Short Communication

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Impact of Machine Learning on the Future of Hearing Aid Fitting

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ABSTRACT

The standard approach to hearing aid fitting currently relies on average-based prescriptive amplification, which lacks a systematic integration of individual hearing preferences. However, machine learning, an emerging tool across various sectors of healthcare, offers a promising approach to incorporate personal hearing preferences into routine fittings. This short communication outlines the prevailing practices in hearing aid fitting and how machine learning can impact hearing outcomes in audio environments that matter most to an individual hearing aid user.

Abbreviations: DSLv5: Desired Sensation Level Version 5; NAL-NL2: National Acoustic Laboratories Non-Linear 2

The emergence of artificial intelligence and machine learning utilization in healthcare are poised to significantly change patient diagnosis, care, management and outcomes. In hearing healthcare, machine learning is being increasingly used by hearing aid manufacturers to fine-tune hearing aid algorithms and features, specifically for processing speech in noise and for allowing a limited degree of unsupervised adjustment by the user. Despite these efforts, there are no widely publicized attempts to leverage machine learning as a clinical tool to optimize hearing aid programming, incorporate user preferences in a systematic way and ultimately enhance outcomes. This gap is surprising, considering that studies have repeatedly shown that many users prefer hearing aid amplification settings that are different than those prescribed by their hearing healthcare provider.

Currently, the most effective way of managing and mitigating the effects of hearing loss in adults is with the use of hearing aids. Millions of users worldwide have benefited from hearing aids across the lifespan and programmable digital hearing aids have been around for decades. However, the clinical approach of fitting hearing aids has remained static during this time, despite significant advances in technology and our understanding of hearing loss. This fitting approach provides amplification based on normative data from hearing impaired users via the use of prescriptive targets across frequency channels to accommodate varying degrees and configurations of hearing loss. The prescriptive approach has led to a systematic, repeatable and relatively successful method of managing hearing loss. However, despite the widespread use of established prescriptive fittings such as Desired Sensation Level Version 5 (DSLv5) and National Acoustic Laboratories Non-Linear 2 (NAL-NL2), as many as half of hearing aid users prefer other settings than those prescribed. Previous studies as well as our own works suggest that incorporating user input can improve hearing performance and ultimately outcomes for hearing aid users who prefer settings that differ from the standard prescriptive setting.

Patients with hearing loss can vary in their degree of hearing disability across the lifespan, even when the degree of hearing loss is similar. This discrepancy is believed to stem from gaps in our understanding of how hearing-impaired individuals utilize their residual hearing, which is largely unaddressed with the current process of fitting hearing aids. Unfortunately, in situations where patients are dissatisfied with hearing aid programming and request changes in

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their prescriptive settings, the clinical process to incorporate these preferences is ad-hoc as there are no widely accepted protocols for systematically deriving and implementing these preferences. Moreover, there is no widely accepted or efficient method to determine whether these ad-hoc adjustments translate to real world benefits. This problem is made even more complex by modern hearing aids which typically have many adjustable frequency channels. Simply put, the preferred amplification function for a given individual across a broad range of frequencies cannot be optimally derived using current ad-hoc methods and hearing aid manufacturers' attempts at personalizing prescriptions are not currently guided by the users' hearing healthcare providers.

Our research team has been developing machine learning approaches as clinical tools that extend the existing prescriptive models by personalizing and optimizing hearing aid settings using direct user feedback [1-11]. These machine learning approaches can also be leveraged as powerful research tools to better understand the critical biological and audiological factors underlying the variability in hearing aid preferences among users. We anticipate that future care will use machine learning derived personalized settings for patients to optimize hearing outcomes with little risk to them. In cases where personalized settings have no benefit, patients can simply be prescribed the standard prescription which is based on population data. Machine learning personalization approaches also allow for establishing databases of preferences, enhancing remote management of hearing aid users, and as research tools for identifying common preferences and values across different populations of hearing-impaired individuals. Further, aggregate data could be used to develop novel amplification strategies driven by data science. Machine learning personalization of hearing aid fitting is expected to enhance hearing outcomes for users worldwide and enable responsive and individualized healthcare.

A clinical tool has been developed by our research team to derive individualized amplification functions, and the overall performance of these functions have been tested relative to the function prescribed by one of the most widely used hearing aid fitting rationales worldwide (DSLv5) [12]. In this clinical tool, DSLv5 is used as the initial condition on which personalization is applied. Consistent with previous other studies, hearing impaired participants preferred our personalized machine learning derived amplification functions. Furthermore, our study participants consistently showed higher word recognition scores in the presence of competing background noise when using our machine learning amplification functions relative to the standard DSLv5. This improvement was evident without the use of additional technology such as noise reduction or directionality. We anticipate the future of hearing aid fitting will involve optimizing machine learning approaches as clinical tools which will play a major role in studies assessing biological factors that likely underlie individual hearing preferences.

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