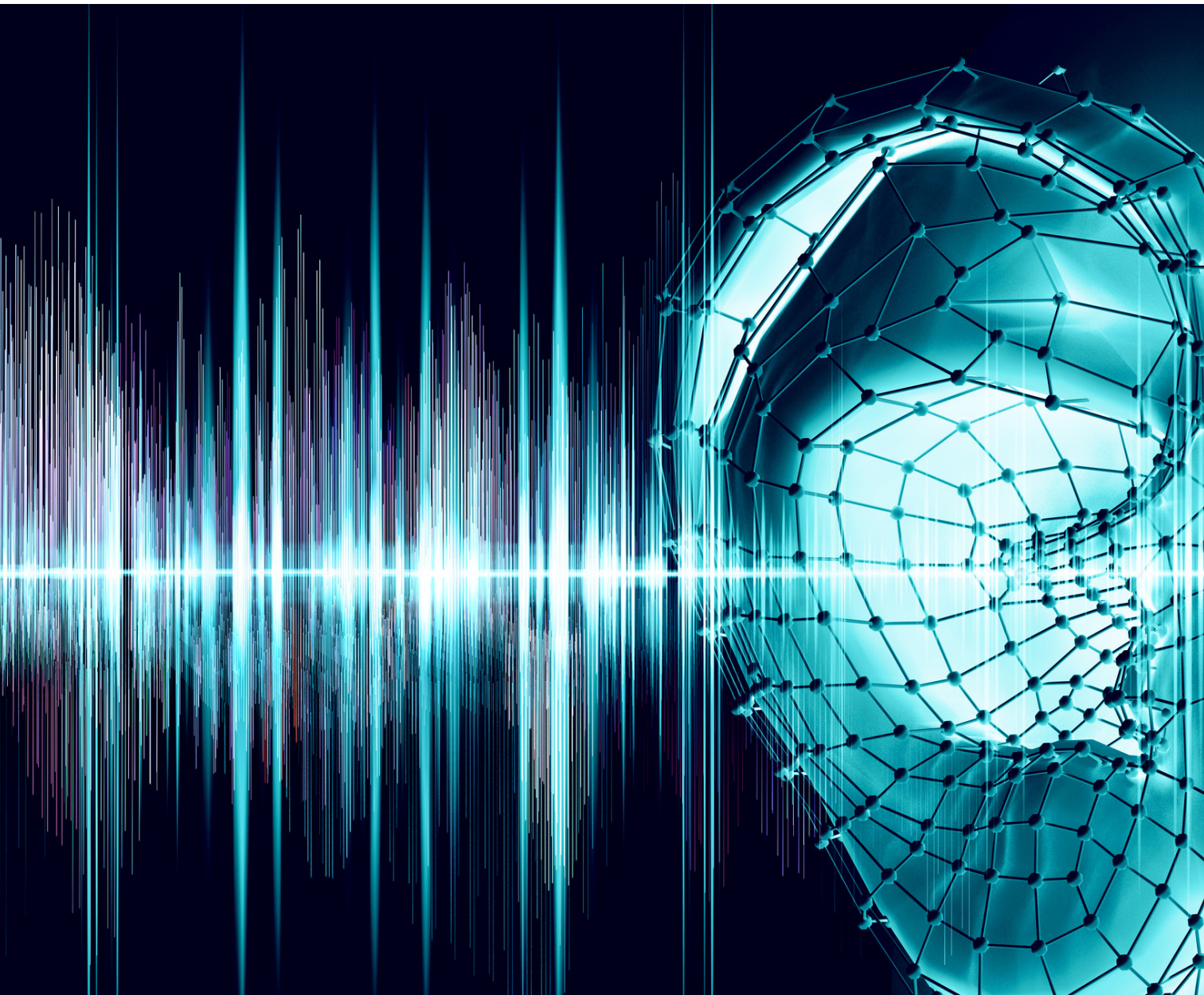
Diagnostic Applications for Artificial Intelligence in Audiology



The Hearing Review

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Diagnostic Applications for Artificial Intelligence in Audiology

Buzz words come and go, but "artificial intelligence" (AI) has burst into the vernacular across multiple industries, with no sign of going away. Nick Hunn, founder and CTO of London-based WiFore Consulting, has a considerable background in hearing technology and data analytics. He has seen the creation of so-called "machine learning" and its evolution into true AI.

Hunn contends that AI is essentially a vast scaling up of the learning process. "Instead of something that's done locally on a device, the work is done on servers in the cloud, using vast quantities of data scraped from the web," Hunn explains. "It's called a 'large language model' or LLM, where chatbots like ChatGPT appear to be able to have conversations, analyze research, write songs, and generate images. With that feast of resources, it is no wonder that they do so well. They have the ultimate database."

Journalists, venture capitalists, and marketing professionals in 2024 are eager to slap the AI label onto various pieces of technology—and in many cases, it's been premature. In the realm of hearing loss, there is much less publicly available audiological data from which to draw.

According to Hunn, some companies may have assembled a few million audiograms, particularly those that have been working on self-assessment tests for hearing loss. However, those are a mere "drop in the ocean" for LLMs. Even where it exists, most of that data is in private silos, inaccessible to larger audiological AI initiatives.

Still, there are advances within the realm of AI-enhanced diagnostics. Don Nielsen, PhD, F-AAA, audiology university advisor at Fuel Medical in Camas, Wash., points to AMTAS Pro, made by GSI. "AMTAS stands for Automated Method for Testing Auditory Sensitivity," Nielsen explains. "It is an in-office, patient-directed hearing assessment tool that uses AI to obtain diagnostic audiometry."

AI could improve the accuracy and efficiency of hearing tests.

Nielsen believes these types of cutting-edge technologies are part of an emerging culture that should allow hearing care professionals (HCPs) to eventually shift their focus from "time-consuming, old-fashioned diagnostics" to more sophisticated diagnostics and treatments, freeing up valuable time.

"Initial diagnoses will come from new sources," Nielsen says. "The U.S. has [more than 250,000] primary care physicians (PCPs) and only 12,000 active audiologists. We see PCPs take responsibility for initial hearing screening and diagnoses. One company called HCRpath (www.hcrpath.com) has embedded hearing healthcare-based AI in PCP Medicare intake forms to identify more people with hearing issues, diagnose them correctly, and guide them to the proper treatment device and provider."

This does not replace audiologists or ENTs. Instead, AI acts as the PCP's co-provider—making informed decisions that guide appropriate patients to optimum providers—maximizing the provider's time and services. "Not only are we seeing intelligent devices and virtual providers help us with diagnostics, but home diagnosis and therapeutics are also growing," Nielsen adds. "BBalance is a maker of smart bathmats that detect posture and balance to predict the risk of neurological diseases of interest to audiologists…A 2020 study from the University of Texas, Arlington, found that floor tiles with embedded sensors could measure the width, length, and speed of a person's steps to predict fall risk and spot warning signs of illness."[1]

If and when AI is more widely used in diagnostics, Marshall Chasin, AuD believes that the most useful area may well be in evoked potential testing, measuring the length of time it takes for nerve signals to reach the brain—specifically electrocochleography (ECoG), measuring electrical potentials generated in the cochlea in response to sound stimuli.

"I can see AI being used to interpret the brain wave activities that we use all the time in audiology in diagnostics to determine whether someone has Meniere's disease, or whether they might have a learning disability and to see whether those waves are exactly where they should be," says Chasin, director of auditory research, Musicians' Clinics of Canada, with offices in Toronto and Hamilton, Ontario.

Chasin predicts that AI will be an effective assistant, much like it is now with radiologists who receive AI assistance to interpret the subtleties of MRIs. "I think radiologists view AI as a supplement to their job so they can be freed up to do other radiological tasks," Chasin

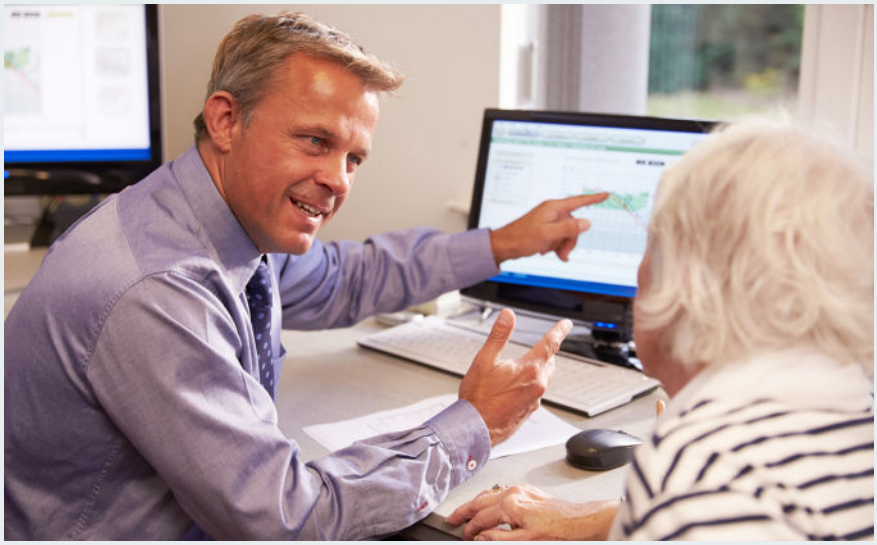
AI: Helpful Or Headache?

Don Nielsen, PhD, F-AAA, audiology university advisor at Fuel Medical, Camas, Wash., has a message for the profession: Generative AI-driven audiology is here and it will power much of audiology to come—not just diagnosis. "AI is improving disease tracking and predictions of patient outcomes, streamlining hearing clinic processes, enhancing patient engagement, enhancing accessibility, reducing costs, and improving patient outcomes," he says. "AI will permeate all aspects of clinical care."

Ruth Reisman, AuD, a full-time doctoral lecturer at Brooklyn College, has also seen colleagues using AI outside of the diagnostic category, specifically with report writing, which has boosted efficiency in the clinical sector. "I also have colleagues who use AI to develop various marketing materials for their practice," says Reisman, who also co-owns Urban Hearing, a private practice.

According to Nielsen, a common impediment to the full embrace of AI is the perceived existential threat, but Nielsen is adamant. "The knee-jerk reaction to AI is, 'It will replace me!' GenAI will not replace you, but audiologists who fully use GenAI may ultimately replace you."

Consider that there are roughly 800 newly minted AuDs each year added to a core of approximately 12,000 practicing audiologists in any given year.[6,7] Meanwhile, industry organizations estimate that at least 40 million people in the U.S. have hearing issues.8 "Many audiologists continue to hang their hats on their ability to conduct all aspects of the diagnostic assessment," says Brian Taylor, AuD, senior director of audiology at Signia, a New Jersey-based hearing aid manufacturer. "Given the shortage of audiologists, this attitude is unsustainable, especially in light of the aging population that needs hearing care services."



Experts believe the worry that artificial intelligence will replace hearing care professionals is overblown.

"We need AI's help to serve more patients," Nielsen agrees. "GenAI allows us to use virtual providers who can learn, converse, read emotions, and solve problems like humans. With supervision, these virtual partners can provide care for patients with low-complexity issues. AuDs can better use their time and skills to see patients with more complex issues. By decreasing cost and increasing accessibility, GenAI is good for patients and providers."

"The technology is coming, and we need to know how to use it to benefit patients," Reisman adds. "Given that there's going to be so many more individuals coming in with hearing loss and hearing disorders—AI is both a threat and an exciting development. It's a threat if you don't know how to evolve with the times. It's also exciting that it's going to give us tools to help make our practices more efficient and more effective so that we can be more accurate in our diagnoses and in our treatment plans."

In the opinion of C. Scot Frink, AuD, owner of Salem Audiology Clinic, Salem, Ore., audiologists looking to boost customer service with AI should think twice. "AI's ability to understand exactly what you need may be fine for simple situations, but often customer service problems are nuanced, requiring someone who can really logic through them and come up with a reasonable solution," Frink laments. "If a hearing aid manufacturer tried to replace its customer service department with AI, they'd have problems."

When Ryan Hill, AuD, owner of The Hill Hear Better Clinic in Cincinnati, ponders AI, he predicts mostly help and fewer headaches. For HCPs, he envisions more accuracy in the interpretation of results, plus a more automated workflow for improved efficiencies. Screening and monitoring tools could even possibly be in the homes of patients.

"AI still has to be coupled with human interaction and coupled to the diagnostic equipment," Hill adds. "It could lead to some user error unless AI was also used for placement checks. AI also removes the interpersonal relationship between providers and patients."

says. "If you want to abrogate your responsibilities for some things in diagnostics that machines can do better, such as interpret delays or changes in amplitude on what looks like amorphous messy-looking waveforms, then I think that's a good thing and I see absolutely no downside."

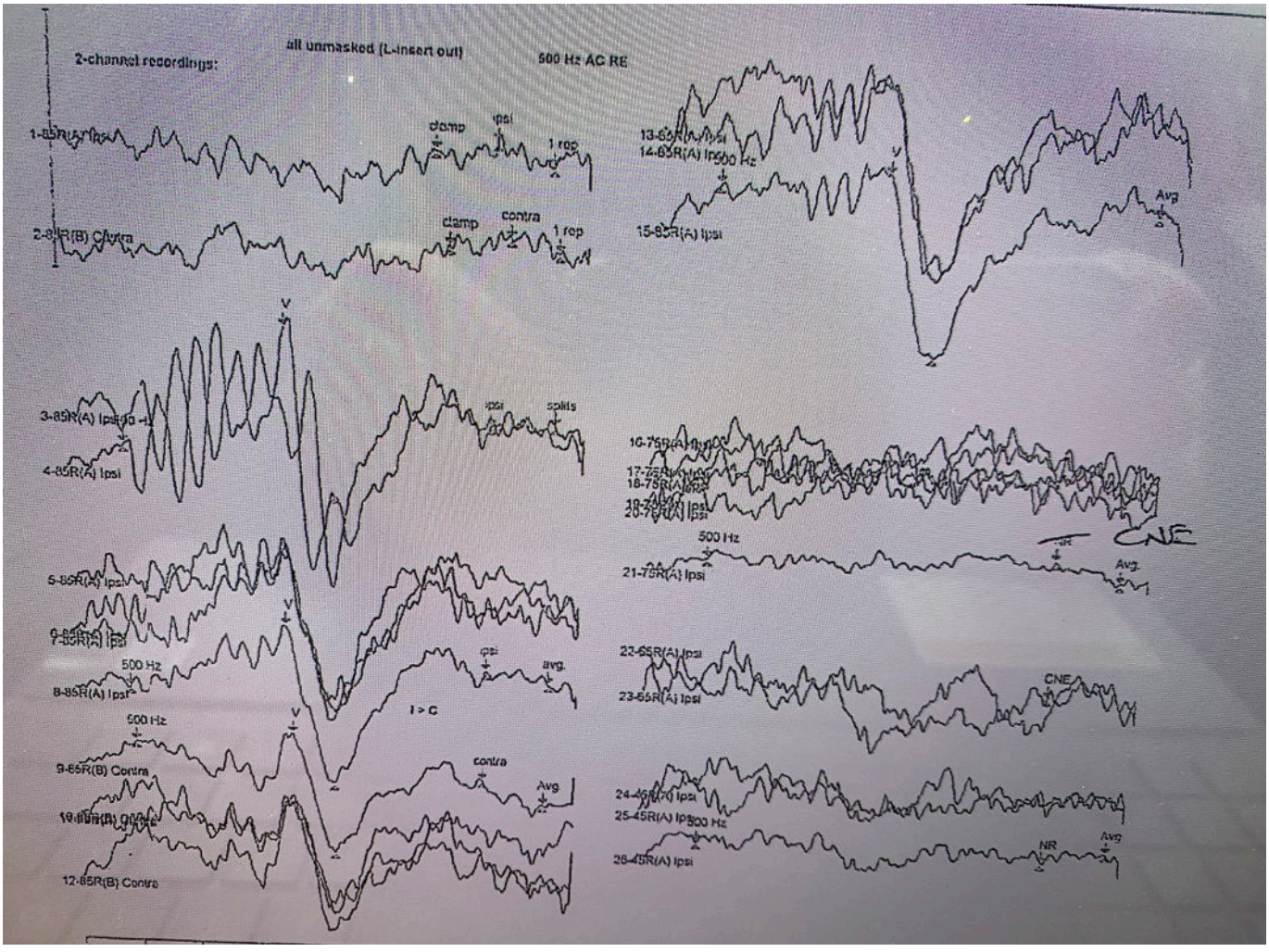
Ruth Reisman, AuD, a full-time doctoral lecturer at Brooklyn College, concedes that much of AI for diagnostic applications is still in development. "However, we use some AI applications to track response delays for auditory processing assessments and for auditory processing rehab," she reveals. "That's been an interesting development to really get down to the nitty-gritty, to the milliseconds in response times—and monitor those improvements over time. It's an objective way to assess patients and see where their delays are compared to their normal developing peers, and then track it in the rehab side of things."

Chasin and Reisman are bullish on AI's ability to improve accuracy and precision in electrophysiological results. For example, AI's role in the automated brainstem response (ABR) test, as well as the previously mentioned ECoG, could help in obtaining results and interpreting and marking the latencies of the waves, and the amplitude of the waves.

"A lot of it right now is done subjectively, although there are some algorithms that help you figure out where it should be by using the normative data," Reisman explains. "The hope is to take thousands of responses, put them into a system, and use AI to generate more accurate readings. It may help us be more precise in our diagnostics, and also more precise in monitoring the benefits of rehabilitation."

Another interesting AI technology is audiometric diagnostic testing in different languages. "It's the ability to use AI to shift the word testing," Reisman adds. "Even to counsel patients on the testing using different languages will be a very interesting component."

Reisman is hopeful that AI can be used to assess patients in the multi-faceted ways that they actually hear. "We hear through intensity, so we test intensity," Reisman says. "We hear in frequency, but it's all very generic.



An auditory brainstem response (ABR) test shows typical "bumpy waves" which are frequently difficult to interpret. How many milliseconds did the wave occur at, and what is its amplitude?

To make it even more customized and individualized for patients to assess intensity, frequency, timing, and temporal processing cues in a more natural environment would be interesting. Using AI in virtual reality for balance assessments is something I've also been waiting for."

Brian Taylor, AuD, senior director of audiology at New Jersey-based Signia, knows many audiologists who "stubbornly hold on to conducting the entire test themselves and don't trust machines," even though data shows automated hearing testing is as accurate as experienced clinicians, as evidenced in studies by Robert Margolis.[2-3] "In my opinion," Taylor adds, "many audiologists wrap too much of their identity into the test rather than the counseling."

Generative Artificial Intelligence

AI is destined to revolutionize hearing healthcare diagnostics because generative artificial intelligence (GenAI) provides the power to quickly analyze massive amounts of data. "GenAI can find associations and connections in bodies of disparate data that are too vast and knotted for humans to unpack," Nielsen explains. "This increasing capability of GenAI to analyze healthcare data across multiple dimensions—from basic metrics collected by a fitness tracker to something as sophisticated as mapping an individual's genomic sequence—is revolutionizing how we diagnose and treat disease."

Precision medicine, powered by GenAI and new genomic technologies, is admittedly not being used much in clinics, but these advances are on a fast track to reshape healthcare—including hearing healthcare. Precision medicine is an intensely personalized approach to healthcare that considers individual differences in genetics, environment, and lifestyle to tailor prevention, cure, and treatment.

"By diagnosing diseases at the level of the sequenced gene, genomics is the most powerful tool in the precision medicine toolbox," Nielsen says. "Previously, we have rarely considered a patient's genome or diagnosed genetic-based hearing issues. We have focused on aging and other acquired hearing loss. For audiologists, this will shift the demographics of hearing healthcare from seniors to fetuses, infants, and children—and better balance the supply and demand for hearing healthcare services. We must consider the genome as part of the hearing system rather than as a tool only applied in diagnosis and treatment.

"We are entering a new epoch where hearing loss will primarily be diagnosed, prevented, cured, or treated through genomics," Nielsen continues. "This is possible because GenAI enables us to analyze tremendous data sets, like the genome sequence in one patient, and relate it to the sequenced genomes of millions of other patients. Audiologists must become knowledgeable and comfortable with genomics."

Nielsen points to research by Martelletti, Ingham, and Steel that showed the first reversal of an existing neurological hearing loss by gene activation in Spns2 mutant mice.[4] And in early 2024, Jun Lv, et al., demonstrated the effectiveness of AI-enabled gene diagnosis and therapy in restoring hearing function in profoundly deaf children aged less than a year to 11 years, with DFNB9 deafness.[5]

"This research clarifies the benefits of diagnosing and treating neurological-based hearing loss early," Nielsen enthuses. "Fetal gene diagnostics and Intrauterine fetal gene therapy allow us to diagnose and treat babies before birth. Correcting gene mutations in embryos can prevent or cure genetic diseases, giving individuals a chance at a healthy life."

Optimism, Skepticism, and Pitfalls

Ryan Hill, AuD, owner of The Hill Hear Better Clinic in Cincinnati, Ohio confesses that he is skeptical of AI, mostly because he believes it is being largely used as "marketing lingo" to enhance the profiles of associated technology. "If AI can benefit patients, there is reason to be optimistic," Hill muses. "However, in the literature I have reviewed, it seems AI will be working with listening preferences and may be avoiding actual prescriptive values—and not encouraging full adaptation to treatment."

In the specific category of diagnostics, Hill is optimistic that AI can help streamline patient flow and help run mundane (although necessary) testing protocols—but all must be done with the oversight of the HCP. AI may also improve clinical accuracy, relieving subjective interpretations of data. It could also help to diagnose degrees of hearing loss—and predict the impact of associated cognitive decline.

Taking the pressure off of subjective interpretations of data may be a welcome feature for many HCPs. However, C. Scot Frink, AuD, owner of the Oregon-based Salem Audiology Clinic, points out that perceptions of sound in the brain contribute a pesky level of nuance that may not be ideal for AI, at least not yet.

"Perception of sound is in the brain," Frink muses. "You can fit 10 people who have the exact same hearing loss with the exact same hearing aids and they could even have the exact same, or similar, ear canals, and each perception of how the hearing aids sound will be very different. This is simply because each individual's cortical memory of sound is different—and that's something AI can't intuit."

It's why the success of the fitting still depends on

time spent by HCPs who are willing to do the work and listen to patients, including counseling patients on expectations and communication strategies. "This isn't to say that someone won't eventually come up with an AI algorithm that can intuit patients' perceptions and needs," Frink says, "but I still think we're years away from that."

"We can feed a lot of parameters into a computer to come up with a diagnosis, but there are some situations that are clearly nuanced and thus will present problems for AI," Frink continues. "This technology primarily depends on objective facts and information, and most of the tests we use are still very subjective, based on patient perceptions and their ability to participate accurately. Thus, I think AI in diagnostics will have problems simply because of the gross variability and subjectiveness of the patients."

Some of the skepticism also stems from a belief that professionals may find it difficult to keep up with the technology. "People could become reliant on the technology too much, and not understand the science behind it," Reisman says. "That's what I'm seeing even at the student level, which is somewhat sad because they should be at the forefront. They're going to be too reliant on the technology doing everything and not utilizing their brain to its capacity."

Chasin echoes Reisman's concerns, citing the potential misuse of certain AI algorithms. "AI is not this homogenous big data thing," he says. "In fact, most researchers in AI have no idea what's going on in the black box. They train the black box to do a certain task, and it gets better over time, and they have no idea how it's getting better over time."

Gyl Kasewurm, AuD at Dr. Kasewurm's Professional Hearing Services, St. Joseph, Mich., points out that the very phrase "artificial intelligence" conjures a less-than-personal touch, which may ultimately be the case if HCPs fail to recognize the humanity of their patients. "You can collect all kinds of data, but if you don't go in there and actually see people, that's a disadvantage," Kasewurm says. "You need that person-to-person contact to really know where the patient is coming from, what their needs are, and what their fears are."

Among HCPs who value their role in patient interaction, empathy, and compassion, Ryan Hill suspects that AI will not be viewed as a threat. While AI will not likely be capable of duplicating those human emotions, Hill warns that AI may indeed be a threat "for those not following best practices, because AI could easily get equal or better results in testing, and even fitting of hearing technology."

"The data sets behind AI are not large enough to provide a better solution than the audiologist's experience," confirms Nick Hunn. "There's also a common belief that the advent of AI will deskill many professions. Audiology should be relatively immune as long as audiologists don't believe the hype. It's the audiologist's job to deliver hearing care and an excellent patient experience."

In an effort to expand the inevitable use of AI capabilities, particularly when it comes to diagnostics, Hunn believes the industry should "start to build up a publicly available database that will feed future AI developments." The chatbots of today succeed because they can scrape the web for trillions of pieces of information, so Hunn reasons, "The hearing industry needs to focus on providing a similar resource for a future generation of AI development."

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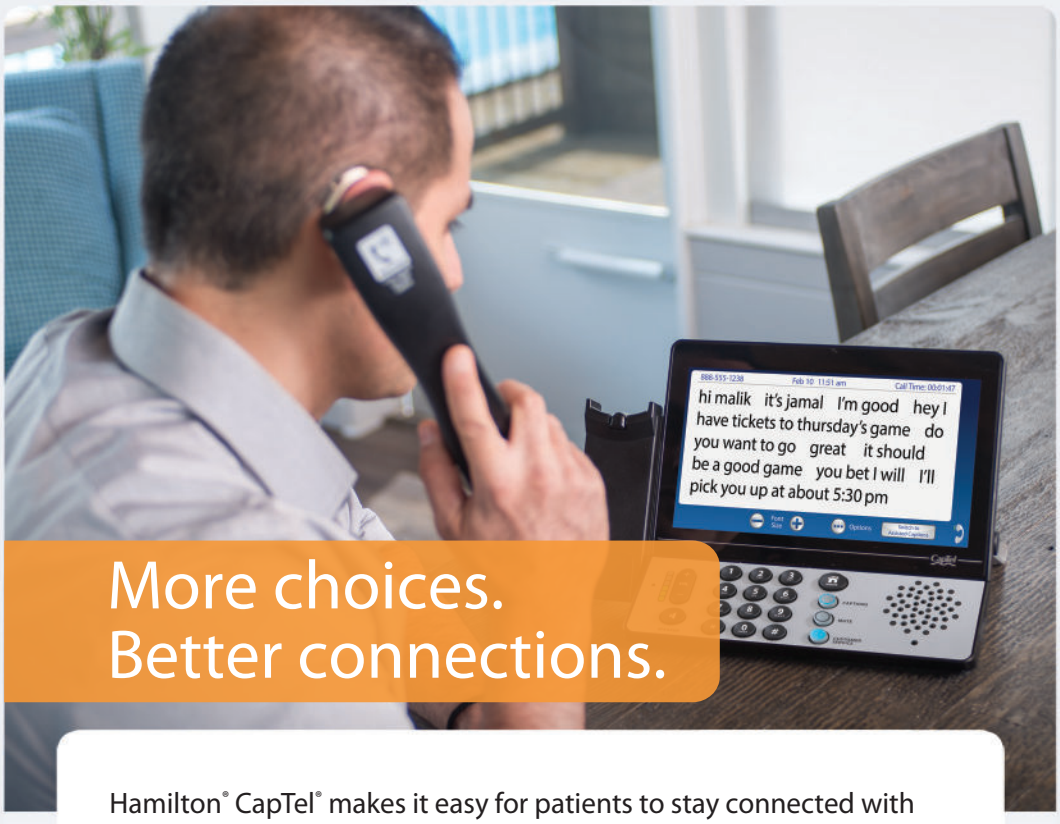

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