Issues in Pediatric Amplification, Auditory Access, and More: An Interview with Ryan McCreery, PhD

By DOUGLAS L. BECK, AuD

With the publication of a new thought-provoking book and a constant stream of high-quality research coming from Ryan M. McCreery, PhD, and his colleagues at Boys Town National Research Hospital, we thought this would be a good opportunity to catch up with Dr McCreery.

Beck: Good morning Ryan! It's been a while since we spoke. I guess I'm a little overdue in congratulating you on your new and varied positions. Although you've been the Director of Audiology at Boy's Town since 2011, you're now also Director of Research of the four research centers at the hospital, and Director of the Audibility, Perception and Cognition Laboratory, too.

McCreery: Thanks Doug. It's a lot of titles, but it's a wonderful place and I get to work with amazing people.

Beck: And, as if you didn't have enough things going on, you just coauthored the book *Pediatric Amplification–Enhancing Auditory Access* with Elizabeth Walker (Plural Publishing, June 2017).

McCreery: Right. Working with Beth was fantastic. She's an assistant professor in the Department of Communication Sciences and Disorders at the University of Iowa, and as you mentioned, our book was just published in 2017.

Beck: OK, let's jump right in. I'd like to start by getting your perspectives on the relationship between cognition and audition in the world of pediatrics.

McCreery: Talk about jumping right in! But OK…as you recall, David Pisoni and colleagues[1] evaluated children who are deaf and had received cochlear implants (CIs). He noted that these same children often have deficits in cognitive domains reflected in their working memory and executive function.[2]

Beck: And they said, more-or-less, their limited auditory exposure and experience impacts these same domains: namely, working memory and executive function.

McCreery: Right. Taking it a step further, one of our tasks has been to look at cognitive function as the result of auditory experience in children who wear hearing aids. And the jury is still out! Nonetheless, it seems probable that, if auditory experience is needed to help develop cognition, then one would expect, in general, children who have better access with their hearing aids to the full complement of sounds may have a better chance to develop cognitive ability than children with reduced access...but we're not really seeing this in the children we're working with.

Beck: That's fascinating. I thought I had read a report a few years back that CIs have been shown to sometimes improve one's cognitive ability, but that was not yet apparent via hearing aids?

McCreery: I think the issue is that there are a vast multitude of confounding variables which we cannot control or individually assess, and so we don't really know what's driving the various factors. For example, we don't know if amplification is protecting cognitive ability in adults. Or, perhaps, is amplification promoting cognitive development in children? These are difficult areas that are not going to be easily resolved.

Beck: And when we look at developing or maintaining cognitive function, there are hard-to-define factors, such as isolation, socialization, depression, and more.

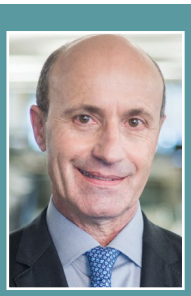
McCreery: Absolutely, and I'm sorry to say this issue has been lost on some of our colleagues. For example, when you dig deep into the excellent 25-year study by Amieva and colleagues,[3] they clearly state [in their Model 2] that, when psycho-environmental factors are considered [ie, depressive symptomatology, social network variables, comorbidities, IADL dependency, psychotropic drug use, and dementia] their research also found no differences in cognitive decline across the groups studied.

Ryan McCreery, PhD

Beck: That's an important point, Ryan, and I agree; many people reporting and referring to their results apparently didn't read the entire report.

McCreery: Right. And we don't know if there's a bi-directional impact such that, when people start to experience cognitive decline, they avoid or reduce their social interactions, and then maybe that snowballs…So we don't really know how it all unfolds at this point. What we have right now is associative relationships, which is a great starting point for exploratory work, but this doesn't prove causality.

Beck: And, of course, in June 2017, the National Academies of Science, Engineering and Medicine (NASEM)[4] stated that, despite recent discoveries in dementia and cognitive decline, we're still unsure as to what's what. Nonetheless, they reported the three main intervention areas are cognitive training, hypertension management, and physical activity. Then again, the recent *Lancet* International Commission on Dementia



Douglas L. Beck, AuD, is Executive Director of Academic Sciences at Oticon Inc, Somerset, NJ. He has served as Editor In Chief at AudiologyOnline, and Web Content Editor for the American Academy of Audiology (AAA). Dr Beck is an adjunct professor of audiology at Lamar University, and adjunct clinical professor of communication disorders and sciences at State University of New York, Buffalo. He also serves as Senior Editor of Clinical Research for the *Hearing Review's* Inside the Research column.

Prevention, Intervention and Care[5] stated that some 35% of all cases of dementia may be attributable to nine risk factors, with hearing loss being among the nine.

McCreery: Yes. So we're making progress, and hopefully one day in the not-too-distant future we'll have a better understanding of the relationship between cognition and audition.

Beck: OK, then, back to the new book. It seems to me about 98-99% of all children born in the United States are screened for hearing loss at birth. Is that about correct?

McCreery: Yes, those are the numbers I'm aware of. However, the loss to follow-up of those children who fail their screenings is between 30-50%. This varies state-by-state. Further, in reality, another huge topic is the failure to meet the JCIH guidelines.

Beck: You're referring to the Joint Commission on Infant Hearing (JCIH)[6] which stated the goals were "1-3-6," meaning screening by age 1 month, diagnosis by age 3 months, and intervention by 6 months of age.

McCreery: Exactly, and it seems that, within our studied cohort, only about one-third of the babies met all of these milestone. So, as a society of pediatricians, parents, audiologists, educators, speech-language pathologists, and more, we have a lot of work yet to do!

Beck: As you state in the book, the auditory experience of the child is diminished if the hearing aids are not worn consistently, and it appears many parents aren't compliant with hearing aid recommendations. In fact, you quote Walker and colleagues who found many infants wear hearing aids only about 4 or 5 hours per day.[7] Of course, we understand how difficult it can be to keep hearing aids on children, but it's worth noting that speech and language develop to a large degree based on exposure to language. So, if the infant is awake some 10-12 hours a day, but only has 4 hours or language exposure, that limited language exposure may reduce the child's speech and language potential.

McCreery: Right. Conversely, children who are consistent hearing aid users are expected to have stronger outcomes than their peers with very limited hearing aid use time. Not that we needed to do a study to figure this out, but we did do the study, and it turns out intuition was right this time! Hearing aid use not only improves speech and language skills, but the children who used their hearing aids consistently and more often were better able to understand speech in noise, even after we controlled for hearing loss and audibility through the hearing aids.

Beck: And so you've taken theoretical predictions and applied them to the day-to-day outcomes and once again proven the obvious! However, all joking aside, unless we actually do the work and run the studies, we're guessing. So, thankfully, we can state with some certainty that early hearing aid intervention *does* impact many aspects of the child's life, ability, and eventual outcomes.

McCreery: Exactly. Based on our model of "Cumulative Auditory Experience," we can state that children who wear their hearing aids consistently are much more likely to have better outcomes in the real world, as long as they have appropriate audibility for speech, comfort, and an improved signal-to-noise ratio (SNR).

Beck: To be clear, are you saying that hearing aids can improve the SNR?

McCreery: It depends on the type of amplitude compression being used, as well as the background noise, or type of masker, and the specific levels that we're talking about. And, of course, there are newer technologies which handle noise differently, and those are still being evaluated. But, absolutely, some of the newer technologies provide listening comfort without over-compressing the speech sounds.

Beck: In 2012, you published an excellent overview of noise reduction circuits available at that time, and you stated conclusively that noise reduction circuits don't increase or degrade word recognition, or speech intelligibility. I agree with that, and I've taken that discussion a little further when I say the advantages of noise-reduction circuits cannot be seen in the sound booth, yet we should use them all the time because the "secondary cognitive benefits" (eg, word recall, listening comfort, word learning rates, decreased listening effort, etc) are well founded, peer-reviewed, and offer significant benefit to the person wearing the hearing aids. Would you agree or disagree?

McCreery: Well, there are many things you just said that I would agree with. I would say that, in general, well-designed contemporary noise-reduction systems are beneficial, and we're not aware of any harm that comes about as a result of using them. However, and very importantly, we haven't really *measured* these benefits in very young children. All-in-all, I can say noise reduction is definitely not harmful, and reduced listening effort and increased listening comfort make good sense.

However, we don't have conclusive or direct evidence of these types of secondary cognitive benefits in very young children, so we need to be cautious. If we're looking for maximal SNR for children using traditional hearing aid noise reduction systems, I'd rather provide a good-or-mid-level hearing aid with an FM system, which might provide an SNR of 15 dB or more. But as you're fond of saying, Doug, "Everything depends on everything." And we all know FM system utility outside the classroom is rather low, so there are certainly times when a more pragmatic excellent noise reduction system will be more beneficial in the real world—depending on the specific situation.

Beck: That makes sense. So, rather than thinking about "A" is a good hearing aid circuit for kids or "B" is a bad circuit, we have to think more globally and determine which circuit is best for which person at which time and in what situation?

McCreery: Exactly, we have to focus on which features are best for the individual person—when they'll be beneficial and when they might be disadvantageous. We have to push the paradigm to not talk about good or bad, but to talk about the best solution for the specific situation.

Beck: Those discussion points take us to the topic of frequency lowering. That is, it's not good or bad; it *absolutely works* if we're talking about hearing or audibility. However, it's at the listening level—the ability to make sense of the sounds—where the controversy lies. The great unknown is who is the best candidate for frequency lowering?

McCreery: Knowing who is, and how to select the best candidate for frequency lowering is not clear and I could not agree more with you. Nothing is going to work all the time. Again, everything depends on everything. We have a new paper coming out in *JAAA* which has as its lead author Marc Brennan. He looked at listening effort with frequency lowering versus extended bandwidth versus restricted bandwidth, and he talks about the issue of making sounds more audible, but perhaps less familiar—and in that situation, it may take more cognitive effort to listen. I don't want to issue a "spoiler alert"; I'll just urge readers to take a look at that article when it comes out later this year.

Beck: OK, fair enough. So let me try this way…Given a moderate-to-severe hearing loss, and given three circuits—extended bandwidth, restricted bandwidth, and frequency

lowering—which is your "go-to" circuit?

McCreery: My "go to" choice would be extended bandwidth, because you're providing audibility without altering the spectral information. Doug, you wrote an article about the benefits of extended bandwidths,[8] and although some people may not believe it, that was pretty accurate; I think receiver bandwidth issues are significant and they're certainly not "parlor tricks." In fact, Kelsey Kimlinger, Dawna Lewis, and I published a paper[9] about how extended high-frequency bandwidth may be difficult to achieve, even for mild sensorineural hearing losses.

So, I believe the first, and usually the best, option is to go with high frequency amplification whenever possible, as some people are simply not going to be able to resolve the frequency-lowered information, even if it is audible. But where the rubber meets the road is how well the person does in background noise. Even if they're doing fabulous in quiet, that does not correlate to any particular speech-in-noise result. Speech-in-noise has to be tested and evaluated with the hearing aids on.

Beck: I absolutely agree. So then, one last question: I'm confused about your preferences regarding contemporary directional microphones?

McCreery: Well, as you say, one cannot really use the directivity index (DI) to tell us what's going to happen in the real world, because the DI is derived from a manikin, listening to pure tones in an anechoic chamber. However, the DI *does* allow us to compare apples to apples. What we need to know is the real impact of the directional circuit in the real world, where some 80-90% of all fittings are open-canal fittings.

Beck: Agreed, and my guess is you rarely get more than 1-2 dB of actual SNR benefit?

McCreery: That's correct. In 2009, Teresa Ching and her colleagues[10] showed that the children in their study were actually in situations where directional mics might be beneficial less than half of the time. For example, clearly a good situation might be found when a teacher is directly in front of the child, but that happens far less often than you might suppose. Nonetheless, all improvements in SNR are good, but some changes are so small they may not be detectable or measurably beneficial, and sometimes the expected benefit is not realized. But, importantly, the harm and the benefit are both so small that they may be irrelevant.

Beck: A new book by Todd Ricketts, Ruth Bentler, and Gus Mueller[11] says that an adaptive directional circuit is not likely to be harmful, and that same circuit may be more reliable than the child attempting to switch it themselves—and so the bottom line is…*Maybe!*

McCreery: Right. Everything depends on everything.

Beck: Ryan, it's been joy speaking with you. Thanks so much for your time and the frank discussion, and thanks to you and Elizabeth for writing a cutting-edge book about pediatric amplification.

McCreery: My pleasure, Doug, and thanks for your thoughts, time, and insights on these same issues!

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CORRESPONDENCE to Dr Beck at: dbec@oticon.com