Neuroscience Seminar

2023

UNDERSTANDING AND ENHANCING PITCH PERCEPTION WITH COCHLEAR IMPLANTS

by **Professor Xin Luo**
Associate Professor
College of Health Solutions, Arizona State University

11:00am - 12:30pm
31 July 2023
(Monday)

Location

Room 6-213,
6/F, Lau Ming Wai Academic Building (LAU),
City University of Hong Kong

Registration **NOW**

Due to limited seats available, registration will be on first come-first serve basis.

Contact

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Biography

Professor Xin Luo is an Associate Professor in Speech and Hearing Science at Arizona State University. He completed his Ph.D. research on speech processing strategies for Mandarin-speaking cochlear implant users, and received post-doc training on speech perception and auditory psychophysics with cochlear implants, both at the House Ear Institute in Los Angeles. He has been a faculty member at Purdue University before joining the Program of Speech and Hearing Science at Arizona State University in July 2015. Funded by the National Institutes of Health and the American Hearing Research Foundation, his current research focuses on understanding how different sensory cues and neural factors contribute to pitch perception in electric and acoustic hearing, and designing sensory compensation, electrical stimulation, and aural rehabilitation strategies for better pitch perception in speech and music with cochlear implants.

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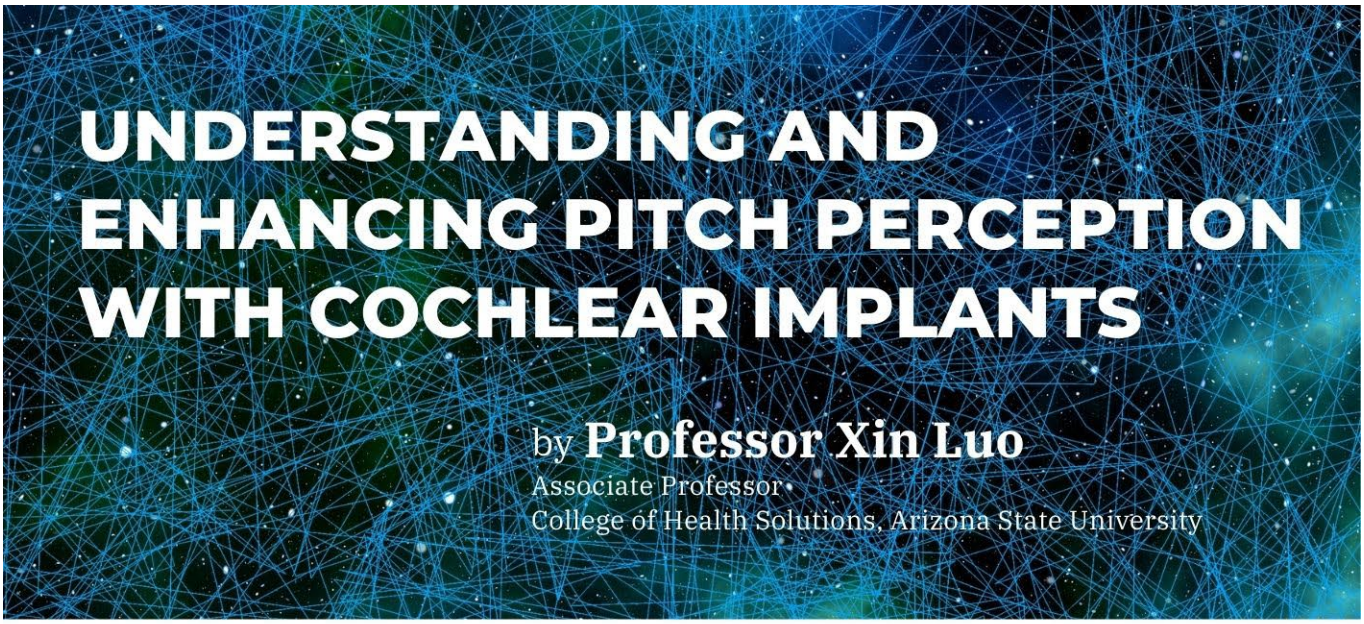
https://www.cityu.edu.hk/neuro/



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Abstract

As a basic aspect of auditory perception related to the repetition rate of sound, pitch plays an essential role in speech and music perception. Roughly speaking, pitch is perceived based on which auditory nerve fibers are activated (place cues) and what is the neural firing rate (temporal cues). However, pitch cues are greatly diminished when cochlear implants (CIs) convert acoustic signals into electrical stimulation of auditory nerve formed by spiral ganglion cells. CI stimulation only conveys slowly varying temporal envelopes carried by high-rate pulse trains on a small number of electrodes each with a broad current spread. A major goal of our research is to understand the sensory cues and neural factors for pitch perception of CI users and normal-hearing listeners, and then leverage the information to design sensory compensation, electrical stimulation, and aural rehabilitation strategies for better CI performance in pitch-related listening tasks.

In this talk, I will first discuss our recently published work on the neural health correlates of pitch perception with CIs. Electrode-neural interface, including both the number and health of spiral ganglion cells and the electrode-modiolus distance and impedance, may underlie the large variability in pitch sensitivity across electrodes and CI users. Previous studies have suggested various psychophysical and electrophysiological estimates of neural health independent of non-neural factors. We found that among these measures, only the inter-phase gap effect on the amplitude growth function of electrically evoked compound action potential, which may reflect the central axon demyelination, had a significant correlation with the place pitch sensitivity in our tested samples.

In the second half of the talk, I will describe our ongoing study to optimize the electrical pulse shape for pitch coding with CIs. For safety purposes, clinical CI devices use symmetric biphasic pulses with the same amplitude and duration for both the anodic (positive) and cathodic (negative) phases. However, triphasic pulses with double amplitude or duration for the center phase than for the two flanking opposite phases show a polarity effect of the center phase on detection threshold, which may indicate the peripheral process conditions of spiral ganglion cells. We found that anodic-centered triphasic pulses (which directly activate the central axons) lead to significantly better place pitch sensitivity than cathodic-centered triphasic pulses (which likely activate the peripheral processes), and performed nearly significantly better than clinical standard biphasic pulses.

Overall, these results highlight the importance of neural health to the effectiveness of CI simulation and suggest novel ways to predict and improve place pitch sensitivity with CIs.