearing aid

The speaker whose voice pattern most closely matches the listener’s brain waves (an indication that this is the person that the listener is most interested in) is amplified over the others

Nima Mesgarani, PhD



Summary

Listening in noise is difficult task

Hearing aids and implants are helpful but have limitations

Human and animal studies increasing understanding of how the brain process speech in noise and is beginning to be introduced in hearing instruments

Hearing aids and implants are helpful but have limitations

Deep learning, machine language and neural nets

Q&A