

Foreign-accented speech recognition: a challenge from hearing to cognition

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The challenge of L2 (i.e. foreign-accented) speech recognition is a complicated phenomenon that arises from mismatches between first-language (L1) and second-language (L2) linguistic structures, and results in more effortful and error-prone processing. L2 English speech must be presented at a significantly more favorable signal-to-noise ratio than L1 (i.e. native-accented) English speech in order to achieve a given level of recognition accuracy by L1 English listeners. This lower noise resistance for L2 speech is further exacerbated for particularly low intelligibility L2 talkers and for complex linguistic structures. Similarly, L2 (i.e. non-native) English listeners need a significantly more favorable signal-to-noise ratio than L1 English listeners to achieve a given level of English speech recognition accuracy. This lower noise tolerance of L2 listeners is particularly pronounced in casual speech and for words in sentences with low contextual support. Taken together, these patterns of lower noise resistance of L2 speech and lower noise tolerance of L2 listeners indicates that the challenge of speech communication across a language barrier extends across the speech transmission system, from talker to signal to listener. Effective strategies for facing this challenge should address all three links in the speech communication chain.

Recognizing important speech under difficult attention conditions

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Aiding hearing clearly cannot mean simply increasing the signal-to-noise ratio for all sounds, or even for all speech, but rather to assist in the ability to recognize sounds that the listener deems to be targets. I will discuss some individual-difference variables that affect the ease or difficulty a listener has in staying on an intended message that is embedded in a background filled with unwanted speech or language, a well-known "cocktail party" experimental situation. There are patterns of paying attention among younger and older adults that are in some ways surprising, and that suggest how future hearing-aid devices might be better adapted to adjust to individual cognitive styles.

Cognitive costs of background noise on children's language processing

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Listening environments that contain multiple sound sources are cognitively demanding for children. For example, children must be able to direct their attention to target speech (e.g., a teacher's voice) and inhibit attention to background sounds. Even if children are able to allocate their attention effectively, background sounds often mask or degrade the target speech. When the target speech input is degraded, children must be able to perceptually restore that input; that process relies on the children's language and cognitive maturity. If children are engaging their cognitive resources to facilitate speech perception, they should have fewer cognitive resources to process speech more deeply. This presentation will highlight results from studies in our lab that show the detrimental effects of background noise on language processing in children.

Hearing, Aging, and Public Health – From Epidemiologic Insights to Policy

Frank Lin, M.D. Ph.D.

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Medicine and public health have evolved through three eras over the past century. Beginning in the first half of the 20th century, infectious diseases were controlled for the first time in human history through vaccinations, antibiotics, and other strategies. Subsequently, throughout the 20th century, chronic diseases of middle and later life (e.g., cardiovascular disease, cancers) became the leading causes of mortality but have also increasingly been better controlled. These successes of public health have led to a rapidly increasing population of older adults living longer than ever before. In this third era of public health, we are now confronting the challenges of aging and how to best optimize the health and functioning of a growing population of older adults. In this era, hearing and our ability to engage effectively with the environment around us are critically important but not yet priorities in the spheres of public health and public policy.

I will discuss research over the past several years that has demonstrated the broad implications of hearing loss for the health and functioning of older adults, particularly with respect to cognitive functioning, brain aging, and dementia. I will then discuss how this epidemiologic research has directly informed and led to current national initiatives in the United States focused on hearing loss and public health. These initiatives include the Aging and Cognitive Health Evaluation in Elders (ACHIEVE) randomized controlled trial and recent passage of the bipartisan Over-the-Counter Hearing Aid Act in 2017. This federal law overturns over 40 years of regulatory precedent around hearing aids in the U.S. in order to directly improve the accessibility and affordability of hearing care for older adults. Finally, I will provide some thoughts on future trends in addressing hearing loss as a public health problem and the need to develop new policies and approaches to hearing care.

Measuring and overcoming cognitive challenge during speech comprehension

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How does hearing impairment affect the way our brains process speech? I will review data from behavioral and brain imaging studies that speak to the added cognitive demands associated with acoustic challenge. Evidence from multiple sources is consistent with a shared resource framework of speech comprehension in which domain-general cognitive processes supported by discrete regions of frontal cortex are required for both auditory and linguistic processing. Although frequently studied in the context of hearing loss, these principles have broader implications for our understanding of how auditory and cognitive factors interact during spoken language comprehension. I will present neuroimaging data from listeners with normal hearing, age-related hearing loss, and cochlear implants implicating executive attention networks in understanding acoustically challenging speech. Finally, I will cover some potential novel approaches for improving speech intelligibility in the face of cognitive challenge.

When does working memory matter? Insights from a hearing aid lab.

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With increasing attention to the role of cognition in communication, many researchers have focused on the role of working memory and the extent to which it predicts speech recognition, with and without hearing aids. Two recent reviews argue that working memory plays a minimal or no role for some listening environments and listeners. How does working memory vary among older adults and under what circumstances does it matter? In this presentation we will review data from older adults with and without hearing loss and share our views as to when working memory does (or doesn't) contribute to communication. [Work supported by NIH].

Attention and hearing across the lifespan: the role of automatic processing in auditory perception.

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We live in a noisy world. Typically, sounds from multiple sources converge on our ears with more sensory input reaching us than we can process at one time. Yet, we don't fully understand how attention facilitates or impedes the ability to perceive discrete sound events when there are competing sound sources. I will provide evidence from our laboratory that attention is a distributed resource across the entire auditory soundscape that affects auditory perception differently throughout the lifespan. This will be demonstrated through behavioral and neurophysiological measures of auditory scene analysis in normal hearing children and younger and older adults. Results will also be discussed in terms of the clinical implications for disorders of auditory processing that are relevant at different stages of life.

Auditory perceptual learning

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Performance on many perceptual tasks improves with practice, indicating that our sensory systems are not rigid but rather can be changed through experience. My coworkers and I have been investigating the factors that induce and those that prevent perceptual learning on auditory skills, including how those factors change with age and are affected by sensory and cognitive disorders. Conclusions drawn from learning on fine-grained auditory discrimination tasks have held for visual and speech learning, suggesting that common principles are at play across multiple domains. Knowledge of these issues will lead to more effective perceptual training strategies to aid rehabilitation and promote skill enhancement.