Researchers seek to improve listening with cochlear implants, hearing aids

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(Medical Xpress)—Over the past two decades, people living with severe-to-profound hearing loss have benefited from cochlear implants—surgically implanted electronic devices that provide a sense of sound. More recently, hearing-impaired individuals with residual low-frequency hearing also have found improvements by supplementing the cochlear implant on one side with a contralateral hearing aid on the nonimplanted side.

Now a research group in the Department of Speech-Language-Hearing: Sciences & Disorders at the University of Kansas, headed by Kostas Kokkinakis, an assistant professor of speech-language-hearing and courtesy assistant professor of electrical engineering & computer science, is testing how to boost the advantage provided by cochlear implant and hearing aid devices in real-life scenarios.

"The ultimate goal of our research is to improve the overall quality of life for cochlear implant recipients," said Kokkinakis. "My lab is working towards inventing new ways to ameliorate the negative effects of noise and reverberation. One way of doing this, for example, is to develop new ways of processing speech in the device. Another way is to help out hearing-impaired individuals by providing two auditory inputs instead of just one."

As director of the Electrical Hearing Laboratory at KU, Kokkinakis and his students carry out translational research by pursuing ideas that can potentially turn basic science into applicable solutions. The team

develops robust signal-processing strategies with application to hearing aids and cochlear implant devices.

A new study by Kokkinakis was recently published by the Acoustical Society of America, where the researcher and his students tested binaural, or two-eared, speech perception by 14 hearing-impaired listeners by presenting speech from the speaker located straight ahead, while noise was presented from either the front, right or left of the listener. For each of these noise locations, listeners were tested when they were using both cochlear implants or hearing aids, then a left and right device only.

They found advantages to listening with both devices, by testing "speech reception thresholds" for each experimental condition. This is a measure of an individual's ability to recognize and repeat familiar words from a closed set of words.

"This study was made possible by the fact that our lab is equipped with a cutting-edge sound simulation system called 'R-SPACE,'" said Kokkinakis. "This system consists of an eight-loudspeaker array placed in a circular pattern around the subject. Each loudspeaker is placed at a distance of 24 inches from the listener's head, while the loudspeakers are each separated by 45 degrees. We are in fact one of the very few research labs in the U.S. to have the R-SPACE installed in our facility."

Kokkinakis said three specific effects benefit normal-hearing people listening with both ears to perceive speech in noise: head-shadow, binaural summation and binaural squelch.

"The head shadow or better ear effect is the ability to attend to the ear with the highest signal level, due to the fact that the head is shadowing or filtering the noise source," he said. "The binaural summation effect is due to the fact that information from both ears is summed up and thus

speech gets louder relative to the noise. The binaural squelch effect relies upon the ability of the central auditory system to compare interaural differences when the speech and noise sources are separated and to selectively target the speech signal for improved intelligibility."

One of Kokkinakis' undergraduate student researchers, Bryne Gonzales, has been investigating the negative effects that reverberation has on the hearing of adults with cochlear implants and potential ways to suppress those effects. Because noise normally is reverberating inside a realistic acoustical environment, it can never be addressed in isolation.

"This kind of research is really important," said Kokkinakis. "First, it addresses the negative effects of reverberation in conjunction with noise on speech perception. Second, it's looking into ways to suppress both noise and reverberation. Bryne is a bright young man with huge potential. On top of an undergraduate research award, he was recently selected as (one of) KU's 2014 'Men of Merit.'"

Kokkinakis knows the importance of mentoring students. As a graduate student, the researcher met Philip Loizou, who was a professor of electrical engineering at the University of Texas at Dallas and a pioneer in the field of speech enhancement for hearing aids and cochlear implants.

"We talked about research, and Philip recruited me," said Kokkinakis. "I was just about to finish my Ph.D., and the prospect of moving to the U.S. and working on cochlear implants was really exciting. So I moved to Dallas in late 2005 and got right to work. I stayed in Dallas for about six years, where I was a postdoctoral researcher and subsequently a research assistant professor in Philip's lab. In August of 2011 I moved to KU."

Ultimately, Kokkinakis said the motivation behind his research is to

change people's lives for the better.

"By aiding people fitted with such devices to operate more efficiently in everyday scenarios, we can reduce listening effort and frustration or isolation, and ultimately provide greater opportunity for integration into mainstream education, increase their productivity at home or work and contribute more in the nation's economic growth and competitiveness," he said.

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