VOLUME 20

2014
ISSN 1529-8604

JOURNAL OF EDUCATIONAL AUDIOLOGY

IN THIS ISSUE:

Official Journal of the Educational Audiology Association

ARTICLES

EDUCATIONAL AUDIOLOGY ASSOCIATION

What is EAA?

The Educational Audiology Association (EAA) is an international professional organization for audiologists who specialize in the management of hearing and hearing impairment within the educational environment. EAA was established in 1984 to advocate for educational audiologists and the students they serve. The American Academy of Audiology (AAA) and the American Speech-Language-Hearing Association (ASHA) recognize EAA as a related professional organization (RPO), which facilitates direct communication and provides a forum for EAA issues between EAA, AAA, ASHA, and other RPOs. Through the efforts of the EAA executive board and individual members, the association responds to issues and concerns which shape our profession.

> **EAA Mission Statement:**
> *The Educational Audiology Association is an international organization of audiologists and related professionals who deliver a full spectrum of hearing services to all children, particularly those in educational settings.*
>
> *The mission of the Educational Audiology Association is to act as the primary resource and as an active advocate for its members through its publications and products, continuing educational activities, networking opportunities, and other professional endeavors.*

EAA Membership

EAA is open to audiologists, speech-language pathologists, teachers of the hearing impaired, and professionals from related fields who have an active interest in the mission of EAA. Student membership is available to those in school for audiology, speech-language pathology, and other related fields. EAA also offers Corporate and Affiliate Memberships, which have unique marketing advantages for those who supply products and services to educational audiologists.

EAA Scholarships and Grants

EAA offers doctoral scholarships, as well as two grants for EAA members. In a continuing effort to support educational audiologists, EAA funds small grants in areas related to audiology services in educational settings. The awards are available to practitioners and students who are members of EAA for both research and non-research based projects. All EAA members are encouraged to submit proposals for these awards.

EAA Meetings and Events

EAA holds a biannual Summer Conference (in odd years), next scheduled for June 24 - 26, 2015, in St. Petersburg, Florida. These meetings provide opportunities for exchanging clinical and professional information with colleagues. The continuing education credits offered are an excellent way to keep updated in a rapidly changing field. These meetings offer individual members an opportunity to hear industry-known keynote speakers, keep up with new technology and information, share best practices, see the latest technology from the exhibitors, network, and more.

EAA Publications

Through its publications, EAA communicates the activities and ideas of educational audiologists across the nation.

- Educational Audiology Review (EAR) Newsletter: This monthly publication includes state-of-the-art clinical information and articles on current professional issues and concerns, legislative information, industry news and more.
- Journal of Educational Audiology (JEA): This annual publication contains articles relating to the practice of educational audiology.

EAA Products

Nowhere else can you find proven instruments, tests, DVDs, forms, accessories, manuals, books and even games created and used by educational audiologists. EAA's product line has grown as members share their expertise and develop proven materials invaluable to the profession. Exclusives available only through EAA include the *Therapy for APD: Simple, Effective Procedures* by Dr. Jack Katz and the *Knowledge is Power (KIP) Manual*.

700 McKnight Park Drive, Suite 708, Pittsburgh, PA 15237
Phone: 800-460-7EAA (7322) ● Fax: 888-729-3489
www.edaud.org ● admin@edaud.org

❖ CONTENTS ❖

❖ ARTICLES ❖

A Critical Review of Remote-Microphone Technology for Children with Normal Hearing and Auditory Differences

Erin C. Schafer, Ph.D.
University of North Texas, Denton, TX

Sarah Florence, Au.D.
University of North Texas, Denton, TX

Christine Anderson, B.A.
University of North Texas, Denton, TX

Jessalyn Dyson, B.A.
University of North Texas, Denton, TX

Suzanne Wright, B.A.
University of North Texas, Denton, TX

Katie Sanders, B.S.
University of North Texas, Denton, TX

Danielle Bryant, B.A.
University of North Texas, Denton, TX

The goal of this review is to provide an overview of published evidence to support the use of remote-microphone, hearing-assistance technology (HAT) in populations of children who have normal pure-tone hearing thresholds but exhibit significantly poorer auditory performance and processing than peers with typical functioning. These populations include children who are diagnosed with Auditory Processing Disorder (APD), Autism Spectrum Disorder (ASD), Attention-Deficit Hyperactivity Disorder (ADHD), Friedreich's Ataxia, Dyslexia, and Language Disorder. Following the review of evidence, an evidence-based protocol will be recommended that may be used to assess and fit HAT to these populations, and a case study will be provided to demonstrate how to implement the recommended assessment and fitting protocols.

Introduction

Published research provides evidence that several populations of children with normal pure-tone hearing thresholds exhibit significantly poorer auditory-processing abilities or speech-recognition performance than peers with typical functioning. These populations include children who are diagnosed with Auditory Processing Disorder (APD), Autism Spectrum Disorder (ASD), Attention-Deficit Hyperactivity Disorder (ADHD), Language Disorder, Friedreich's Ataxia (FRDA), and Dyslexia. The goal of this article is to provide educational audiologists and school personnel research evidence to support the educational hearing needs of these populations. The following sections will (1) provide an overview of the auditory deficits reported for these populations, (2) review published studies that support remote-microphone, hearing-assistance technology (HAT) for these populations (e.g., frequency/digital modulation [FM/DM] systems), and (3) recommend an evidence-based assessment and fitting protocol for HAT on these populations. The fourth and final section of this article will present a case study to demonstrate how the recommended protocols may be used to assess and fit remote-microphone HAT on children with normal hearing and disabilities.

I. Auditory Deficits

There is a large body of evidence to support the presence of auditory deficits in children diagnosed with APD, ASD, ADHD, Language Disorder, FRDA, and Dyslexia relative to peers with typical auditory processing and performance. The goal of this article, however, is to focus on published studies that simulated listening experiences in a noisy classroom, which will provide evidence for educational need for HAT in these populations.

First, given the varied nature of APD, children with this disorder may experience significant difficulties over a wide range of auditory tasks, such as temporal aspects of speech, dichotic listening, and hearing speech in the presence of background noise (Chermak, 2002). More specifically, one study suggested that children with APD showed significantly poorer speech recognition in noise at 0 and +3 signal-to-noise ratios (SNRs) by an average of 10% when compared to a control group without APD (Lagacé, Jutras, Giguére, & Gagné, 2011). Similarly, Muchnik et al. (2004) reported in a study that 12 of the 15 children with APD had speech-in-noise thresholds in at least one ear that were, on average, at least 20% lower and two standard deviations below the age and gender-matched control group. The behavioral deficits reported in the aforementioned studies are well-supported with subjective reports from parents and children regarding their listening and academic difficulties at school relative to peers who reported significantly less difficulty (Johnston, John, Kreisman, Hall, & Crandall, 2009). Additionally, results of this study highlighted the potential for significantly lower psychosocial function (i.e., locus of control, anxiety, depression, attention problems, and interpersonal relationships) in children with APD relative to peers. The underlying mechanisms involved in APD are not well understood. However, some investigators believe APD is associated with abnormalities in the efferent auditory pathway, more specifically, the medial olivocochlear bundle (Mishra, 2014; Muchnik et al., 2004).

Second, children diagnosed with ASD and ADHD also exhibit substantial and similar listening difficulties in background noise (Alcántara, Weisblatt, Moore, & Bolton, 2004; Corbett & Constantine, 2006; Gomez & Condon,1999; Rance, Saunders, Carew, Johansson, & Tan, 2010; Schafer et al., 2013b, 2014b; Tomchek & Dunn, 2007; Updike, 2006). In fact, these two groups are combined or compared in several studies because these children show similar deficits on many tasks including speech recognition in noise, auditory and visual attention, and parent-observed behaivors (Schafer et al., 2013b; Corbett & Constantine, 2006). When examining speech-recognition thresholds at 50% correct levels in children who were high functioning and diagnosed with ASD and/or ADHD as compared to performance of typically-functioning children in a control group, children with the disorders had significantly poorer (higher) thresholds on the order of 2 to 5 dB SNR relative to the control groups (Alcántara et al., 2004; Schafer et al., 2013b). Similarly, in a study specific to children with ADHD and learning disabilities, Gomez and Condon (1999) reported significantly poorer speech recognition in noise composite scores relative to a neurotypical control group of children with ADHD and no learning disabilities. In another study, Rance et al. (2014) reported significantly poorer auditory temporal processing (less sensitive to amplitude variations) and spatial processing (poorer binaural integration) for children with ASD relative to a neurotypical control group. One final study compared performance of children with ASD and ADHD and reported that both groups showed significantly poorer auditory attention in a quiet condition relative to a group of neurotypical children (Corbett & Constantine, 2006).

Behavioral deficits of the children in the ASD and ADHD aforementioned studies are supported by subjective data from the children and parents. First, both children with ASD and ADHD exhibit similar deficits for auditory filtering and sensitivity (Corbett & Constantine, 2006; Gomez & Condon, 1999; Mangeot, Miller, McGrath-Clarke, Simon, & Hagerman, 2001; Tomchek & Dunn, 2007). For example, 58% to 79% of parents reported that their children with ASD were distractible or could not function in noisy environments, were unresponsive to discriminative auditory stimuli, and had difficulty attending to auditory information (Tomchek & Dunn, 2007). Furthermore, another study suggests that the most significant predictor of educational performance is the child's auditory-filtering ability, defined as the ability to hear speech stimuli, complete tasks, and function in the presence of background noise (Ashburner, Rodger, & Ziviani, 2008).

Although the behavioral and observed characteristics of ADHD and ASD are similar, the underlying mechanisms involved in the two disorders are likely different. For example, Brennan and Arnsten (2008) reported structural differences in the prefrontal cortex and its connections to other parts of the brain. The prefrontal cortex is critical to achieving many tasks including sustained attention, behavioral inhibition, divided attention, and allocation of attentional resources; deficits in the prefrontal cortex result in forgetfulness, impulsivity, distractibility, and poor planning. On the other hand, recent research suggests that the multisensory deficits in children with ASD likely result from gene mutations and increased dendritic spine density (i.e., connections between neurons) in the temporal lobe relative to control groups (Tang et al., 2014). The increased number of connections among neurons is predicted to result in increased excitation and overstimulation in children with ASD. Additionally, according to Russo and colleagues, children diagnosed with ASD show abnormal speech-evoked cortical responses in quiet as well as noisy conditions relative to neurotypical peers (Russo, Zecker, Trommer, Chen, & Kraus, 2009).

Third, the presence of language disorders is also of concern because many children diagnosed with APD, ASD, and ADHD exhibit coexisting disabilities with language disorders as one of the most common. In fact, two of the first author's previous studies included several children who were diagnosed with multiple disabilities including ASD, ADHD, and language disorders (Schafer et al. 2013b, 2014b). Given the importance of language processing for completing speech-recognition and comprehension-focused tasks in the classroom, it is critical that HAT be considered for children diagnosed with language disorders, particularly when children are diagnosed with multiple disabilities.

Fourth, FRDA is a rare, neurodegenerative disease that results in steady multisensory decline as well as auditory neuropathy spectrum disorder. In one study highlighting the auditory difficulties in this population, Rance et al. (2014) reported that, on average, children with FRDA had significantly poorer phoneme-recognition scores in noise at a 0-dB SNR by 26% than typically functioning controls. Additionally, the children reported on a subjective questionnaire significantly more difficulty than a control group when communicating as well as in noisy and reverberant environments.

Finally, children diagnosed with Dyslexia often exhibit abnormal phonological processing. In one study, children with dyslexia showed significantly poorer average perception of Vowel-Consonant-Vowel stimuli in noise by 9% correct relative to children of the same chronological age (Ziegler, Pech-Georgel, George, & Lorenzi, 2009). The underlying neurobiological mechanisms associated with Dyslexia are still unknown.

II. Reported Benefits of Remote-Microphone HAT

Table 1 provides an overview of published evidence over the last decade that support the use of FM systems for improving speech recognition in noise and other auditory behaviors in children who are diagnosed with APD, ASD, ADHD, Language Disorder, FRDA, and Dyslexia. In most studies, children used ear-level, open-ear FM system devices designed for children with normal-hearing sensitivity. However, one study utilized body-worn FM systems with earphones. To date, there are not published articles on the digital (i.e., DM) systems for children with normal hearing, which were recently released to the market. Across most of the studies, there is a clear improvement in speech-recognition performance in background noise in conditions with versus without the FM system, with FM gains ranging from 17 to 86% for fixed-intensity stimuli and 6 to 10 dB for adaptive-test stimuli. Several studies also included behavioral tests specific to the population including tests of psychosocial function for children with APD (Johnston et al., 2009), comprehension in noise for children with various disorders (Schafer et al., 2014b), and phonological processing for children with Dyslexia (Hornickel, Zecker, Bradlow, & Kraus, 2012). In addition to behavioral measures, most studies utilized a subjective questionnaire for the child, parent, or teacher. Results of these questionnaires lend strong support for the use of FM systems in order to improve communication, comprehension, attention, and listening abilities, particularly in noisy or reverberant environments. The published evidence provided in the previous two sections may be used as part of the evidence-based assessment described below.

Table 1. Evidence Regarding Benefit of Remote-Microphone Technology in Children with Normal Hearing and Auditory Differences

Disorder; Participants	**Authors, Year**	**Test Measure: Results**
APD: • 10 APD • 13 controls	Johnston et al., 2009	1. Sentence recognition in speech-shaped noise at +5 dB SNR: Improved significantly by 10 dB with FM vs. without FM with greater FM benefit for APD vs. control group 2. Parent SIFTER: At baseline, APD significantly worse than controls for 'Academics', but the difference no longer existed for Academics after the FM trial 3. Participant LIFE: Significant benefit of FM over no FM when teacher talking in front of room, teacher talking with back turned, and other students making noise 4. Psychosocial function BASC-2: Improved ratings for locus of control, anxiety, depression, and interpersonal relationships
ASD: • 10 ASD with FM • 10 controls	Rance et al., 2014	1. Word recognition in babble at 0 dB SNR: Average improvement of 17% from no-FM to FM condition for ASD group and 10% improvement for control group 2. Child APHAB: Significantly less difficulty with communication, in noise, and in reverberation 3. Teacher LIFE: Teachers rated FM as "highly beneficial" for each child; FM improved listening/comprehension, classroom behavior, and general attentiveness
ASD/ADHD: • 7 ASD (2 ADHD; 2 APD) • ADHD (2 APD) • 11 controls	Schafer et al., 2013	1. Sentence recognition in babble, decreasing SNRs: Improved significantly by 6 dB over 2 separate test sessions; performance significantly worse than controls with no-FM, but with FM, performance similar to controls 2. Examiner-observed classroom behavior: Significant improvement of on-task behavior with FM vs. no FM 3. Teacher SIFTER: No significant improvements with FM vs. no FM 4. Teacher CHAPS: Significant improvements for noise, quiet, ideal, auditory memory sequencing, and auditory attention span with FM vs. no FM
ASD, ADHD, LD, or SLI • 12 subjects	Schafer et al., 2014	1. Sentence recognition in babble at -5 dB SNR: Right ear FM, left ear FM and bilateral FM significantly better than no-FM condition by an average of 65 to 86% 2. Listening comprehension in classroom noise at -5 dB SNR: Significant improvement with FM vs. no FM on main idea, details, reasoning, vocabulary, and understanding messages subtests 3. Student LIFE-R (n=8) and CHILD (n=7): Significant benefit of FM at school in classroom situations on LIFE; significant benefit of FM at home when in noise and in social situations on the CHILD 4. Parent CHILD: Significant benefit of FM in quiet, in noise, at a distance, in social situations, and for media
ADHD/ADD: • 31 subjects	Updike, 2006	1. Closed-set word recognition in white noise at +4 dB SNR: Average improvement of 34% with FM over no FM 2. Teacher questionnaires: Significant improvement in attention and listening skills
Friedreich Ataxia: • 10 subjects	Rance, 2010	1. Word recognition in babble at 0 dB SNR: Average improvement of 27% from no-FM to FM condition 2. Child APHAB: Significantly less difficulty with communication, in noise, and in reverberation
Dyslexia: • 38 subjects • 19 used FM • 19 controls with Dyslexia	Hornickel et al., 2012	1. Phonological processing and reading: Significant improvements after 1 year trial with FM while controls had no improvements 2. Auditory brainstem response to stop consonants: FM group had significantly improved neural consistency (i.e., repeatability) relative to the control group, particularly in children who showed the greatest gains in phonological awareness

Note. ADHD=Attention-Deficit Hyperactivity Disorder; APD=Auditory Processing Disorder; ASD=Autism Spectrum Disorder; APHAB=Abbreviated Profile of Hearing Aid Benefit; BASC-2=Behavior Assessment System for Children, 2nd edition; CHAPS=Children's Auditory Performance Scale; FM=frequency modulation system; LIFE=Listening Inventory for Education; LD=language disorders; SIFTER=Screening Instrument for Targeting Educational Risk; SLI=Specific Language Impairment; SNR=signal-to-noise ratio.

III. Evidence-Based Assessment and Fitting Protocol for HAT

According to the Individuals with Disabilities Education Act (IDEA, 2004), children with documented disabilities, such as those discussed in this article, may receive special education support when the disability interferes with their education. Additionally, children who are eligible for special education or who qualify under Section 504 services may receive assistive technology, which is defined by IDEA (2004) as any item, piece of equipment or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of children with disabilities. Remote-microphone technology, such as FM or digital-transmission (DM) systems, is a form of assistive technology because, as outlined in Table 1, it may be used to increase, maintain, and improve the functional capabilities of children with these disabilities. However, because these are not the typical populations who receive FM/DM systems, such as those with hearing aids or cochlear implants, educational audiologists and other school personnel often must show that the child has "educational need" in order to purchase the assistive technology. According to IDEA (2004), educational need should be determined through a functional evaluation of the child in the child's customary environment. However, no explanation of the components that should be included in the functional evaluation are provided. As a result, the following section will outline a recommended protocol for determining educational need in children diagnosed with APD, ASD, ADHD, Language Disorder, FRDA, and Dyslexia. This protocol also applies to children with hearing loss, hearing aids, and cochlear implants. The evidence-based protocol was based on methods used successfully in published studies (e.g., Table 1) as well as through clinical and educational audiology experience of the authors. Although, each the following measures has clinical value, the functional evaluation will need to be individualized to meet the needs of each student. The components of the recommended functional evaluation are outlined in Table 2.

When writing a report for a functional evaluation, an audiologist may, first, consider citing peer-reviewed literature related to listening difficulties, poorer speech recognition, and degraded auditory processing in children who are diagnosed with the child's disorder. Section I and Table 1 in this article may be used to cite degraded performance and to provide evidence that remote-microphone HAT significantly improves behavioral performance and subjective listening abilities of the children in these populations.

Table 2. Recommended Test Measures for a Functional Evaluation for Remote-Microphone Hearing-Assistance Technology (HAT)

Test Measure/Item	Description
1. Cite literature on the population	In report, cite research related to the benefit of HAT in the population under assessment.
2. Cite acoustics research/ measure classroom acoustics	In report, cite research about typical classroom acoustics that do not meet ASHA and ANSI recommendations. Measure classroom acoustics using software apps.
3. Classroom observation and interviews	Observe and document seating location, attention, participation, independence, and on-task/off-task behavior relative to a peer. Interview the child to assess hearing difficulty in class; interview parents to determine concerns.
4. Speech recognition or comprehension in noise	Conduct speech recognition or comprehension measures in soundbooth or child's classroom with speech and noise loudspeakers spatially separated.
5. Teacher questionnaires	Assess child's academic performance, communication, and listening behaviors in each academic class with questionnaires.
6. Other evaluations/goals and academic standing	Examine other evaluations and IEP goals to see if HAT could support difficulties found, and examine academic standing.
7. Trial with HAT	Conduct pre/post trial observations, interviews, questionnaires, and speech recognition/comprehension.

Note. ASHA=American Speech-Language-Hearing Association; ANSI=American National Standards Institute; IEP=Individual Education Plan.

Second, the audiologist may consider citing acoustics of typical classrooms (Knecht, Nelson, Whitelaw, & Feth, 2002; Nelson, Smaldino, Erler, & Garstecki, 2007/2008), which do not meet the recommended levels for unoccupied noise or reverberation recommended by the American Speech-Language-Hearing Association (2005; 2010) or the American National Standards Institute (ANSI; 2010). Additionally, Cruckley, Scollie, and Parsa (2011) reported occupied noise levels across different child listening environments including a daycare/toddler room, daycare pre-school, elementary school, and high school where, for 85% of the day, noise levels ranged from approximately 60 to 80 dBA. If the teacher's speech were approximately 64 dBA at a distance of 2 meters (~6.5 feet; Olsen, 1998), the majority of the school day could involve listening at negative SNRs.

Furthermore, because of today's handheld software apps, it is possible to measure classroom acoustics. In an article published in 2012, Ostergren and Smaldino (2012) describe how to measure unoccupied or occupied noise levels as well as reverberation times using one commercially available software app. Screen shots from this software may be saved or emailed in order to incorporate the data into the child's functional evaluation report.

Third, classroom observations may be conducted by the educational audiologist, speech-language pathologist, or special-education personnel to examine the child's seating location, attending behavior, classroom participation, independence on teacher-assigned tasks, and general classroom acoustics. The authors of this article use a form to organize the abovementioned information as well as to record information about the number of teachers and classrooms in which the student is educated, to document use of FM-system technology by other children in the child's school, to chart on-task versus off-task behaviors relative to a typically-functioning peer, and to record information from a student and parent interview regarding hearing abilities and difficulties at school.

Fourth, speech recognition and comprehension in noise measures are particularly useful for identifying hearing difficulties in simulated classroom environments and to examine benefit of remote-microphone HAT by comparing test conditions with and without HAT. To conduct speech recognition measures in the soundbooth or classroom, the examiner will need two loudspeakers (one at 0 degrees and one at 180 degrees azimuth equidistant from child: 3 to 6 feet), a compact disc player, a sound-level meter or acoustics software app to calibrate the signal levels, and a 2-channel speech-in-noise test to allow for spatial separation of speech and noise stimuli and loudspeakers. A critical review of speech-in-noise tests for children may be found in Schafer (2010), but the authors of this article typically utilize the Phrases in Noise Test (PINT) for younger children ages 3 to 5 years and the Bamford-Kowal-Bench Speech-in-Noise (BKB-SIN) test for children ages 6 years and older. The PINT estimates the 50% correct speech-in-noise threshold using 12 closed-set phrases and multi-classroom noise at pre-recorded SNRs (Schafer et al, 2012a, 2012b). The stimuli, recorded on a CD, may be repeated or acted out with a doll and objects (e.g., brush his teeth; comb his hair). The BKB-SIN standard or split-track (i.e., 2 channel) CD consists of open-set sentences in the presence of multi-talker babble presented at pre-recorded SNRs (Etymotic Research, 2005). The authors typically use the split-track CD to allow for testing with the remote-microphone technology, which would require spatial separation of the speech and noise loudspeakers (i.e., 0 and 180 degrees, respectively). Normative data from the PINT and BKB-SIN test manuals may be used to identify when children have significantly poorer performance than typically-functioning peers and to determine any significant improvement in speech recognition when using a FM/DM system relative to the unaided condition.

Recent studies showed that children with normal hearing have significantly poorer auditory comprehension (e.g., answering questions about story content) relative to speech recognition (e.g., repeating sentences) in conditions with the same SNR and level of reverberation (Schafer et al., 2013a; Valente, Plevinsky, Franco, Heinrichs-Graham, & Lewis, 2012). Comprehension, a higher auditory-skill level than recognition, is difficult for children because it requires a combination of recognition, cognition, attention, and working memory. Unfortunately, there are few, if any, recorded comprehension-based measures that are available for use in the clinic or classroom. However, the authors of this study have utilized the Listening Test 2 (Bowers, Huisingh, & LoGiudice, 2006) as well as the Ross Information Processing Assessment – Primary (RIPA-P; Ross-Swain, 1999) to examine the child's ability to comprehend auditory-only information. The Listening Test 2 consists of a series of stories, increasing in length, each of which are followed by questions about the story's main idea, details, vocabulary, reasoning, and understanding of the entire message. In a previous study (Schafer et al., 2013a), the authors of this study recorded the speech stimuli in this test using acoustic software on Channel 1 of a CD, and added classroom noise from the PINT to Channel 2 of the CD. Although this recorded version is not commercially available, audiologist may consider presenting the speech stimuli using live voice. Using the live-voice presentation mode, children could be tested in a quiet versus a fixed-intensity noise condition (e.g., speech-shaped noise from the audiometer or recorded multi-talker babble from the split-track BKB-SIN CD) or noise conditions with and without a FM/DM system. In a current study, the authors of this manuscript are using two sections of the RIPA-P to assess comprehension and auditory memory. The first subtest, Immediate Memory, requires participants to repeat digits, words, and sentences that increase in length and complexity. The second subtest, Recent Recall, requires participants to recall and provide verbal information about their environment and recent activities. Again, the RIPA is not recorded, but may be presented live voice and in the presence of noise.

Fifth, teacher questionnaires may be utilized to document auditory-listening, communication, and academic difficulties in the classroom relative to typically-functioning peers. The American Academy of Audiology (AAA, 2008) has an excellent resource that outlines functional outcome questionnaires for children. In the authors' experience, three questionnaires are particularly helpful for assessing children in the schools and include the Screening Instrument for Targeting Educational Risk (S.I.F.T.E.R.; Anderson, 1989), the Children's Auditory Performance Scale (C.H.A.P.S.; Smoski, Brunt, & Tannahill, 1998), and the Listening Inventory for Education – Revised (L.I.F.E.-R) for the teacher (Anderson, Smaldino, & Spangler, 2012). Each of these questionnaires provides normative data to suggest when a child has educational risk, listening problems, or auditory processing differences when compared to classmates. If the audiologist plans to assess listening difficulties in the home environment, the examiners often use the parent and child versions of the Children's Home Inventory for Listening Difficulty (C.H.I.L.D.; Anderson & Smaldino, 2011)

Sixth, when possible, educational audiologists or other school personnel may examine Individual Education Plan (IEP) goals and objectives as well as reports from other professionals to examine areas of difficulty. For example, many speech-language tests include subtests focusing on listening comprehension (e.g., following multi-step directions), which is often negatively affected in children diagnosed with ASD, language disorders, and sometimes APD. Additionally, the educational psychologist or diagnostician may administer intelligence tests that consist of verbal and non-verbal sections. In a child with a language disorder or listening difficulties, the verbal section likely will be substantially poorer than the non-verbal section.

Finally, when time and equipment permits, the audiologist may consider a four- to six-week trial period with remote-microphone HAT. The trial will also require a HAT fitting (described below) as well as teacher and school personnel training regarding appropriate use of the HAT during teacher-led instruction, group situations with a pass around microphone, and therapy situations. In the authors' opinions, there are some times during a school day where the child may not use HAT, such as on the playground, during P.E., and during lunch. Several of the measures listed in Table 2 can be repeated after the trial period including the classroom observations and interviews, speech recognition/comprehension, and teacher questionnaires. Additionally, the audiologist may want to interview other school personnel, such as the speech-language pathologist, occupational therapist, or teacher's aide, who use the HAT during the trial period.

After completing a previous study on children with ASD (Schafer et al., 2013b), the first author of this article realized the importance of individualizing the HAT fitting to each child, rather than choosing the manufacturer default volume setting, because several children reported that they would prefer a softer or louder signal from the FM system. We attributed these reports, in part, to the 30-dB range of normal hearing (i.e., -5 to 25 dB HL) for many school hearing screenings and the different size of children's ear canals. As a result, a step-by-step fitting protocol was developed and tested in typically-developing children with normal hearing (Schafer et al, 2014a) as well as in children diagnosed with various disorders (Schafer et al., 2014b) using the AAA recommendations (2008) as a guide. The four steps to the recommended fitting using the Audioscan Verifit are outlined in Table 3. Prior to the fitting, the audiologist will need to conduct an otoscopic exam and a behavioral hearing test. Also, the audiologist may consider determining the real-ear-to-coupler difference with foam insert earphone (ER-3A) to account for the difference between the 2-cc coupler and the child's ear, which is likely smaller. Otherwise, estimated age-related RECDs may be selected on the Verifit. In the previous investigations, the authors used estimated RECDs (Schafer et al., 2014a, 2014b) given the expected variability of RECDs with the open fittings.

Table 3. Recommended Real-Ear Measures for fitting Hearing Assistance Technology (HAT) on Children with Normal Hearing

Measurement	Description
1. Meet DSL v5 Target	On Verifit, select 'FM' as instrument and 'On-ear' as mode; present Speech-std[1] passage at 65 dB SPL. Inspect visually, and adjust FM/DM volume or gain to meet DSL target at 1, 2, and 4 kHz.
2. Measure MPO	Use same Verifit settings, but change stimulus to MPO. Inspect visually to ensure estimated uncomfortable loudness level not exceeded.
3. Measure REOR	Change instrument to 'Open' and mute transmitter. Present Speech-std[1] passage at 65 dB SPL.
4. Measure REUR	Remove the FM/DM receiver from ear, but leave probe in ear. Repeat presentation of Speech-std[1] passage at 65 dB SPL. Compare REOR to REUR to determine change in ear canal resonance.

Note. DSL=Desired Sensation Level v5; FM=frequency modulation system; DM=digital modulation system; MPO=maximum power output; REOR=real ear occlusion response; REUR=real ear unaided response; SPL=sound pressure level.

In Measurement 1, the goal is to meet the Desired Sensation Level v5 (Scollie et al., 2005) child prescriptive targets. To do this, the child's hearing thresholds are entered into the Verifit, the active transmitter microphone is placed in the Verifit sound chamber, and the probe microphone is placed in the ear canal along with the open-fit FM/DM receiver. With the Verifit set to 'FM' as the instrument and 'On-ear' as the mode, a 65 dB SPL speech input is then presented to the transmitter microphone. The examiner will, then, inspect the output on the Verifit screen and adjust the volume of the FM/DM receiver (often with the FM/DM transmitter), if necessary, to match the DSL v5 target as closely as possible for 1000, 2000, and 4000 Hz.

The second measurement will ensure that the maximum power output (MPO) does not exceed the estimated uncomfortable loudness level (UCL), which is predicted based on the child's thresholds and plotted on the Verifit screen. The settings for this measurement are the same as those used for Measurement 1, but the stimulus is changed to MPO. The examiner will visually inspect the output of the FM receiver to ensure the estimated UCL is not exceeded.

The third and fourth measurement are conducted to determine any changes in the unaided ear canal resonance from the placement of the receiver in the ear. Prior to this measure, the FM transmitter is turned off or muted, and the Verifit instrument is changed to 'Open'. The stimulus for both measurements is a 65 dB SPL speech input. Measurement 3 determines the Real Ear Occlusion Response (REOR) by leaving the FM/DM receiver on the ear (muted). Measurement 4, however, determines the Real Ear Unaided Response (REUR) by removing the FM/DM receiver with the probe microphone still in the ear. If the dome or method used to couple the FM/DM receiver to the ear causes a large change in the ear canal resonance (i.e., > 5 dB), particularly at 1000, 2000, and 4000 Hz, the audiologist may see other, more open, coupling methods (i.e., smaller dome) for the receiver.

Of course, not every child will participate in the fitting procedures, and in these cases the authors have adopted several procedures. First, if a behavioral hearing test cannot be obtained, we attempt to conduct distortion product otoacoustic emissions (OAE) to confirm normal outer hair cell function. Second, if a child cannot tolerate OAEs, the authors interview the parents regarding hearing responsiveness and previous hearing testing. If hearing thresholds must be estimated for the fitting procedures, the authors recommend very conservative 10 dB HL thresholds. Next, if children will not tolerate the real-ear fitting, the authors estimate the appropriate setting, at least for the Phonak iSense and Focus, at a +6 volume setting, which was the average volume setting necessary to meet DSL v5 targets in the Schafer et al. (2014a, 2014b) studies and in current research with the Focus. Future research will need to be conducted to examine settings for other products. Additionally, future research will need to more closely examine potential benefits of FM/DM classroom soundfield systems (loudspeaker) as well as less expensive, personal, body-worn FM systems coupled to children with earphones and earbuds.

III. Case Study

The following case study demonstrates how the abovementioned evidence-based assessment and fitting protocols may be utilized with a child who has normal hearing but exhibits substantial listening difficulties in noise and in the classroom.

Cheri is a 9-year-old girl who was referred for an assistive-technology evaluation following a request by her mother who was interested in determining the potential benefit of a FM system for use at school and at home. At the time of the evaluation, Cheri was diagnosed with ADHD, ASD, Language Disorder, and Intellectual Disability, and she had normal hearing from 250 to 8000 Hz according to pure-tone audiometry. During a parent interview, her mother reported that Cheri has poor grades as well as a difficult time listening and understanding, conversing with others, following directions at school, and attending at school. She frequently needs re-direction to complete a task. For the assessment, the educational audiologist decided to conduct behavioral testing in her soundbooth and to administer questionnaires before and after a six-week trial period with a bilateral open-fit FM system (Phonak iSense micro; inspiro).

Prior to the trial period, the system was fit using the abovementioned real-ear protocol (Table 3). For real-ear measurements 1 and 2, the audiologist was able to achieve FM output that was within 2 dB SPL of DSL v5 target, and according to the MPO, the estimated UCL was not exceeded for any frequency. Measurements 3 and 4 revealed minimal (3 dB) changes to the REUR when the receiver was in place (REOR) for 1000 through 4000 Hz.

Pre-post speech-recognition performance in noise, using fixed-intensity BKB-SIN at a -5 dB SNR, revealed a substantial increase in performance from 0% key-words correct with no FM to 70% key-words correct with bilateral FM. The Listening Test 2 was attempted, but she was unable to reliably complete the task in the no-FM or FM-system condition. The teacher C.H.A.P.S. reveled an average improvement from the at-risk to the normal range in noise (i.e., average noise score of -2 to 1), and the teacher L.I.F.E.-R indicated an average improvement from 39 (i.e., sometimes experiences listening challenges) with no FM to 59 (i.e., occasional listening challenges) with the FM system. Although the child's responses were somewhat unreliable on the student version of the L.I.F.E., average scores increased from 48 without the FM (i.e., sometimes experiences listening challenges) to 85 with the FM system (i.e., no listening challenges or very rare). Based on FM-system use in the home, the parent rated each situation on the C.H.I.L.D. questionnaire (i.e., quiet, noise, distance, social, and media) as better when Cheri was using the FM system versus when it was not used. Finally, the mother used a journal during the trial period to document situations where the systems was helpful or not helpful. Specific comments from the beginning to the end of the journal and trial period outlined in Table 4.

Using the recommended measures outlined in Table 2, the audiologist wrote a report that (1) cited literature and described the hearing difficulties of children diagnosed with ASD and ADHD; (2) outlined the impact of poor acoustics in typical classrooms; (3) explained the child's listening difficulties, which were described by the mother during the initial interview; (4) described the substantial improvements in speech recognition with the FM system and attempted comprehension testing; (5) reported the positive subjective FM-system ratings on the student, teacher, and parent questionnaires, and (6) provided the student's current academic standing in her courses. The test measures and citations used to assess the hearing needs of this child provide a clear picture of her functional performance in the customary listening environment, which in this case was at school and at home. Incorporation of the pre-post measures and the trial period allowed the audiologist to document and report degraded performance without the FM system at home and at school and substantially improved performance with the FM system in these same environments.

Conclusions

As discussed in Section 1 of this article, there are numerous peer-reviewed publications that reported significantly poorer speech recognition in noise, auditory processing (behavioral and electrophysiological), classroom performance, and overall listening abilities in children diagnosed with APD, ASD, ADHD, Language Disorder, FRDA, and Dyslexia. Educational audiologists have the opportunity to improve auditory performance in these populations by recommending the use of remote-microphone HAT, which is well-supported in the literature (Table 1). However, recommendations for HAT in these populations may be hindered by budgetary constraints or because the audiologist must document educational need for the HAT. As a result, the authors of this article provided recommendations for conducting an evidence-based assessment (Section III; Table 2) for HAT, which is intended to aid audiologists in obtaining the financial support necessary to purchase the equipment. Additionally, a step-by-step HAT fitting protocol was reviewed to standardize remote-microphone fittings these populations with normal hearing (Section III; Table 3). Finally, the case study provides a concrete example of how the recommended assessment and fitting protocols may be used with a child who is being assessed for remote-microphone HAT.

Table 4. Progression of Parent Journaling During a 6-Week FM-System Trial Period

1. She loved it and seemed more confident with it.
2. Her responses were quick without explanations and fewer questions.
3. She asked to wear the system.
4. She wore it in the car today, and her answers were quick; she seems less confused.
5. She wore it while playing with a friend and responded even when involved in play.
6. She wore it in a noisy lobby and answered me from across the room with a big smile. In the car, conversations were direct without confusion.
7. Still seeing a lot of quick and direct responses.
8. She does not like wearing it in the heat.
9. She is hearing and responding great in noisy places, even with kids crying next to her.
10. Wore system at mall; she was very responsive.
11. She had two friends sleep over, and there was a lot of activity and noise from 4 girls. She was hearing and responding to my statements.
12. The teacher told me that she thought the system was helping.
13. I am excited the system is helping my daughter. I would like the microphone to be wireless and for the earpieces to be labeled blue or red.

Note. Some journal entries were paraphrased.

References

Alcántara, J. I., Weisblatt, E. J., Moore, B. C., & Bolton, P. F. (2004). Speech-in-noise perception in high-functioning individuals with autism or Asperger's syndrome. *Journal of Child Psychology and Psychiatry, 45*(6), 1107–1114.

American Academy of Audiology Clinical Practice Guidelines. (2008, April). *Remote Microphone Hearing Assistance Technologies for Children and Youth from Birth to 21 Years*. Retrieved from http://audiology-web.s3.amazonaws.com/migrated/ HAT_Guidelines_Supplement_A.pdf_53996ef7758497.54419000.pdf

American National Standards Institute. (2010). *Acoustical performance criteria, design requirements, and guidelines for schools, Part 1: permanent schools* (No. ANSI S12.60-2010). Melville, NY.

Anderson, K. (1989). S.I.F.T.E.R. - Screening Instrument for Targeting Educational Risk. Tampa, FL: Educational Audiology Association.

Anderson K. L., & Smaldino, J. J. (2011). Children's Home Inventory for Listening Difficulties. Retrieved from http://successforkidswithhearingloss.com

Anderson, K., Smaldino, J., & Spangler, C. (2012). *Listening Inventory for Education - Revised (L.I.F.E. - R) - Teacher Appraisal of Listening Difficulty*. Retrieved from http://successforkidswithhearingloss.com/wp-content/uploads/2011/09/revised-Teacher-LIFE-R.pdf

Ashburner, J., Ziviani, J., & Rodger, S. (2008). Sensory processing and classroom emotional, behavioral, and educational outcomes in children with autism spectrum disorder. *The American Journal of Occupational Therapy, 62*(5), 564-573.

BKB-SIN: Bamford-Kowal-Bench Speech in Noise Test. (2005). Elk Grove, IL: Etymotic Research.

Bowers, L., Huisingh, R., & LoGiudice, C. (2006). The Listening Comprehension Test 2. East Moline: LinguiSystems, Inc.

Brennan, A. R., & Arnsten, A. F. (2008). Neuronal mechanisms underlying attention deficit hyperactivity disorder: the influence of arousal on prefrontal cortical function. *Annals of the New York Academy of Sciences, 1129*, 236-245.

Chermak, G. D. (2002). Deciphering auditory processing disorders in children. *Otolaryngologic Clinics of North America, 35*(4), 733-749.

Corbett, B., & Constantine, L. (2006). Autism and attention deficit hyperactivity disorder: assessing attention and response control with the integrated visual and auditory continuous performance test. *Child Neuropsychology*, 12, 335–348.

Cruckley, J., Scollie, S., & Parsa, V. (2011). An exploration of non-quiet listening at school. *Journal of Educational Audiology, 17*, 23-35.

Gomez, R., & Condon, M. (1999). Central auditory processing ability in children with ADHD with and without learning disabilities. *Journal of Learning Disabilities, 32*(2), 150–159.

Hornickel, J., Zecker, S. G., Bradlow, A. R., & Kraus, N. (2012). Assistive listening devices drive neuroplasticity in children with dyslexia. *Proceedings of the National Academy of Sciences. 109*(41), 16731-16736.

Individuals with Disabilities Education Improvement Act of 2004. Vol Public Law 108-446; 2004.

Johnston, K. N., John, A. B., Kreisman, N. V., Hall, J. W. III, & Crandell, C. C. (2009). Multiple benefits of personal FM system use by children with auditory processing disorder (APD). *International Journal of Audiology, 48*(6), 371–383

Knecht, H. A., Nelson, P. B., Whitelaw, G. M., & Feth, L. L. (2002). Background noise levels and reverberation times in unoccupied classrooms: predictions and measurements. *American Journal of Audiology, 11*, 65-71.

Lagace, J., Jutras, B., Giguere, C., & Gagne, J. P. (2011). Speech perception in noise: Exploring the effect of linguistic context in children with and without auditory processing disorder. *International Journal of Audiology, 50*(6), 385-395.

Mangeot, S. D., Miller, L. J., McIntosh, D. N., McGrath-Clarke, J., Simon, J., Hagerman, R. J., et al. (2001). Sensory modulation dysfunction in children with attention-deficit-hyperactivity disorder. *Developmental Medicine and Child Neurology, 43*(6), 399-406.

Mihra, S. K. (2014). Medial efferent mechanisms in children with auditory processing disorders. *Frontiers in Human Neuroscience, 27*(8), 860.

Muchnik, C., Ari-Even Roth, D., Othman-Jebara, R., Putter-Katz, H., Shabtai, E. L., & Hildesheimer, M. (2004). Reduced medial olivocochlear bundle system function in children with auditory processing disorders. *Audiology & Neuro-Otology, 9*(2), 107-114.

Nelson, E. L., Smaldino, J., Erler, S., & Garstecki, D. (2007/2008). Background noise levels and reverberation times in old and new elementary school classrooms. *Journal of Educational Audiology, 14*, 16-22.

Olsen, W. O. (1998). Average speech levels and spectra in various speaking/listening conditions: A summary of the Pearson, Bennett, & Fidell (1977) report. *American Journal of Audiology, 7*, 1-5.

Ostergren, D., & Smaldino, J. (2012). Technology in Educational Settings: It May Already Be In Your Pocket or Purse! *Journal of Educational Audiology, 18*, 10-13.

Rance, G., Corben, L. A., Du Bourg, E., King, A., Delatycky, M. B. (2010). Successful treatment of auditory perceptual disorder in individuals with Friedreich ataxia. *Neuroscience, 171*(2), 552-555.

Rance, G., Saunders, K., Carew, P., Johansson, M., & Tan, J. (2014). The use of listening devices to ameliorate auditory deficit in children with autism. *Journal of Pediatrics, 164*(2), 352-357.

Russo, N., Zecker, S., Trommer, B., Chen, J., & Kraus, N. (2009). Effects of background noise on cortical encoding of speech in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39*(8), 1185-1196.

Ross-Swain, D. (1999). Ross Information Processing Assessment – Primary (RIPA-P). Austin: PRO-ED.

Schafer, E. C. (2010). Speech perception in noise measures for children: A critical review and case studies. *Journal of Educational Audiology, 16*, 4-15.

Schafer, E. C., Beeler, S., Ramos, H., Morais, M., Monzingo, J., & Algier, K. (2012a). Developmental effects and spatial hearing in young children with normal-hearing sensitivity. *Ear & Hearing, 33*(6), e32-43.

Schafer, E. C., Bryant, D., Sanders, K., Baldus, N., Lewis, A., Traber, J….Algier, K. (2013a). Listening comprehension in background noise in children with normal hearing. *Journal of Educational Audiology, 19*(58-64). a

Schafer, E. C., Bryant, D., Sanders, K., Baldus, N., Algier, K., Lewis, A…Amin, A. (2014a). Fitting and verification of frequency modulation systems on children with normal hearing. *Journal of the American Academy of Audiology, 25*(6), 529-540.

Schafer, E. C., Mathews, L., Mehta, S., Hill M, Munoz, A., Bishop, R., & Moloney, M. (2013b). Personal FM systems for children with autism spectrum disorders (ASD) and/or attention-deficit hyperactivity disorder (ADHD): An initial investigation. *Journal of Communication Disorders, 46*(1), 30-52.

Schafer, E. C., Traber, J., Layden, P., Amin, A., Sanders, K., Bryant, D., & Baldus, N. (2014b). Use of Wireless Technology for Children with Auditory Processing Disorders, Attention-Deficit Hyperactivity Disorder, and Language Disorders. *Seminars in Hearing, 35*(3), 193-205.

Schafer, E. C., Wolfe, J., Algier, K., Morais, M., Price, S., Monzingo, J…Ramos, H. (2012b). Spatial hearing in noise of young children with cochlear implants and hearing aids. *Journal of Educational Audiology, 18*, 38-52.

Smoski, W. J., Brunt, M. A., & Tannahill, J. C. (1998). Children's Auditory Performance Scale. Tampa, FL: Educational Audiology Association.

Tang, G., Gudsnuk, K., Kuo, S. H., Cotrina, M. L., Rosoklija, G., Sosunov, A., …Sulzer, D. (2014). Loss of mTOR-dependent macroautophagy causes autistic-like synaptic pruning deficits. *Neuron, 83*(5), 1131-43.

Tomchek, S. D., & Dunn, W. (2007). Sensory processing in children with and without Autism: A comparative study using the short sensory profile. *American Journal of Occupational Therapy, 61*, 190–200.

Updike, C. D. (2006). The use of FM systems for children with attention deficit disorder. *Journal of Educational Audiology, 13*, 7-14.

Valente, D. L., Plevinsky, H. M., Franco, J. M., Heinrichs-Graham, E. C., & Lewis, D. E. (2012). Experimental investigation of the effects of the acoustical conditions in a simulated classroom on speech recognition and learning in children. *Journal of the Acoustical Soc America, 131*(1), 232-246.

Ziegler, J. C., Pech-Georgel, C., George, F., & Lorenzi, C. (2009). Speech-perception-in-noise deficits in dyslexia. *Developmental Science, 12*(5), 732-745.

A Critical Theory Response to Empirical Challenges in Report-Writing: Considerations for Clinical Educators and Lifelong Learners

Stella L. Ng, PhD, FAAA
Centre for Faculty Development, St. Michael's Hospital, Toronto CA
Centre for Ambulatory Care Education, Women's College Hospital, Toronto, CA
Department of Speech-Language Pathology, Faculty of Medicine, University of Toronto, Toronto, CA

Farah Friesen, MI
Centre for Faculty Development, St. Michael's Hospital, Toronto, CA

Elizabeth Maclagan, MPC
School of Professional Communication, Ryerson University, Toronto, CA

Victoria Boyd, MPC
School of Professional Communication, Ryerson University, Toronto, CA

Shanon Phelan, PhD, OT
Department of Occupational Therapy, Faculty of Rehabilitation Medicine, University of Alberta, Edmonton, CA

Purpose
Audiologists working with/in school settings write reports, communicating assessment results and recommendations. Yet there is a gap in education and professional development regarding report-writing and the effects reports can have on children and interprofessional relationships. This article highlights the ways that the linguistic and visual construction of reports affect possibilities for children and inter-sector collaboration among clinicians, school-based professionals, and families.

Methods
We began with two main problems stemming from report-writing, as identified in a larger research study of the clinic-school interface. We employed a critical social science theoretical framework to generate three considerations for report-writers to ameliorate the two problems.

Results
Two main issues were generated from a secondary examination of the empirical dataset: 1) clinicians advocate by proxy, through written reports brought to schools by parents, thereby precluding dialogue among clinicians and school-based professionals; and 2) parents place importance upon clinicians' reports, which contributes to the exclusion of parent and child perspectives. The three considerations to address the issues were: 1) include dialogic language in report-writing to invite direct communications amongst families, clinicians, and school-based professionals; 2) develop awareness of how language actively shapes and impacts children's identities and opportunities; and 3) format written reports based on visual rhetoric to invite and represent family-clinician-school dialogue.

Conclusions
Applying a critical social science perspective to report-writing enables us to provoke change in recurrent, problematic practices at the clinic-school interface. This article is not meant to be a prescription; rather, it is an opportunity to question assumptions and engage in more sensitive and informed practices for and with children, families, and other professionals.

Introduction

Reports have been described as "the tickets of safe passage for patients traveling to seek further care, and they are the visible currency of sanctioned co-operation among healthcare providers" (Lingard, Hodges, MacRae, Freeman, 2004). Indeed, health professionals frequently create and receive written reports, detailing assessment results and recommendations (Angell & Solomon, 2014; McConnellogue, 2011; Ng, Fernandez, Buckrell, & Gregory, 2010; O'Keeffe & McDowell, 2004; Oberklaid, 1988; Schryer, Gladkova, Spafford, & Lingard, 2007). Importantly, these reports may be the primary communication method between clinical and educational professionals (Ng et al., 2013a). Yet reports may not always serve as "tickets of safe passage" in actual practice. Problems in supporting children with school-based health needs are well documented, and often stem from a breakdown in the communication and collaboration between clinicians (e.g. audiologists in clinical practice) and school-based professionals (e.g. teachers, principals, educational audiologists and speech-language pathologists) (Ng et al., 2013a; Roberts, Price, & Oberklaid, 2012; Villeneuve, 2009).

There is a dearth of literature to guide the education of audiologists toward creating meaningful, sensitive, and useful reports for a school-based audience (Baxley & Bowers, 1992; English, 2006; Gozenbach, 2000; Pannbacker, 1975). This gap exists in spite of the established importance of written communication in representing, reinforcing, or resisting professional boundaries (Schryer, Lingard, & Spafford, 2007). These boundaries are linked to the notion of 'discourses.' According to the critical social sciences, any field, including biomedical sciences, operates within and through particular 'discourses,' which are language- and text-mediated systems of meaning and truth (Greenhalgh & Wieringa, 2011; Wodak & Meyer, 2009).

A critical social science perspective on report-writing could thus shed new light on the matter by challenging commonly and tacitly held discursive (discourse-based) assumptions. Specifically, in report-writing, critical social sciences let us 'deconstruct' the linguistic and visual construction of reports, in order to identify and thus change unintended negative practices. Therefore, the critical social sciences are crucial for the realization of report-writers' intents, by uncovering taken-for-granted routine practices and their discursive and social influences. Further, the language and texts (texts include documents and other visual representations) that audiologists and other professionals use to describe and discuss children is influential in the shaping of children's identities (Phelan, Wright, & Gibson, 2014; Phelan & Kinsella, 2009). Therefore, one must be conscious and sensitive in writing about children and their needs (Phelan et al., 2014).

In this article, we use the broad theoretical framework of critical social sciences to encourage audiologists to create written reports that are as helpful as possible and unlikely to cause harm. We will also draw upon visual rhetoric to offer some practical, theoretically-informed strategies to meet this challenge. A starting point for audiologists new to the critical social sciences is to appreciate that language is an active, constitutive force in the shaping of actions, identities, knowledge, and opportunities. Language, in this view, is not merely a neutral mechanism that enables humans to communicate. Rather, language is a social act that carries intended and unintended meaning, reproduces or resists social norms, structures society, represents and constitutes ideology, and actively shapes individuals' identities and possibilities (Phelan et al., 2014; Stooke, 2010; Wodak & Meyer, 2009). We suggest that while this article may, at times, challenge commonly held assumptions about knowledge and practice, it is precisely the bridging of audiology with the critical social sciences that will enable the field to see and practice differently if it so chooses.

The rationale for this article is to respond to empirical evidence, from the authors' and others' research of the types of problems that written reports can create, and the role they play, in helping children and families access appropriate school support (McConnellogue, 2011; Ng et al., 2013a; Rix & Matthews, 2014). The authors are interdisciplinary social science scholars with a health professions education and practice research focus. They have practice backgrounds in audiology, library science, professional communication, and occupational therapy. The considerations proposed may be useful to the educators of audiologists (clinical supervisors and academic faculty members), and to practicing audiologists who seek change and emancipation from social structures insidiously governing practice. In creating this article, we drew from the programs of research of the first and last authors (Ng et al., 2013a, 2010; Phelan & Kinsella, 2013; Phelan & Ng, 2014; Phelan et al., 2014; Phelan, 2011; Phelan & Kinsella, 2009), and the research projects of two Master of Professional Communication scholars (VB and EM), all which focus on various aspects of the clinic-school interface for children with disabilities.

The clinic-school interface serves as the context of this article, and refers to any interaction – among families, clinicians, and school-based professionals – occurring when a child with disability requires access to school-based health support. The article structure is as follows. Two overarching theoretical orientations inform this report and are introduced herein: critical social theory and semiotics. Within these broad theoretical domains, we focus specifically on critical sociology, critical disability studies, and visual rhetoric. We begin with a summary of common problems related to written reports at the clinic-school interface, derived from the dataset of the authors' ongoing program of research. Next theoretical frameworks are used to generate considerations to ameliorate these problems. Suggestions for change include more thoughtful language practices, with an awareness of language as social action, and attention to the visual construction of written reports.

Method

This article is not a primary research paper. Instead it re-analyzes an empirical dataset that was derived from a long-term qualitative program of research that began in 2011 and continues today. This program of research aims to understand what 'work' occurs at the clinic-school interface to support children with disabilities, and what coordinates or influences this work. Work, in this context, is broadly defined to include both official paid work and unofficial unpaid work (Quinlan, 2009; Turner, 2006). An example of the latter type of unofficial work is a mother bringing reports from a clinician to the school. The dataset that we draw upon for this paper included three types of data from 27 informants: interviews with parents and professionals, observations of school meetings, and an archive of texts. The textual archive included forms, reports, protocols, and policies at the clinic-school interface, as well as related news media reports. Interviews were recorded and transcribed verbatim; the researchers performing observations typed up their fieldnotes, and the document archive was compiled digitally.

The analytic process involved a qualitative analysis of data, conducted by the first author, with use of qualitative coding software to assist with data organization (QSR International Pty Ltd., 2008; SocioCultural Research Consultants LLC, 2014). First, data were labeled (coded) based on the work processes that were occurring. Next the work processes were categorized according to common and routinized work processes across the dataset. Associations were made between the identified work processes and related documents from the textual archive. It became apparent that the texts and documents (e.g. professional discourses, policies) served as social coordinators of the work processes; that is, the documents affected how clinicians performed their work (e.g. report-writing). This analytic process is consistent with the institutional ethnography approach – an approach rooted in critical social science – that was employed for the larger study (Ng et al., 2013a; Smith, 2006). In qualitative research, data are not numeric but rather textual. Therefore, findings do not tend to take the form of graphs and statistics, but rather of textual representations such as diagrams or written explanations.

In generating the considerations included in this article, we started with two key problems identified in our prior research, shared in the following section. Then we turned to critical and semiotic theory to examine how the challenges identified at the clinic-school interface could be ameliorated through more attentive discursive and visual construction of written documents. The aim of introducing these theoretical considerations to the practice of report-writing is to enable genuine collaboration amongst families, professionals, agencies and systems, toward enablement of children to achieve their self-determined goals.

Findings: Two Relevant Issues

Two main issues were derived from two main work processes identified in the empirical dataset. The two work processes were previously reported by the team of investigators conducting the larger study (Ng et al., 2013a; Ng & Lingard, 2014; Ng et al., 2013b; Phelan & Ng, 2014). We summarize the work process findings here to situate them within the audiology / educational audiology context. The two main work process findings were: 1) clinicians from our dataset were often advocating for children to gain school support through written reports; in so doing, clinicians were advocating by proxy and 2) clinicians were often navigating a complex terrain (school context) without a map (contextual awareness and understanding) of the education system's structure. These two work processes, in turn, resulted in two problematic issues: 1) conflict can be instigated and perpetuated by clinical reports, and 2) parents and children can be inadvertently excluded or silenced by clinical reports. These issues are explored next, as the basis for this article.

Issue 1: Conflict can be instigated and perpetuated, to the detriment of children and families

Clinicians were advocating by proxy, using written reports in an attempt to secure school support for children. Indeed, all of the clinician participants espoused advocacy as a key function they served, yet they described their advocacy as taking the form of a written report handed to a parent or sent to a school (Ng et al., 2013b). While this work occurred with good intent, it often created problems in which conflicts or confusion about the content of the reports were not always communicated back to the clinician. For example, educators described how written reports may contain unrealistic or infeasible recommendations; yet, there was no standard mechanism for clinicians and educators to discuss such recommendations. Therefore, clinicians may not be informed or aware that some recommendations were perceived as inappropriate in the school context. Without a communication channel between clinicians and school-based professionals, the clinician's practices (e.g. report writing) may fail to become more effective over time, and may perpetuate conflicts within the education context, hindering rather than facilitating children in receiving school support. Written reports cannot fully speak for themselves nor respond to questions, and they are often translated into other forms, including being excerpted, in direct quotation or paraphrased form, on Individual Education Plan (IEP) documents. In contexts where an educational audiologist (or other intermediary) is present, this situation may be ameliorated. But educational audiologists in our dataset reported facing similar challenges in trying to mediate between clinicians and school-based professionals.

Issue 2: Parents and children can be excluded through written reports

Some clinicians demonstrated savvy and had built relationships with school-based professionals, enabling them to work effectively with and for families. Other clinicians – particularly those unfamiliar with the education system – were struggling. This clinician-professed naivety was concerning because parents often put significant weight on the content of reports. We even witnessed parents wielding reports in school meetings in an attempt to accrue and establish more authority in their advocacy attempts. Not all clinicians were fully aware of the role(s) of written reports, or of how reports were used and interpreted by parents, educators, or school-based health professionals. Without contact between clinicians and school-based professionals, the written report was often perceived as the only tool available for parents to use as 'proof' in acquiring support for their children. Therefore, clinicians may have affected the behavior of parents by consciously and unconsciously guiding parents to use written reports to advocate. In this way, parents' and children's voices were rendered somewhat peripheral in the process of determining support at school. That is, parents and children may be involved in meetings, and parents may use reports to advocate, but in some respects, the report-writing practices reinforce their backseat role relative to the professionals who create and supply the 'official' knowledge of documents and records. We saw, in our dataset, instances of considerable time and effort exerted in pursuit of one support (e.g. technology) at the cost of other forms of support. Meanwhile, actual desires and voices of parents and children were sidelined as the focus became the pursuit of, resistance to, or resolution of conflict about the object of a written report.

These two issues, presented above, are not identified as the faults of clinicians; systems are complex and practices are influenced by many social factors. For example, the classification discourse, represented and mediated by the Diagnostic and Statistical Manual and other diagnostic standards, leads to the creation of reports that identify or diagnose children with disabilities or disorders (Wang, 2012). This classification discourse pervades medical and educational settings. In educational settings, classifications and categorizations of children are documented in IEPs, through which needs and support can be outlined. Although there may be instances when categorizing a child may have harmful effects, professionals and parents are in some sense guided toward the classification route, as if it is the only course of action. These classification practices, which may inadvertently cause burden and harm to families, are normalized and regularized as everyday processes at the clinic-school interface (Blum, 2012; Gibson et al., 2009; Innocenti, Huh, & Boyce, 1992; Rehm, Fisher, Fuentes-Afflick, & Chesla, 2013; Smith, Oliver, & Innocenti, 2001). We have previously reported data in which parents lamented the need to classify or label their children, yet they realized that it was necessary in order to function within current systems (Phelan & Ng, 2014). The classification approach is not the only available approach, but it is the current dominant approach, largely influenced by the International Classification of Functioning (Hollenweger, 2013). An alternative is the social relational approach, which is subtly but importantly different, and requires engagement with critical social sciences as opposed to biopsychosocial perspectives (see Reindal, 2008).

Applying a Critical Social Sciences Lens: A Brief Introduction

The tendency for members of society to adhere to the status quo, even when the status quo may be harmful, is termed hegemony (Wodak & Meyer, 2009). It is the function of critical social scientists to reveal how dominant, hegemonic discourses function in everyday life. Recall, the use of the term discourse throughout this article refers to a language- and text-based (including visual images) system of meaning that shapes how we 'see,' what we think and do, and what is considered 'normal' (Hodges, Martimianakis, McNaughton, & Whitehead, 2014; Hodges, Kuper, & Reeves, 2008; Phelan et al., 2014; Wodak & Meyer, 2009). These ways of seeing, thinking, and conceiving of normality are 'socially constructed' by those with authority in society. These ideologies (ways of thinking and understanding) may be preserved as a way to maintain prevailing power relations (Wodak & Meyer, 2009). Foucault has referred to "regimes of truth" and "technologies of power" that limit and constrain practice, at the service of particular groups and at the expense of other groups (Kemmis, 2005). While we are not implying that particular groups are striving consciously to maintain power per se, these regimes of truth may influence actions such that existing ideological and work structures are perpetuated, along with their hidden or subtle effects (Smith, 2006; Wodak & Meyer, 2009).

For example, the discourse of 'compliance' positions patients to follow the instructions of a health professional. Otherwise, they are 'constructed' as non-compliant (Hodges, Kuper, & Reeves, 2008). Recall that by 'constructed,' we refer to how discourses construct possibilities for individuals and groups in society, and create objects as products of the discourses. This discourse of compliance creates a particular power structure between the patient and the health professional and thus constructs typical subject positions or identities for patients and health professionals. But compliance is not a natural phenomenon that has been discovered scientifically. Rather, the discourse of compliance is a social construction, which has powerful effects on how patients are discursively/socially 'constructed' as either 'good, compliant' patients, or 'deviant/difficult, noncompliant' patients. Therefore, in a discourse of compliance, an adolescent choosing not to use his/her hearing assistive technology (e.g. an FM system) is framed as choosing poorly in terms of setting him/herself up for 'success.' Efforts to encourage use are then framed, within this discourse, as educating and counseling the teen (toward compliance) to appreciate how the FM system will enable him/her to achieve his/her goals. But these goals are often presented as normative societal expectations and definitions of educational and social success. When seeing through only a discourse of compliance, one may fail to consider how the very efforts to educate, counsel, and convince a teen to use his/her FM system can be disempowering and evoke resistance from the adolescent. A discourse of compliance constructs a lack of autonomy in a teen at a time when s/he may be avidly seeking a sense of autonomy. Through a critical perspective, we would argue that we, as a field, are limited in our understanding and approach when we operate naively within a discourse that constructs teens as making the 'right' choice for themselves only when they are following the wishes of older, wiser, health professionals, educators, and parents.

Critical disability studies, as a field, was sparked by resistance to "regimes of truth" that have driven the medicalization of disabilities (Block et al., 2005; Erevelles, 2005; Molloy & Vasil, 2002; Phelan et al., 2014). While professions like medicine, audiology, and occupational therapy espouse intentions of enabling equitable access and opportunity for individuals with disabilities, the language used to discuss disability can be entrenched within a dominant discourse that sets up health and rehabilitation professionals to fix, to rehabilitate, and to treat. This arrangement can have inadvertent negative effects on patients when it contributes to negative portrayals of individuals with disabilities as having something that needs to be 'overcome' or to be 'fixed.'

Indeed, person-first language is problematized (challenged) in critical disability studies. Calling someone "a person with disability," while supposedly aiming to be sensitive, implicitly suggests that individuals are people first, but carry their disability with them at all times, as if it is something they possess (Titchkosky, 2001). Critical disability studies reclaims the term disability, and uses the term 'disabled,' by explaining that societal factors can disable people. For example, if a train station has poor signage and poor acoustics, this societal context has disabled certain individuals. They are not people with disabilities, but, in this instance, are disabled by society. This framing, thereby, positions disablement as something to be overcome in society rather than in individuals. The disablement is an action that is done to the individual, rather than a ‘natural’ feature that is inherently affixed to the individual (Liasidou, 2013; Phelan, 2011).

We intend, through the example of disability and disablement and the prior example of compliance and technologies of power, to demonstrate a key practice of critical social science: critical reflexivity. Critical reflexivity involves reflection upon taken-for-granted assumptions, values, norms, possibilities, and positions, in relation to power structures embedded in cultural, social, political relations (Phelan & Ng, 2014). We next apply this practice to the process of creating recommendations to redress the two issues presented above (the issue of creating and perpetuating conflict with reports, and the issue of silencing and excluding parents and children).

The Recommendations

In this section, critical social theory is used to reveal hegemonic practices within clinicians’ written reports. Recall that hegemonic practices refer to recurrent, normalized practices that we may not realize are doing harm because they seem natural. By identifying these hegemonic practices, we seek to illuminate ways that clinicians may be more critically conscious and thereby more sensitive to how their language practices are implicated in a complex social web. With the type of awareness we raise next, report-writers may be empowered to exact more deliberate control over their own language practices toward realizing their espoused goals of supporting children.

Written construction considerations

We begin with a disclaimer – we presume that no competent audiologist intends harm in their written reports. Instead, we assume the opposite – that audiologists write reports with the hope of supporting children. Therefore, if report-writers can be sensitized to the powerful effects of language, they may be able to avoid some of the pitfalls in creating reports that reproduce hegemony and dominant discourses. Again, we emphasize that the reproduction of dominant discourses is not necessarily conscious; yet, it is important to recognize how and when one might be caught up in doing so. Through actions, all individuals unintentionally (and at times intentionally) reproduce societal norms that may be harmful, as that is the very nature of a dominant discourse and of hegemony. Language is social action (Lingard, 2007). Critical theory raises awareness to the potentially harmful effects of routinized social acts, including language use, showing the interconnectedness of seemingly independent acts, and thus liberating us from their rule (Smith, 2006; Wodak & Meyer, 2009).

Practically speaking, report-writers might consider the following two effects of language. First, directive phrases in reports, from clinician to school, can set up children, families, and professionals for conflict even if they were written with collaborative or advocacy intent. Second, report-writers should pay attention to language that 1) alludes to disability as a feature inherent in the individual, 2) sets those involved on a path of striving for normality, and 3) implies a passive role of the child and family.

Directive phrasing (e.g. “the teacher should…”) in clinicians’ reports can set up a relationship precluding collaboration and dialogue. It is important for clinicians to recognize that school-based professionals may have a different (but not necessarily incorrect) position relative to supporting a child’s needs and context. Paying attention to language use would alert report-writers to the possibility that phrasing in reports can come across as either directive (as if clinicians can and should dictate and direct what happens at a school), or as collaborative (in which case genuine dialogue between clinicians and school-based professionals is invited). For example, a clinical audiologist may be unaware of the complexities of the classroom setting (e.g. there are 6 children, in one classroom of 24 students, all requiring considerable support). Further, the clinical audiologist may not fully realize the ways in which the work of educators is tied, inextricably, to policies and discourses of categorization and classification. Therefore, the clinician may have unrealistic expectations of the educators. In our dataset, we saw that clinicians and school-based professionals were often ‘pitted against’ one another, as a result of dueling systems and not of their own desire to work against one another.

Here, a critical approach can help in illuminating the influence of discourses and policies on local practices. For instance, critical theorists and sociologists describe how texts like medical reports, policies, and protocols, are a mechanism for social coordination, which carry within them the messages of dominant discourses (Smith, 2006; Smith & Schryer, 2008; Stooke, 2010). Because we use these texts every day, we become unaware of their influence on our actions as we tend not to question their authority. Therefore, we may not question why we use texts in the way that we use them, or see how they shape our choices. It is difficult to see and think outside a dominant discourse, since it is a dominant system of meaning and truth. Critical reflexivity is an attempt to do this: How often have you, as an audiologist or educator, questioned the taken-for-granted language in use, such as ‘accommodation’ and ‘(re)habilitation,’ and what these discourses lead one to do and see as normal?

Applying critical theory would enable audiologists to see that they are socialized to practice in a particular way. That is, audiologists are wording assessment results and recommendations in a way that is deemed ‘professional,’ perhaps in the name of advocacy, which is a key professional duty. Through a critical lens, one may see that similarly, school-based professionals have been socialized through a related but different set of social structures. For instance, when a clinical report arrives at school recommending hearing assistive technology for a child, the recommendations may be contraindicated in socially complex ways (e.g. children in one classroom with competing needs). The contraindications may be apparent to school-based professionals, but not to the clinical audiologist. Without the opportunity for dialogue among parents, children, clinicians, and school-based professionals, parents may be compelled to explain or advocate for the clinician’s recommendations. Due to the advocacy role placed on parents, they may feel that a tangible solution directly recommended by an expert clinician is being resisted, without good reason, by the school. The communication channels may be open between clinicians and parents, or parents and schools, but all three groups are not usually in dialogue together at once.

Opening up dialogue through truly collaborative report-writing is thus an opportunity for clinicians to circumvent such conflict. For example, the school professionals’ concerns about the technology’s appropriateness may be valid; or, the school professionals may misunderstand the report writer's intent. Together, the family, clinicians, and school-based professionals may be able to find an appropriate solution. While many will argue that the health and education systems are not set up for such collaborative dialogue to occur, we argue that through critical awareness individuals may be better able to act as agents of change. In our larger dataset, we saw instances of clinicians who had indeed employed a critical social awareness to their practices. For example, a pediatrician described long, nurtured relationships with audiologists, speech-language pathologists, school principals, and others. She had developed relationships that enabled her to make phone calls to teachers, and to send notes as a clinician partner to the school rather than as just another faceless clinician. She did not speak of clinicians and school professionals working on different 'sides;' she seemed subtly aware of power relations between organizations and individuals and able to work within them in a nuanced way. We argue that structures and protocols to enable dialogue could be helpful but would be insufficient if implemented without a critical social science orientation.

In addition to the first consideration of directive phrasing, clinician report-writers could also critically examine language use in relation to disability and normality. For example, a sentence suggesting that a child has "best chances for success through technology" risks representing the child as passive and powerless, yet at the same time positions the child to shoulder the burden of achieving 'success' as s/he grows up. A recommendation worded as "John should be reminded to run through his hearing aid and FM system check every morning. He needs to use the FM system to ensure he has the best chance at success in the classroom" indicates a narrowly conceived view of what is 'best' and what is 'success.' In this phrasing, what is 'best' and what is 'success' is vague, and assumes a universal definition of 'best' and 'success' (Phelan et al., 2014). Further, while enabling John's self-advocacy and independence may be the intent of the preceding example, alternative phrasing could place more responsibility on others to be accepting and supportive, while also sending a message that John is an agent of his own journey. This message could perhaps be conveyed in a section labeled "What we can do to support John."

Linguistically passive conceptualizations of children directly contradict attempts to support children to actively work towards their own development and decision-making (Gibson et al., 2009). These representations insinuate that children do not possess the autonomy, ability, or ambition to achieve their goals. While we suggest linguistically positioning children in written reports as active agents in their own lives, we simultaneously raise caution against independence as the singular ideal. In the discourse of independence, which is prevalent in rehabilitation technology marketing materials and thus influences clinicians' written reports, lies a potentially harmful effect (Phelan et al., 2014). Independence may be a goal that seems universally positive and inherently better than dependence (such dualisms are not productive, nor do they consider culture and context), but there are instances in which independence as a discourse may actually transition a child from having support to not having support, since independence was the goal of the initial support (Phelan et al., 2014; Phelan, 2011). This message toward independence could also be detrimental, particularly as a child transitions from elementary to secondary school, and secondary school to the workforce or post-secondary education. Independence can be construed as an attempt to normalize a child with hearing loss, by conforming him/her to society and enabling him/her to 'fit in' through technology use, rather than building a society to be accepting and supportive. As a field, we could take some onus off of children to conform, through critical awareness of the subtle messages transmitted through language in written reports. Specifically, we need nuanced understandings of how messages of normality, disability, success, and failure actively shape, define, and affect a child's identity and opportunities (Phelan, 2011; Phelan & Kinsella, 2009).

A failure to attend to these discursive influences may underlie failed attempts at supporting children and families (Phelan & Ng, 2014). For example, audiologists may be socialized to reproduce discourses that aim to minimize the perceived differences of children with hearing loss. This discourse is exemplified through the notion that assistive technology can make children appear more 'normal'(Phelan et al., 2014). Although these messages may stem from good intentions, they can potentially damage children's self-image by reinforcing their perceived differences (Phelan et al., 2014; Phelan, 2011). This critical perspective does not aim to position assistive technologies as harmful. Rather, it demonstrates that the language used to describe such technologies can be rooted in hegemonic (entrenched, normalized) practices that may be damaging for children. Children receive mixed messages, on one hand, about "being accepted for who they are," and on the other hand, the importance of using technology to "be more like everyone else." Critical theory enables critical reflection on report-writing, encouraging awareness of linguistic choices and what and whose message and interests are represented.

We emphasize that it is not a matter of finding the single best phraseology. Any attempt to find the singularly best way to talk about disability will be mired in negative consequences of standardizing and categorizing a group of diverse individuals as the same in some fundamental way (Titchkosky, 2001). Assuming that there is one way to represent such varied individuals is misguided. A variety of ways to talk about a variety of individuals is likely more helpful (Titchkosky, 2001). Therefore, instead of suggesting 'the best' practice in terms of language to use, we suggest, instead, continually (re)examining what articulations in one's reports are actually saying and doing.

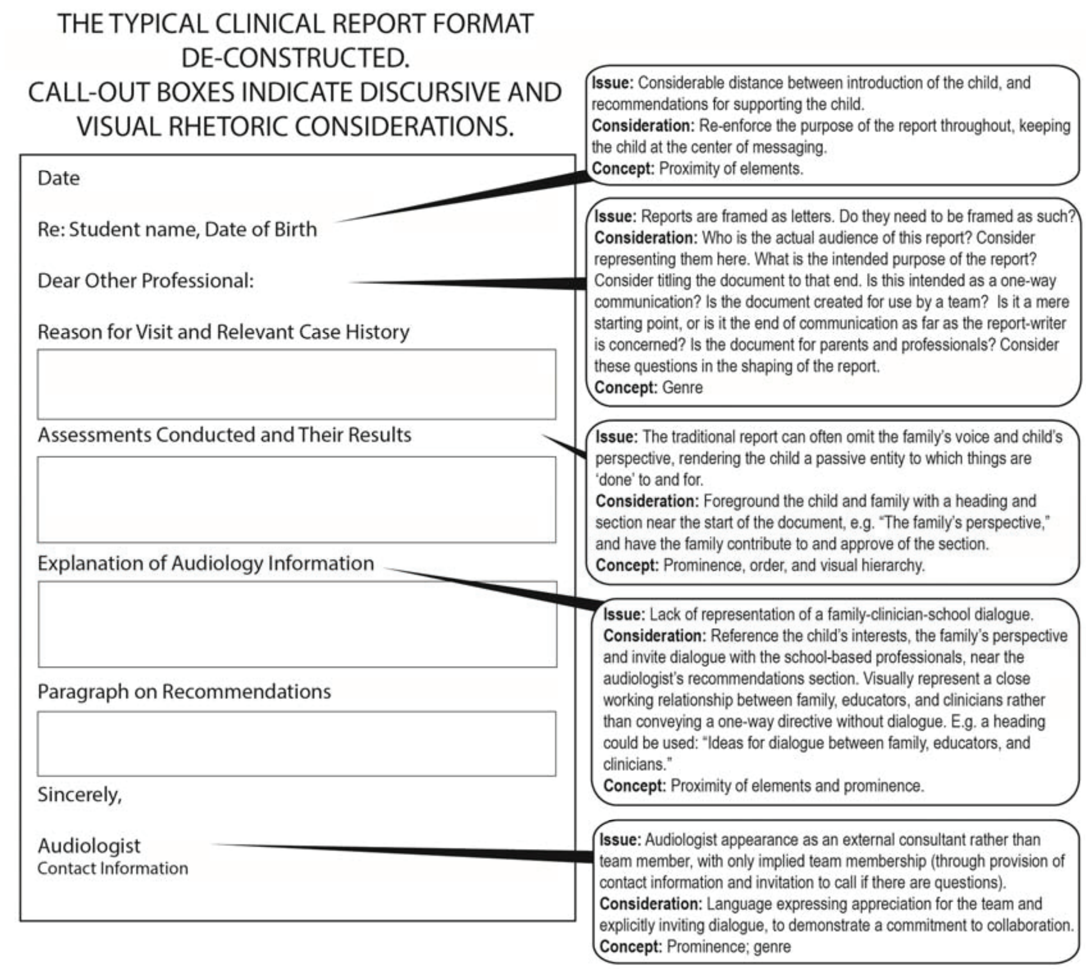
Visual construction considerations

Next, visual rhetoric is introduced to encourage the inclusion of parents and children through written reports. Visual rhetoric is the effective use of visual elements to communicate information (Rosenquist, 2012). When designing forms and reports, primary information is displayed as a visually prominent feature, whereas supplemental information is more subdued in visual presence (Horton, 1990). Further, page-formatting techniques are effective in communicating the structural hierarchy of a document; elements placed at the beginning of the document automatically convey that they are the most important items, while elements at the end are understood as the least important. Lastly, according to the Gestalt principle of proximity, the strength of the relationship of visual elements is directly proportional to the distance separating the items (Gribbons, 1991). By referring to the Gestalt principle of proximity, one can understand how specific elements within a document may be perceived as related or unrelated due to their proximity or distance from one another on the page.

In visual rhetoric, it is necessary to consider the context of use as well as the technical details of documents (Kwasnik & Crowston, 2005). For example, when considering a clinical report, one can better understand how the structure (e.g. sections) can enable or prevent collaboration between clinicians, school-based professionals, and parents. Discourses create, maintain, and transform relational bonds or structures (Barrett, Thomas, & Hocevar, 1995). Through this understanding of the way texts constitute relational bonds, one can come to understand how the contributions of parents and children to a child's educational planning can be enabled or constrained by the written reports created and circulated to advance that plan.

As the literature attests, there is great emphasis on parent involvement and positive outcomes in supporting children with health needs at school (Elbaum, 2012; Frew, Zhou, Duran, Kwok, & Benz, 2012; Griffin, Taylor, Urbano, & Hodapp, 2013). However, traditional genres (genres are regularized formats, styles, and content expectations of texts) (Miller, 1984) of forms and reports do not necessarily display the importance of parent or child input. In order to invite and enforce family involvement, report-writers could include a section labeled *"Parent's Name Here* Input" as well as one for *"Student's Name Here* Input." In addition to parents' and children's rights to contribute to the child's educational programming, families and the children can provide crucial information that clinicians and school-based professionals need to know (Cannon, 2011; Gibson et al., 2009). In order to fully incorporate parent and child experiences, perspectives, and concerns and to actualize family-centered care, parent and child input sections should be considered when composing the clinical report. Based on visual rhetoric theory, parent and child sections must be placed prior to an educational plan or clinicians' recommendations because information that is at the top or beginning of a form is unconsciously perceived by readers as the most important element. Refer to Figure 1 for a deconstruction of a typical audiology report format through the lens of critical theory and visual rhetoric principles.

Figure 1. Deconstruction of a typical audiology report format through the lens of critical theory and visual rhetoric principles.



Conclusion

This article presents two main problems: firstly, clinical professionals like audiologists may be advocating for children at school by proxy, thus lacking the opportunity for collaborative dialogue with school-based professionals and parents; secondly, children and families may be disempowered by language choices if clinician report-writers lack a critical social awareness of the constituting power of language.

Three opportunities, informed by critical social science theories, to ameliorate the above problems were also presented. Specific considerations are: 1) to include more dialogic language in reports to facilitate true collaboration rather than unintentionally promote conflict, 2) to be aware of the shaping effects of language on children's identities and opportunities, and 3) to make use of visual rhetorical theory to construct reports that represent and highlight parents', children's, clinicians', and school-based professionals' perspectives as equally important and in mutual ongoing dialogue.

Research and experiential evidence have shown how clinicians, school-based professionals, and parents may experience frustration and difficulty in working well together for and with children when trying to access school-based health supports; written reports are strongly implicated in these problems. Applying a critical social science perspective to the common practice of report-writing presents possibilities for overcoming these persistent and insidious challenges at the clinic-school interface. This article is not meant to be prescriptive, but rather an opportunity to challenge assumptions and engage in ever more sensitive and informed practices. The article also serves, for clinical educators, faculty members, clinicians, and learners of all types, as an introductory lesson in some principles and practices of critical social theory. The references to theories throughout this article may be a starting point for anyone interested in the sociological call to "make the familiar strange." We suggest that the critical social sciences offer us an opportunity, as a field, to engage in empowered social change.

Acknowledgements

We would like to thank the research team involved in the ongoing program of research from which this case was derived: Dr. Lorelei Lingard, Dr. Kathryn Hibbert, Dr. Sandra Regan, Dr. Rosamund Stooke, Ms. Christine Meston, Dr. Silke Dennhardt, and Dr. Catherine Schryer. Great appreciation is also extended to the collaborators and participants of the larger study. Funding was provided by a Canadian Institutes of Health Research open operating grant to the research team (CIHR MOP-130433).

References

Angell, A. M., & Solomon, O. (2014). The social life of health records: understanding families' experiences of autism. *Social Science & Medicine (1982)*, 117, 50–7. doi:10.1016/j.socscimed.2014.07.020

Barrett, F., Thomas, G., & Hocevar, S. (1995). The central role of discourse in large-scale change: A social construction perspective. *The Journal of Applied Behavioral Science, 31*(3), 352–372. doi:10.1177/0021886395313007

Baxley, B., & Bowers, L. (1992). Clinical Report Writing: The Perceptions of Supervisors and Supervisees. *National Student Speech Language Hearing Association Journal, 19*, 35–40.

Block, P., Ricafrente-Biazon, M., Russo, A., Chu, K. Y., Sud, S., Koerner, L., … Olowu, T. (2005). Introducing disability studies to occupational therapy students. *The American Journal of Occupational Therapy: Official Publication of the American Occupational Therapy Association, 59*(5), 554–60. doi:doi:10.5014/ajot.59.5.554

Blum, L. M. (2012). Mother-blame in the Prozac nation: Raising kids with invisible disabilities. *Gender and Society, 21*(2), 202–26. doi:10.1177/0891243206298178

Cannon, Y. (2011). Who's the Boss?: The Need for Thoughtful Identification of the Client (s) in Special Education Cases. *American University Journal of Gender, Social Policy & the Law, 20*(1), 1–79. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2266008

Elbaum, B. (2012). Challenges in interpreting accountability results for schools' facilitation of parent involvement under IDEA. *Journal of Disability Policy Studies*, 24(4), 206–17. doi:10.1177/1044207312461947

English, K. (2006). How is Educational Audiology Being Taught ? A Review of Syllabi from Au.D. Programs, Fall 2005. *Journal of Educational Audiology, 13*, 15–17.

Erevelles, N. (2005). Understanding curriculum as normalizing text: Disability studies meet curriculum theory. *Journal of Curriculum Studies, 37*(4), 421–39. doi:10.1080/0022027032000276970

Frew, L. a., Zhou, Q., Duran, J., Kwok, O.-M., & Benz, M. R. (2012). Effect of School-Initiated Parent Outreach Activities on Parent Involvement in School Events. *Journal of Disability Policy Studies, 24*(1), 27–35. doi:10.1177/1044207311427163

Gibson, B. E., Darrah, J., Cameron, D., Hashemi, G., Kingsnorth, S., Lepage, C., … Menna-Dack, D. (2009). Revisiting therapy assumptions in children's rehabilitation: clinical and research implications. *Disability and Rehabilitation, 31*(17), 1446–1453. doi:10.1080/09638280802621390

Gozenbach, S. (2000). Preparing the Clinical Report. In M. V. Holly Hosford-Dunn, Ross J. Roeser (Ed.), *Audiology Practice Management* (pp. 231–246). New York, NY: Thieme.

Greenhalgh, T., & Wieringa, S. (2011). Is it time to drop the "knowledge translation" metaphor? A critical literature review. *Journal of the Royal Society of Medicine, 104*(12), 501–9. doi:10.1258/jrsm.2011.110285

Gribbons, W. (1991). Visual literacy in corporate communication: some implications for information design. *IEEE Transactions on Professional Communication, 34*(1), 42–50. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=68427

Griffin, M. M., Taylor, J. L., Urbano, R. C., & Hodapp, R. M. (2013). Involvement in transition planning meetings among high school students with Autism Spectrum Disorders. *The Journal of Special Education, 47*(4), 256–64. doi:10.1177/0022466913475668

Hodges, B. D., Martimianakis, M. a, McNaughton, N., & Whitehead, C. (2014). Medical education... meet Michel Foucault. *Medical Education, 48*(6), 563–71. doi:10.1111/medu.12411

Hodges, B., Kuper, A., & Reeves, S. (2008). Qualitative research: Discourse analysis. *BMJ: British Medical Journal, 337*(7669), 570–2. doi:10.1136/bmj.a879

Hollenweger, J. (2013). Developing applications of the ICF in education systems: Addressing issues of knowledge creation, management and transfer. *Disability and Rehabilitation, 35*(13), 1087–91. doi:10.3109/09638288.2012.740135

Horton, W. (1990). Visual rhetoric for online documents. *IEEE Transactions on Professional Communication, 33*(3), 108–114. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=59084

Innocenti, M. S., Huh, K., & Boyce, G. C. (1992). Families of Children with Disabilities: Normative Data and Other Considerations on Parenting Stress. *Topics in Early Childhood Special Education, 12*(3), 403–427. doi:10.1177/027112149201200310

Kemmis, S. (2005). Knowing practice: Searching for saliences. *Pedagogy, Culture & Society, 13*(3), 391–426. doi:10.1080/14681360500200235

Kwasnik, B., & Crowston, K. (2005). Introduction to the special issue: Genres of digital documents. Information *Technology & People, 18*(2), 76–88. doi:dx.doi.org/10.1108/09593840510601487

Liasidou, A. (2013). Intersectional understandings of disability and implications for a social justice reform agenda in education policy and practice. *Disability & Society, 28*(3), 299–312. doi:dx.doi.org/10.1080/09687599.2012.710012

Lingard, L. (2007). The rhetorical “turn” in medical education: what have we learned and where are we going? Advances in *Health Sciences Education : Theory and Practice, 12*(2), 121–33. doi:10.1007/s10459-006-9046-y

Lingard, L., Hodges, B., MacRae, H., & Freeman, R. (2004). Expert and Trainee Determinations of Rhetorical Relevance in Referral and Consultation Letters. *Medical Education, 38*, 168–76. doi:DOI: 10.1111/j.1365-2923.2004.01745.x

McConnellogue, S. (2011). Professional roles and responsibilities in meeting the needs of children with speech, language and communication needs: joint working between educational psychologists and speech and language therapists. *Educational Psychology in Practice, 27*(1), 53–64. doi:10.1080/02667363.2011.549354

Miller, C. R. (1984). Genre as social action. *Quarterly Journal of Speech, 70*(2), 151–167. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/00335638409383686

Molloy, H., & Vasil, L. (2002). The social construction of Asperger Syndrome: The pathologising of difference? *Disability & Society, 17*(6), 659–69. doi:10.1080/0968759022000010434

Ng, S. L., Fernandez, V., Buckrell, B., & Gregory, K. (2010). Report on a school board’s interprofessional approach to managing the provision of Hearing Assistance Technology for Auditory Processing Disorders. *Journal of Educational Audiology, 16*(16), 73–85.

Ng, S. L., Stooke, R., Regan, S., Hibbert, S., Schryer, C. F., Phelan, S. K., … Hibbert, K. (2013). An institutional ethnography inquiry of health care work in special education: a research protocol. International *Journal of Integrated Care, 13*(3). Retrieved from http://www.ijic.org/index.php/ijic/article/view/URN:NBN:NL:UI:10-1-114741/2030

Ng, S., & Lingard, L. (2014). Learning to balance privacy and patient care [abstract]. Oral presentations. *Medical Education Special Issue: Abstracts of the Canadian Conference on Medical Education, 25-29 April 2014*, Ottawa, Canada, 48(S1), 16. doi:10.1111/medu.12485

Ng, S., Lingard, L., Rai, R., Stooke, R., Regan, R., & Hibbert, K. (2013). Clinicians beyond clinic: Mapping health professional practice in the special education context [abstract]. Oral presentations. *Medical Education Special Issue: Abstracts of the Canadian Conference on Medical Education, 20-23 April, Quebec, Canada, 47*(S1), 93. doi:10.1111/medu.12221

O’Keeffe, M. J., & McDowell, M. (2004). Bridging the gap between health and education: words are not enough. *J Paediatr Child Health, 40*(5-6), 252–257. doi:10.1111/j.1440-1754.2004.00359.x

Oberklaid, D. F. (1988). Learning Disorders in the School Aged Child; A Paediatric Perspective. *Early Child Development and Care, 34*(1), 179–189. doi:10.1080/0300443880340113

Pannbacker, M. (1975). Diagnostic Report Writing. *Journal of Speech and Hearing Disorders, 40*, 367–379. doi:doi:10.1044/jshd.4003.367

Phelan, S. K. (2011). Constructions of disability: A call for critical reflexivity in occupational therapy. *Canadian Journal of Occupational Therapy, 78*(3), 164–172. doi:10.2182/cjot.2011.78.3.4

Phelan, S. K., & Kinsella, E. A. (2013). Occupation and identity: Perspectives of children with disabilities and their parents. *Journal of Occupational Science*, (January), 1–23. doi:10.1080/14427591.2012.755907

Phelan, S. K., & Ng, S. (2014). A Case Review: Reframing School-Based Practices Using a Critical Perspective. *Physical & Occupational Therapy in Pediatrics*. doi:10.3109/01942638.2014.978933

Phelan, S. K., Wright, V., & Gibson, B. E. (2014). Representations of disability and normality in rehabilitation technology promotional materials. *Disability and Rehabilitation*, (Early Online), 1–8. doi:10.3109/09638288.2014.891055

Phelan, S., & Kinsella, E. A. (2009). Occupational identity: Engaging socio-cultural perspectives. *Journal of Occupational Science, 16*(2), 85–91. doi:DOI:10.1080/14427591.2009.9686647

QSR International Pty Ltd. (2008). NVivo qualitative data analysis software, Version 8.

Quinlan, E. (2009). The "actualities" of knowledge work: an institutional ethnography of multi-disciplinary primary health care teams. *Sociology of Health & Illness, 31*(5), 625–641. doi:10.111/j.1467-9566.2009.01167.x

Rehm, R. S., Fisher, L. T., Fuentes-Afflick, E., & Chesla, C. A. (2013). Parental advocacy styles for special education students during the transition to adulthood. *Qualitative Health Research, 23*(10), 1377–87. doi:10.1177/1049732313505915

Reindal, S. M. (2008). A social relational model of disability: a theoretical framework for special needs education? *European Journal of Special Needs Education, 23*(2), 135–146. Retrieved from http://dx.doi.org/10.1080/08856250801947812

Rix, J., & Matthews, A. (2014). Viewing the child as a participant within context. *Disability & Society, 29*(9), 1428–1442. doi:10.1080/09687599.2014.934955

Roberts, G., Price, A., & Oberklaid, F. (2012). Paediatrician's role in caring for children with learning difficulties. *Journal of Paediatrics and Child Health, 48*(12), 1086–90. doi:10.1111/j.1440-1754.2012.02469.x

Rosenquist, C. (2012). Visual Form, Ethics, and a Typology of Purpose: Teaching Effective Information Design. *Business Communication Quarterly, 75*(1), 45–60. doi:10.1177/1080569911428670

Schryer, C. F., Gladkova, O., Spafford, M. M., & Lingard, L. (2007). Co-management in healthcare: negotiating professional boundaries. *Journal of Business and Technical Communication, 1*(4), 452–479. doi:doi: 10.1177/1750481307082208

Schryer, C. F., Lingard, L., & Spafford, M. (2007). Regularized practices: Genres, improvisation, and identity formation in health-care professions. In M. Zachry & C. Thralls (Eds.), *Communicative practices in workplaces and the professions: Cultural perspectives on the regulation of discourse and organizations* (pp. 21–44). Amityville, NY: Baywood Publishing Company, Inc.

Smith, D. E. (2006). *Institutional Ethnography as Practice*. Lanham, MD: Rowman & Littlefield Publishers, Inc.

Smith, D., & Schryer, C. F. (2008). On documentary society. In C. Bazerman (Ed.), *Handbook of research on writing: history, society, school, individual, text* (pp. 114–128). New York, NY: Taylor & Francis.

Smith, T. B., Oliver, M. N. I., & Innocenti, M. S. (2001). Parenting Stress in Families of Children with Disabilities. *American Journal of Orthopsychiatry*, 71(2), 257–261. doi:10.1037/0002-9432.71.2.257

SocioCultural Research Consultants LLC. (2014). Dedoose Version 5.0.11, web application for managing, analyzing, and presenting qualitative and mixed method research data. Los Angeles, CA. Retrieved from www.dedoose.com

Stooke, R. (2010). Investigating the textually-mediated work of institutions: Dorothy E. Smith's sociology for people. In J. B. G. Leckie & L.Given (Ed.), *Critical theory for Library and Information Science: Exploring the social from across the disciplines* (pp. 283–294). Westport, CT: Libraries Unlimited.

Titchkosky, T. (2001). Disability: A Rose by Any Other Name? "People-First" Language in Canadian Society. *Canadian Review of Sociology, 38*(2), 125–40. doi:10.1111/j.1755-618X.2001.tb00967.x

Turner, S. M. (2006). Mapping institutions as work and texts. In D. Smith (Ed.), *Institutional ethnography as practice* (pp. 139–161). Lanham, MD: Rowman & Littlefield Publishers Inc.

Villeneuve, M. (2009). A critical examination of school-based occupational therapy collaborative consultation. *Canadian Journal of Occupational Therapy, 76*(July), 206–18.

Wang, S. S. (2012). The long battle to rethink mental illness in children. *Wall Street Journal*. Retrieved from http://online.wsj.com/articles/SB10000872396390444273704577633412579112188

Wodak, R., & Meyer, M. (2009). *Methods for Critical Discourse Analysis*. Thousand Oaks, CA: SAGE.

Effects of Looking Behavior on Listening and Understanding in a Simulated Classroom

Dawna E. Lewis, PhD
Boys Town National Research Hospital, Omaha, NE

Shannon Wannagot, BA
Boys Town National Research Hospital, Omaha, NE
University of Connecticut, Storrs, CT

Audiovisual cues can improve speech perception in adverse acoustical environments when compared to auditory cues alone. In classrooms, where acoustics often are less than ideal, the availability of visual cues has the potential to benefit children during learning activities. The current study evaluated the effects of looking behavior on speech understanding of children (8-11 years) and adults during comprehension and sentence repetition tasks in a simulated classroom environment. For the comprehension task, results revealed an effect of looking behavior (looking required versus looking not required) for older children and adults only. Within the looking-behavior conditions, age effects also were evident. There was no effect of looking behavior for the sentence-repetition task (looking versus no looking) but an age effect also was found. The current findings suggest that looking behavior may impact speech understanding differently depending on the task and the age of the listener. In classrooms, these potential differences should be taken into account when designing learning tasks.

Introduction

Spoken speech is a complex signal containing numerous auditory cues that can be used to aid in understanding (Pisoni & Remez, 2008). In natural environments visual cues also play a role in that understanding. Research has shown that the availability of audiovisual cues improves speech-perception performance in conditions where the auditory signal is degraded for both adults and children over that seen with auditory or visual input alone (Erber, 1969; Massaro & Cohen, 1995; Ross, Saint-Amour, Leavitt, Javitt, & Foxe, 2007; Sumby & Pollack, 1954; Wightman, Kistler, & Brungart, 2006). The addition of this information also has been shown to positively impact speech understanding when degraded acoustics are not an issue (Arnold & Hill, 1976; McGurk & MacDonald, 1976).

Development plays a role in children's ability to understand speech that is presented auditory-only in noise and reverberation and in the ability to integrate auditory and visual input. Separately and together, noise and reverberation have a greater effect on children than on adults (Crandell & Smaldino, 2000; Neuman & Hochberg, 1983; Neuman, Wroblewski, Hajicek, & Rubenstein, 2010; Wroblewski, Lewis, Valente, & Stelmachowicz, 2012; Yang & Bradley, 2009), with some skills improving into adolescence (Johnson, 2000). Although infants have been shown to use visual information in the perception of speech (Desjardins & Werker, 2004; Kuhl & Meltzoff, 1982; 1984), this early skill is rudimentary and continues to develop through childhood and into adolescence (Desjardins, Rogers, & Werker, 1997; Massaro, 1984; Massaro, Thompson, Barron & Laren, 1986; McGurk & McDonald, 1976; Ross, Molholm, Blanco, Gomez-Ramirez, Saint-Amour & Fox, 2011; Wightman, et al., 2006; see also Soto-Faraco, Calabresi, Navarra, Werker, & Lewkowicz, 2012, for a review).

In classrooms, elementary-age children often encounter unfavorable listening conditions, where poor signal-to-noise ratios (SNR) and extended reverberation times (RT) may affect hearing, understanding and overall academic success (Dockrell & Shield, 2006; Jamieson, Kranjc, Yu, & Hodgetts, 2004; Klatte, Hellbruck, Seidel, & Leistner, 2010; Klatte, Lachman, & Meis, 2010). ANSI S12.60-2002 provides standards for SNR and RT in schools (American National Standards Institute [ANSI], 2002). However, numerous studies have shown that typical classrooms often exceed the recommended SNR and RT (see Picard & Bradley, 2001, for a review; Nelson, Smaldino, Erler, & Garstecki, 2008). Under such conditions, children may be less able to process the compromised auditory signal for understanding. This may be especially true for younger children whose abilities to understand speech in noise and reverberation are still developing. As a result, the benefit of combined auditory and visual input has the potential to improve speech perception in this population. However, multiple factors can influence that potential benefit.

In classroom environments many listening tasks may require attention to multiple talkers and not all talkers will be easily visualized. Variability among talkers has the potential to negatively impact speech perception in adults and children (Mullennix, Pisoni, & Martin, 1989; Ryalls & Pisoni, 1997), and recent research has suggested that, at least for adults, this may occur for both auditory-only and auditory-visual presentations of speech (Heald & Nusbaum, 2014). To benefit from combined auditory and visual input under such conditions, the listener must be able to locate the appropriate talker while that person is speaking. It also is possible that some actual and potential talkers could distract the listener from the speech signal of interest. In those instances, both auditory and visual attention could serve as distracters (Ricketts & Galster, 2008; Valente, Plevinsky, Franco, Heinrichs-Graham, & Lewis, 2012). In these instances, the effort required to locate and understand multiple talkers may expend cognitive resources that otherwise would be used for comprehension, with potentially negative consequences.

In view of the potential for both positive and negative effects of looking behavior when attempting to understand speech, it can be helpful to examine that behavior during speech perception tasks. Potential effects of looking behavior during complex listening tasks were examined as part of recent studies in our laboratory investigating speech comprehension and sentence repetition in a simulated classroom environment (Valente et al., 2012). As part of those studies, participants were asked to attend to audiovisual recordings of a teacher and four students who were reading lines from a play which were presented from loudspeakers and LCD monitors located around the listener. Participants were told that they could look as much or as little as they needed to understand the play. At the end of the play, they answered factual questions about its content. Looking behavior during the comprehension task was monitored via a head-worn gyroscope that recorded head movements in the horizontal plane. The results of the gyroscopic recordings were analyzed in two ways. The first measurement (proportion of events visualized, POEV) represented the proportion of time a listener looked directly at each talker when he/she was speaking. The second measurement (overall looking behavior) represented general looking across all talkers during the task and provided an indication of participants' attempts to look at talkers. The same participants repeated auditory-only sentences that contained three keywords each and were presented from the same locations used for the comprehension task.

As part of the first experiment reported in Valente et al. (2012), adults and children (8-12 years) with normal hearing performed the task in an acoustic environment with an SNR of 10 dB and an RT of 0.6 seconds. This acoustic environment is comparable to that found in many classrooms (Bradley & Sato, 2008). Although results revealed ceiling or near-ceiling performance for both children and adults on the sentence repetition task, children exhibited lower scores than adults on the comprehension task. Thus, under typical classroom acoustic conditions, children demonstrated a high level of sentence-recognition ability that was similar to that of adults. However, under those same conditions their performance on a more complex listening task was poorer.

Analysis of looking behavior during the comprehension task revealed that both adults and children looked directly at the talkers as they were speaking less than 50% of the time. This finding was not surprising given that the task required participants to follow multiple talkers who changed often. As a result, even if participants attempted to look at all talkers, they may not have been able to visualize them as they were speaking. However, children did localize the talkers significantly more often than adults.

For the measure of overall looking behavior, children exhibited greater overall looking than adults and participants who exhibited higher looking behavior showed poorer performance on the task. These finding suggested that, although children were more likely to attempt to look at the talkers during the comprehension task, their understanding of the material may not have benefited from looking.

During listening tasks in which it may be difficult to visualize talkers as they speak, attempts to access visual information may not always be beneficial. In such activities attempts to locate talkers may use cognitive resources that are needed for comprehension. When interpreting the relationship between looking behavior and comprehension in Valente et al. (2012), it is important to remember that participants were instructed to look as much or as little as they felt necessary during the comprehension task. If individuals' strategies for listening and looking were chosen to optimize understanding, it is possible that some participants made better choices for that particular task than others. Adult-child differences in both performance and looking behavior could indicate that children were less adept at choosing the appropriate looking strategies during this particular task.

Just as there is development in the ability to benefit from audiovisual input, there also may be development in the ability to decide how and when to use that information appropriately for a given task. As a first step in examining this possibility, the current study evaluated the effects of required looking behavior on speech understanding of children and adults with normal hearing (NH) during the comprehension and sentence-repetition tasks used in Valente et al. (2012) and described above. During the comprehension task, participants were instructed to look at each talker as he/she spoke. Results were compared to those of listeners with NH from Valente et al. (2012) and a subsequent study (Lewis, Valente & Spalding, 2014) using the same task during which participants also had not been required to look at the talkers. In those studies, looking behavior had not been examined during the sentence-repetition tasks. Thus, for the current study participants were instructed to locate the loudspeaker for half of the sentence presentations and to look straight ahead for the other half allowing a within-subject examination of looking behavior to be completed for the sentence-repetition task.

Method

Participants

Forty children (8-11 years) and 10 adults (19-29 years) with audiometric thresholds within the normal range of hearing (NH; ≤20 dB HL for octave frequencies from 250 to 8000 Hz) participated. No child scored greater than 1 SD below the mean for receptive vocabulary as measured by the Peabody Picture Vocabulary Test (PPVT-IV, Dunn & Dunn, 2007). All children were typically developing by report and were native speakers of English.

Results from 39 children (8-11 years old) and 20 adults with NH from previous studies in our lab (Valente et al., 2012; Lewis et al., 2014) were included in the analysis of the comprehension task to compare performance between listeners who were required to look (current study) and listeners who were instructed that they could look as much or as little as they needed to understand the talkers (previous studies). The children from the previous studies had the same demographic characteristics the currently evaluated group. Table 1 lists the number of participants in each age group.

Table 1. Number of participants in each age group from current and previous studies.

Age Group	8 years	9 years	10 years	11 years	Adult
N (previous studies)	10	9	9	11	20
N (current study)	10	10	10	10	10

This study was approved by the Institutional Review Board (IRB) for Boys Town National Research Hospital and assent/consent was obtained for all children. Children were paid $15 per hour for their participation and received a book at the completion of the study.

Simulated acoustic environment

The simulated acoustic environment was the same as reported in Valente et al. (2012). Readers are referred to that paper for a detailed description of the creation and validation of the environment and it will be described briefly here. The simulated environment was comprised of a physical room and a virtually-modeled room. The physical room was acoustically treated and loudspeakers and LCD monitors were placed on small tables around a participant's location (Figure 1). In the physical room ambient acoustics at the participant's location (RT = 0.35 sec and background noise = 35 dBA) were below those selected for the simulated environment. Real-time simulation techniques (Braasch, Peters & Valente, 2008) were used to create a virtually-modeled room (Virtual Microphone Control; ViMiC) with the same dimensions as the physical room and with virtual microphones and sound sources positioned at the same locations as the loudspeakers and monitors in the physical room. The simulated room (which combined the physical and virtual rooms) included direct sound and both first-order and late reflections. As a result, room acoustics could be set to represent those found in a classroom. Background noise within the simulated room had a spectrum similar to that of heating, ventilation, and air-conditioning (HVAC) systems.

Figure 1. Simulated classroom set-up. Used with permission from Lewis, D., Valente, D.L., & Spalding, J. (2015). Effect of minimal/mild hearing loss on children's speech understanding in a simulated classroom. *Ear & Hearing, 36*, 136-144.

For both tasks, the level of speech at the participant's location was 60 dBA and RT was set to 0.6 s. For the comprehension task, noise was adjusted for a 10 dB SNR. Due to the fact that sentence repetition at a 10 dB SNR resulted in ceiling or near ceiling performance in the Valente et al. (2012) study, a SNR of 0 dB was chosen for the sentence repetition task in the current study to reduce potential ceiling effects that could obscure differences across looking conditions.

Procedures

Comprehension. The video recordings from Valente et al. (2012) were used. In those recordings, a teacher and four students read lines from an unfamiliar 10-minute elementary-age-appropriate Reader's Theater play (Shepard 2010). For the task, each talker was located at one of the five loudspeaker/monitor arrangements around the participant. Each talker acted as a different character and there was no overlapping speech across talkers. Participants were instructed to look at each of the talkers whenever they spoke. At the end of the presentation, participants were asked 18 factual questions (e.g., Where did the troll go each day while Leif worked? What did Leif think was going to happen when the troll was chasing him and Master Maid?). Listeners responded orally and their answers were written down by the experimenter for later percent-correct scoring.

Looking Behavior. To monitor looking behavior during the comprehension task, each child wore a custom-designed gyroscope (Analog Devices, EVAL-ADXRS610) attached to a headband. The gyroscope tracked head movement in the horizontal plane. Output from the gyroscope was converted into a digital signal for analysis (Teabox; Electrotap LLC).

Participants' looking behavior was analyzed in two ways using the procedures from Valente et al. (2012). *Proportion of events visualized* (POEV) signified the proportion of time a participant looked directly at each talker (+/- 15^o) when he/she was speaking. For this measure, the location of each of the simulated talkers relative to the participant location was compared to the gyroscopic data that were obtained for that participant. *Overall looking behavior* was measured using the head-angle recordings of the participant. The standard deviation (SD) of the head tracking measurement represented the degree of head movement relative to 0o azimuth. Following the convention developed for Valente et al. (2012), overall looking behavior was classified into three categories: low (SD < 20^o), medium (20^o < SD < 45^o) and high (SD > 45^o).

Sentence repetition. Participants heard and repeated 50 auditory-only sentences with three key words (Bamford-Kowal-Bench sentences [BKB]; Bench, Kowal, & Bamford, 1979) spoken by a female talker from each of the five loudspeakers. The sentences were digitally recorded in a sound booth using a condenser microphone (AKG Acoustics C535 EB) with a flat frequency response (±2 dB from 0.2 to 20 kHz). Sentences were presented one at a time. The screen of each monitor was lighted when a sentence was being presented from that location. Although the lighted screens did not provide content information, spatial visual cues have been shown to improve speech intelligibility in adverse listening environments (Best, Ozmeral, & Shinn-Cunningham, 2007). Thus, this option offered a visual cue to assist participants in determining talker location. Two looking conditions were utilized during the speech-perception task. In this within-subject task these two conditions were different from those described for the comprehension task. In the *looking* condition, participants were instructed to localize and visualize the lighted screen before repeating the sentence. In the *no-looking* condition, participants were instructed to look straight ahead at the front screen (i.e., they were instructed not to look around). Each participant completed the sentence repetition task in both conditions, listening to half of the sentences in one condition and half in the other. The starting condition for the task was alternated across listeners in each age group. Responses were scored for correct repetition of each of the three target words in each sentence.

Results

Comprehension Task

Individual results for performance on the comprehension task and overall looking behavior are shown in Figure 2 for the previous studies (left panel) and the current study (right panel). When looking was not required, the range of scores for 8-10 year olds was more widely distributed than that of the 11-year olds and adults. However, the older children and adults for whom looking was required showed a distribution of scores that was more similar to that of the younger children in either looking-behavior condition.

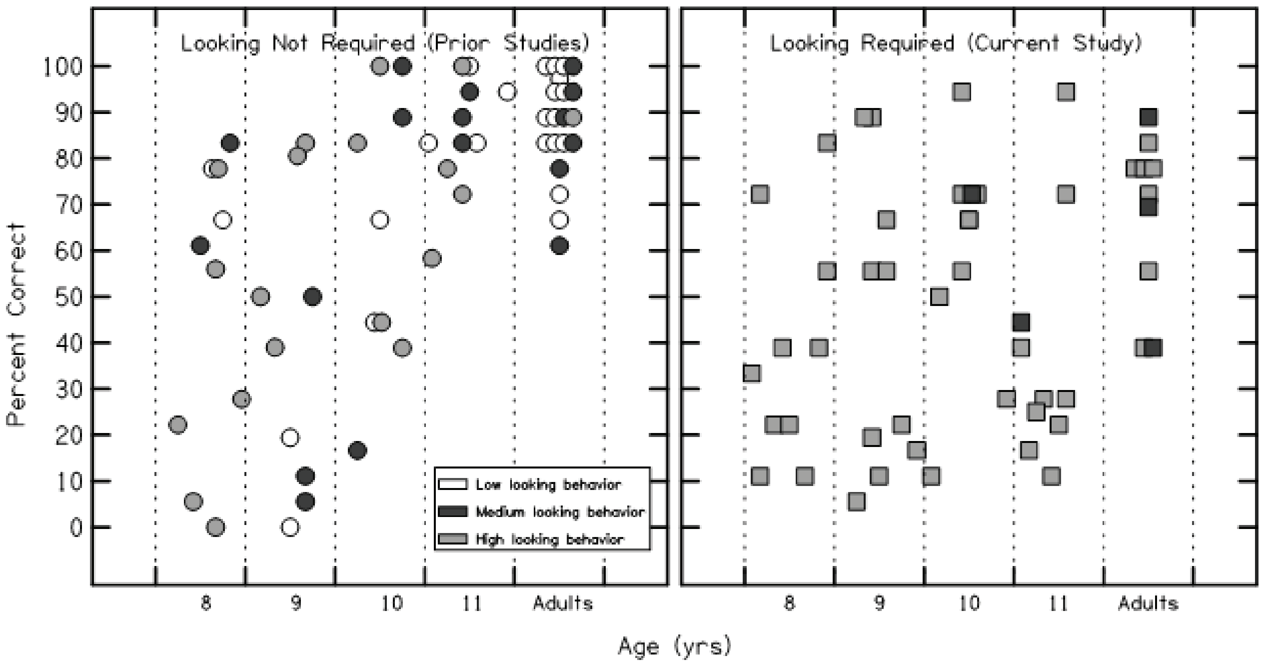


Figure 2. Individual comprehension scores and overall looking behavior for the classroom listening task when participants were not required (left) and were required (right) to look at the talkers. Looking behavior is represented as low (white), medium (black) or high (gray). For the children (8-11 yrs), age within each year is indicated by the horizontal position of the symbols. For the adults, symbols are randomly jittered on the horizontal axis for visibility only.

Means and standard deviations for comprehension scores across looking condition and age group are shown in Table 2. A two-way analysis of variance (ANOVA) was conducted with age group and looking condition as between-subject factors. Results revealed significant main effects on comprehension of looking condition ($F_{(1,99)}$ = 10.409; p =.002, η_p^2 =0 .095) and age group ($F_{(4,99)}$ = 9.197; p<.0001, η_p^2 = 0.271) as well as a looking condition by age group interaction ($F_{(4,99)}$ = 3.503; p =.010, η_p^2 = 0.124). Overall, performance was higher when looking was not required. Minimal mean differences (Fisher's LSD) revealed that across looking conditions adults and 11-year olds for whom looking was not required performed better than those for whom looking was required. Across age groups, adults and 11-year olds performed better than 8-, 9-, and 10-year olds and 10-year olds performed better than 8- and 9-year olds when looking was not required. When looking was required, adults performed better than 8-, 9-, and 11-year olds and 10-year olds performed better than 11-year olds.

Table 2. Means and standard deviations (in parentheses) for comprehension scores across looking condition and age group.

	8 years	9 years	10 years	11 years	Adult
Looking Not Required	47.8 (31.2)	37.7 (31.1)	64.8 (30.1)	85.1 (12.6)	87.6 (11.3)
Looking Required	38.9 (24.7)	43.1 (31.9)	58.9 (24.2)	38.1 (26.2)	68.1 (17.7)

In Figure 2 overall looking behavior for individual participants also is categorized: low (white), medium (black) or high (gray). As expected, in the current study most participants (all except three adults, one 10 year-old, and one 11 year-old) demonstrated high looking behavior (SD >45°). Those five participants displayed medium looking behavior (20°<SD<45°). These findings indicate that the majority of participants in the current study followed the directions to attempt to look at the talkers as they were speaking. In the previous studies when participants were allowed to look as much or as little as they chose, overall looking behavior was variable. The majority of adults exhibited low looking behavior, with only one showing high overall looking. In contrast, the majority of the youngest children exhibited high looking behavior, with only two showing low looking. By 11 years of age there were almost equal numbers of children showing high and low looking behavior.

Despite the pattern of high overall looking behaviors in the required-looking condition, the mean proportion of time participants were looking at talkers while they were speaking (POEV) was still less than 0.60 for all ages. POEV as function of age group and looking condition is shown in Figure 3 and means and standard deviations are shown in Table 3.

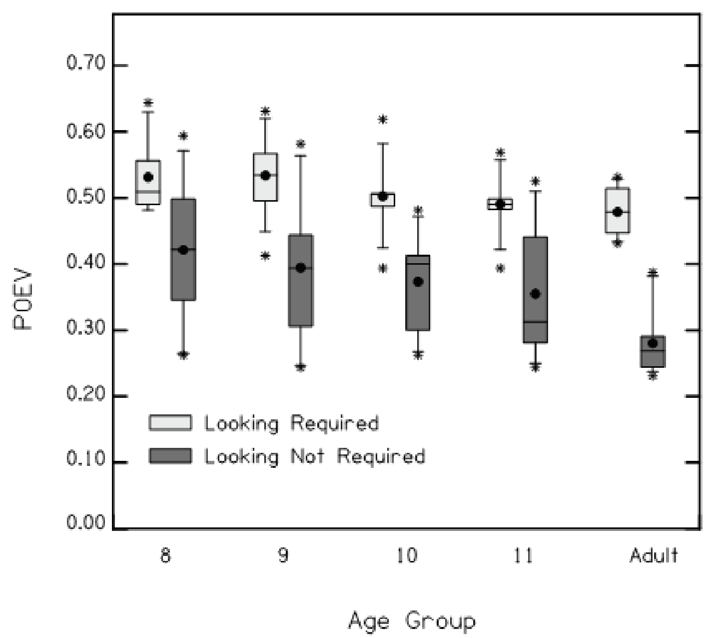


Figure 3. Proportion of events visualized (POEV) during the comprehension task for listeners who were required (light gray) and who were not required to look (dark gray) at the talkers. Boxes represent the interquartile range and whiskers represent the 5th and 95th percentiles. For each box, lines represent the median and filled circles represent the mean scores. Asterisks represent scores that fell outside the 5th-95th percentiles.

A two-way ANOVA revealed significant main effects of looking condition ($F(1,99) = 94.436$; $p < .0001$, $\eta p2 = 0.488$) and age group ($F(4,99) = 6.028$; $p <.0001$, $\eta p2 =0 .0263$) but no looking condition by age group interaction ($F(4,99) = 1.209$; $p =.312$, $\eta p2 =0 .047$). Participants who were required to look exhibited higher POEV than those who were not required to look. In addition, POEV was lower for adults than for any of the groups of children. No other age-group differences were significant.

Table 3. Means and standard deviations (in parentheses) for Proportion of events visualized (POEV) across looking condition and age group.

	8 years	9 years	10 years	11 years	Adult
Looking Not Required	0.421 (0.024)	0.394 (0.025)	0.374 (0.025)	0.355 (0.023)	0.280 (0.017)
Looking Required	0.531 (0.024)	0.534 (0.024)	0.502 (0.024)	0.491 (0.024)	0.479 (0.024)

Sentence Repetition Task

Recall that a within-subject design was used in the current study to examine the relation between sentence repetition and looking behavior. Percent-correct sentence repetition as a function of age group and looking condition is shown in Figure 4 with means and SDs shown in Table 4.

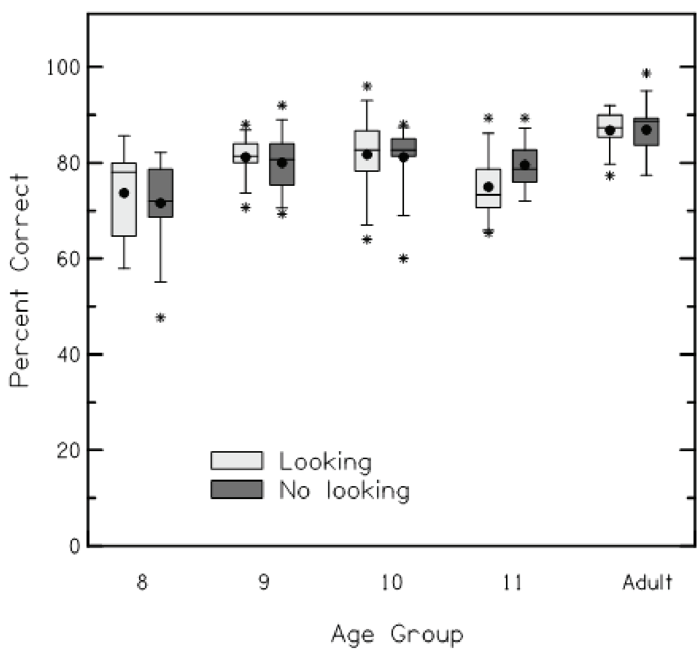


Figure 4. Sentence-repetition scores for the looking (light gray) and no looking (dark gray) conditions. Boxes represent the interquartile range and whiskers represent the 5th and 95th percentiles. For each box, lines represent the median and filled circles represent the mean scores. Asterisks represent scores that fell outside the 5th-95th percentiles.

A mixed-model ANOVA was conducted with looking condition as a within-subject factor and age group as a between-subject factor. Results revealed a significant main effect of age group ($F(4,44) = 5.815$; $p =.001$, $\eta p2 = 0.329$). There was no significant effect of looking condition ($F(4,44) =.028$; $p = 0.867$, $\eta p2 = 0.001$) and no looking condition by age group interaction ($F(4,44) =1.246$; $p = 0.305$, $\eta p2 = 0.102$). Adults performed better than 8- and 11-year olds. No other effects of age group were noted. (Note: One 11-year-old was not included in statistical analyses due to inattention during the no-looking portion of this task).

Table 4. Means and standard deviations (in parentheses) for sentence repetition scores across looking condition and age group.

	8 years	9 years	10 years	11 years	Adult
No Looking	71.6 (10.5)	80.0 (6.8)	81.2 (7.9)	79.6 (5.8)	86.9 (6.5)
Looking	73.7 (10.75)	81.2 (4.9)	81.73 (8.0)	75.0 (7.7)	86.8 (4.5)

Discussion

The current study examined the effect of looking behavior on children's speech understanding in a simulated classroom environment. During the comprehension task, participants in the required-looking condition located and looked at talkers as they were speaking less than 60% of the time. This occurred despite the fact that overall looking behavior was high for all but five participants, indicating that the majority were following instructions and making an attempt to locate the talkers. Similar to the previous studies (Valente et al., 2012; Lewis et al., 2014), it is likely that the discrepancy between overall looking behavior and POEV was impacted, at least in part, by the rapid transitions among talkers and their locations relative to the participant. In addition, it is important to note that a head-mounted gyroscope was used to monitor head movements. This method would not pick up changes in looking behavior that did not require head movements (i.e., those for which eye movements alone would be sufficient to allow visual attention to the talker or where there was a combination of head and eye movement). As a result, POEV may under-estimate visual attention to the talker to some degree. Other methods that could provide information regarding visual attention based on eye-movements (e.g., eye-tracking) were not possible in the current experimental paradigm due to the range of locations for the five talkers.

When looking was required for the comprehension task, adults and 11-year olds demonstrated significantly poorer performance than those that were not required to look. Based on our previous studies (Valente et al., 2012; Lewis et al., 2014), we hypothesized that the cognitive resources required to perform the listening task may impact children's ability to process the speech signal under adverse conditions. This hypothesis also is supported by research with adults and children showing that factors that increase listening effort (defined as attention and cognitive effort required for speech understanding) can negatively impact speech understanding (Fraser, Gagne, Alepins & Dubois, 2010; Gosselin & Gagne, 2011; Hicks & Tharpe, 2002; Larsby, Hallgren, Lyxell & Arlinger, 2005; Pichora-Fuller, Schneider & Daneman, 1995).

For the comprehension task, the cognitive load/listening effort could be impacted by multiple factors: the task itself (processing new information over a 10-minute period of time, linguistic complexity of the material), the acoustic environment (realistic noise and reverberation), age of the participants, and looking behavior (required versus not-required looking). The factor that differed between our current and previous tasks was that of looking behavior. As noted previously, one could assume that the previous participants chose looking strategies that they believed would optimize their understanding during the task, with some participants making better choices regarding looking than others. Examination of Figure 2 suggests that there was little difference in the range of scores for the younger children (8-10 years) when comparing required and not-required looking. In these age groups, few participants demonstrated low overall looking behavior when allowed to choose. However, 11-year olds and adults who were required to look exhibited a wider range of scores and poorer mean performance compared to those who were not required to look. In addition, very few of the participants in those age groups exhibited high overall looking behavior when given the choice. These findings suggest the possibility that high looking behavior was not the optimal looking option for the older children and adults and this requirement may have consumed cognitive resources that had been used for comprehension in the previous studies. Many of the younger children may still be learning how to maximize looking and listening behaviors and may be less likely to choose a strategy that will optimize their performance.

While differences in performance across looking conditions were significant, it should be noted that there was only one story available for the comprehension task. This limitation precludes examination of within-subject performance under the two conditions, which impacts interpretation of the results. Further studies, which are in preparation, will allow examination of comprehension across a variety of tasks and acoustic environments.

There were no significant within-subject effects of looking condition for the sentence-repetition task. In addition, while there were age effects, there was no consistent developmental trend. These findings suggest that during simple speech perception tasks, attempts to locate the talker may not negatively impact cognitive resources necessary to complete the task. It should be recalled that the sentence-repetition task was presented auditory-only. Although there was a visual cue to help listeners locate the signal source, they did not receive any additional visual cues that would have been available from seeing the talker's face. Thus, it is possible that with an audiovisual presentation there may have been an improvement in scores in the required looking condition. However, the relatively high scores in both the looking and non-looking conditions suggest that any potential improvement under the current acoustic conditions would have been small.

The sentence recognition task, as used in this study, was chosen to because word- and sentence-recognition tasks are commonly used in studies that examine the effects of room acoustics on speech perception (e.g., Crandell & Smaldino, 2000; Neuman et al., 2010; Yang & Bradley, 2009). Although these high-context, short sentences provide information about children's speech understanding, the cognitive effort required to fill in any missing acoustic-phonetic information in individual sentences would be expected to be lower than that of tasks children regularly encounter in classrooms. The comprehension task represented a classroom task in which there are multiple talkers who change rapidly (e.g., a classroom discussion; group interaction). In order to answer comprehension questions about the story, the listener had to be able to attend to all of the talkers over the entirety of the story, place that information in memory and process it for later recall. Such a task would utilize greater cognitive resources than simply repeating individual sentences. Under conditions that have the potential of further impacting the cognitive load of the speech perception task (e.g. poor acoustics, additional simultaneous tasks), the resources that are available for storage and recall may be negatively impacted. Further examination of this issue in greater detail is in progress.

Although, as previously discussed, the addition of visual cues can improve speech understanding in many situations, attempts to look for and at talkers may not always be beneficial for listeners. Although having someone else determine when looking is required may not typically occur in natural environments (decisions are made by the individual), the findings reported here suggest looking behavior may impact comprehension differently depending on the task and the age of the listener. During complex listening tasks with frequent changes in talkers, attempts to locate talkers may not always aid in comprehension, while in less complex listening tasks, looking strategies may have less of an impact on understanding. During a complex listening task, younger children may employ different looking strategies than older children and adults.

Differences in both looking strategies and potential benefits/limitations of such strategies should be taken into account when considering how learning tasks will be presented in classrooms. For example, in a task with multiple talkers, the environment could be arranged so that all talkers are easily visualized with limited looking effort (e.g., placing all children who are reading at the front of the room; arranging desks in a u-shape so that each of the children can more easily see all of the other children). For some tasks, working in small groups may provide better audiovisual access than would be available in large groups. For children with hearing loss, audibility of the speech signal may be poorer than for their peers with normal hearing. For these children, poor acoustics may place an even greater load on cognitive resources and the children may rely more heavily on combined audiovisual input for understanding. Future research examining how audiovisual cues and looking behavior impact this population relative to those with normal hearing can provide importance guidance for educational personnel.

Acknowledgements

This work was supported by grants R03 DC009675, T32 DC000013, and P30 DC004662 from the National Instituted of Deafness and Communication Disorders and grant P20 GM109023 from the National Institute of General Medical Sciences, both of the National Institutes of Health. The content of this article is the responsibility and opinions of the authors and does not represent the views of the NIH. The first author serves on the Pediatric Advisory Board of Phonak, but there are no conflicts with the work presented here. No other conflicts of interest are noted by the authors.

References

American National Standards Institute (2010). *Acoustical Performance Criteria, Design Requirements and Guidelines for Schools, Part 1: Permanent Schools*. ANSI 12.60-2010/Part 1. New York: ANSI.

Arnold, P. & Hill, F. (2001). Bisensory augmentation: A speechreading advantage when speech is clearly audible and intact. *British Journal of Psychology*, 92, 339-355.

Bench, J., Kowal, A., & Bamford, J. (1979). The BKB (Bamford-Kowal-Bench) sentence lists for partially-hearing children. *British Journal of Audiology*, 13, 108–112.

Best, V., Ozmeral, E. & Shinn-Cunningham, B. (2007). Visually-guided attention enhances target identification in a complex auditory scene. *Journal of the Association for Res in Otolaryngology*. 8, 294-304

Braasch, J., Peters, N. & Valente, D.L. (2008). A loudspeaker-based projection technique for spatial music applications using virtual microphone control. *Computer Music Journal*, 32, 55-71.

Bradley, J. & Sato, H. (2008). The intelligibility of speech in elementary school classrooms. *Journal of the Acoustical Society of America*, 123, 2078-2086.

Crandell, C. & Smaldino, J. (2000). Classroom acoustics for children with normal hearing and with hearing impairment. *Language Speech and Hearing Services in Schools*, 31, 362-370.

Desjardins, R., Rogers, J. & Werker, J. (1997). An exploration of why preschoolers perform differently than do adults in audiovisual speech perception tasks. *Journal of Experimental Child Psychology*, 66, 85-110.

Desjardins, R. & Werker, J. (2004). Is the integration of heard and seen speech mandatory for infants? *Developmental Psychology*, 45, 187-203.

Dockrell, J. & Shield, B. (2006). Acoustical barriers in classrooms: the impact of noise on performance in the classroom. *British Educational Research Journal*, 32, 509-525.

Dunn, L.M. & Dunn, D.M. (2007). *The Peabody Picture Vocabulary Test*, Fourth Edition, Bloomington, MN: NCS Pearson, Inc.

Erber, N. (1969). Interaction of audition and vision in the recognition of oral speech stimuli. *Journal of Speech and Hearing Research*, 12, 423-425.

Fraser, S., Gagne, J.-P., Alepins, M. & Dubois, P. (2010). Evaluating the effort expended to understand speech in noise using a dual-task paradigm: The effects of providing visual cues. *Journal of Speech, Language, Hearing Research*, 53, 18-33.

Gosselin, P. & Gagne, J.-P. (2010). Use of a dual-task paradigm to measure listening effort. *Canadian Journal of Speech-Language Pathology and Audiology*, 34, 43-51.

Heald, S. & Nusbaum, H. (2014). Talker variability in audio-visual speech perception. *Frontiers in Psychology*, 5, 1-9. Doi: 10.3389/fpsyg.2014.00698.

Hicks, C. & Tharpe, A.M. (2002). Listening effort and fatigue in school-age children with and without hearing loss. *Journal of Speech, Language, Hearing Research*, 45, 573-584.

Jamieson, D., Kranjc, G., Yu, K. & Hodgetts, W. (2004). Speech intelligibility of young school-aged children in the presence of real-life classroom noise. *Journal of the American Academy of Audiology*, 15, 508-517.

Johnson, C. (2000). Children's phoneme identification in reverberation and noise. *Journal of Speech, Language, and Hearing Research*, 43, 144-157.

Klatte, M., Hellbrück, J., Seidel, J. & Leistner, P. (2010). Effects of classroom acoustics on performance and well-being in elementary school children: a field study. *Environment & Behavior*, 42, 659-692.

Klatte, M., Lachmann, T. & Meis, M. (2010). Effects of noise and reverberation on speech perception and listening comprehension of children and adults in a classroom-like setting. *Noise Health: Special Issue on Noise, Memory and Learning 12*, 270-282.

Kuhl, P. & Meltzoff, A. (1982). The bimodal perception of speech in infancy. *Science, 218*, 1138-1141.

Kuhl, P. & Meltzoff, A. (1984). The intermodal representation of speech in infants. *Infant Behavior & Development, 7*, 361-381.

Larsby, B., Hallgren, M., Lyxell, B. & Arlinger, S. (2005). Cognitive performance and perceived effort in speech processing tasks: Effects of different noise backgrounds in normal-hearing and hearing-impaired subjects. *International Journal of Audiology, 44*, 131-143.

Lewis, D., Valente, D.L., & Spalding, J. (2015). Effect of minimal/mild hearing loss on children's speech understanding in a simulated classroom. *Ear & Hearing, 36*, 136-144.

Massaro, D. (1984). Children's perception of visual and auditory speech. *Child Development, 55*, 1777-1788.

Massaro, D. & Cohen, M. (1995). Perceiving talking faces. *Current Directions in Psychological. Science, 4*, 104-109.

Massaro, D., Thompson, L., Barron, B. & Laren, E. (1986). Developmental changes in visual and auditory contributions to speech perception. *Journal of Experimental Child Psychology, 41*, 93-113.

McGurk, H. & MacDonald, J. (1976). Hearing lips and seeing voices. *Nature, 264*, 746-748.

Mullenix, J., Pisoni, D. & Martin, C. (1989). Some effects of talker variability on spoken word recognition. *Journal of the Acoustical Society of America, 85*, 365-378.

Nelson, E., Smaldino, J., Erler, S., & Garstecki, D. (2008). Background noise levels and reverberation times in old and new elementary school classrooms. *Journal of Educational Audiology, 14,* 16-22.

Neuman, A. & Hochberg, I. (1983). Children's perception of speech in reverberation. *Journal of the Acoustical Society of America, 74*, 215-219.

Neuman, A., Wroblewski, M., Hajicek, J. & Rubenstein, A. (2010). Combined effects of noise and reverberation on speech recognition performance of normal-hearing children and adults. *Ear & Hearing, 31*, 336-344.

Picard, M. & Bradley, J.S. (2001). Revisiting speech interference in classrooms. *Audiology 40*, 221-244.

Pichora-Fuller, M.K., Schneider, B. & Daneman, M. (1995). How young and old adults listen to and remember speech in noise. *Journal of the Acoustical Society of America, 97*, 593-608.

Pisoni, D. & Remez, R. (Eds.). (2008). *The Handbook of Speech Perception*. Malden, MA: Blackwell Publishing.

Ricketts, T. & Galster, J. (2008). Head angle and elevation in classroom environments: Implications for amplification. *Journal of Speech Language Hearing Research, 51*, 516-525.

Ross, L., Molholm, S., Blanco, D., Gomez-Ramirez, M., Saint-Amour, D.& Foxe, J. (2011). The development of multisensory speech perception continues into the late childhood years. *European Journal of Neuroscience, 33*, 2329-2337.

Ross, L., Saint-Amour, D., Leavitt, V., Javitt, D. & Foxe, J. (2007). Do you see what I am saying? Exploring visual enhancement of speech comprehension in noisy environments. *Cerebral Cortex 17*, 1147-1153.

Ryalls, B. & Pisoni, D. (1997). The effect of talker variability on word recognition in preschool children. *Developmental Psychology, 33*, 441-452.

Shepard, A. (2010). "Aaron Shepard's RT Page: Scripts and tips for reader's theater," http://www.aaronshep.com/rt/index.html#RTE (Last viewed December 18, 2014).

Soto-Faraco, S., Calabresi, M., Navarra, J., Werker, J. & Lewkowicz, D. (2012). The development of audiovisual speech perception. In A. Bremmer, D. Lewkowicz, and C. Spence (Eds.). *Multisensory Development* (pp. 207-228). Oxford, UK: Oxford University Press.

Sumby, W. & Pollack, I. (1954). Visual contribution to speech intelligibility in noise. *Journal of the Acoustical Society of America, 26*(2), 212-215.

Valente, D.L., Plevinsky, H.M., Franco, J.M., Heinrichs-Graham, E.C. & Lewis, D.E. (2012), Experimental investigation of the effects of the acoustical conditions in a simulated classroom on speech recognition and learning in children *Journal of the Acoustical Society of America, 131*, 232-246.

Wightman, F., Kistler, D., & Brungart, D. (2006). Informational masking of speech in children: auditory-visual integration. *Journal of the Acoustical Society of America, 119*, 3940-3949.

Wroblewski, M., Lewis, D., Valente, D. & Stelmachowicz, P. (2012). Effects of reverberation on speech recognition in stationary and modulated noise by school-aged children and young adults. *Ear & Hearing, 33*, 731-744.

Yang, W. & Bradley, J. (2009). Effects of room acoustics on the intelligibility of speech in classrooms for young children. *Journal of the Acoustical Society of America, 125*, 922-933.

How Hard Can It Be To Listen? Fatigue in School-Age Children with Hearing Loss

Fred H. Bess
Samantha J. Gustafson
Benjamin W.Y. Hornsby
Department of Hearing & Speech Sciences,
Vanderbilt University School of Medicine,
Vanderbilt Bill Wilkerson Center,
Nashville, TN

Teachers and parents have long believed that children with hearing loss (CHL) are at increased risk for fatigue. CHL may be physically and mentally "worn out" as a result of focusing so intently on a teacher's speech and on conversations with other students. Moreover, increased listening effort, stress, and subsequent fatigue could compromise a child's ability to learn in a noisy classroom environment. Only recently, however, have we begun to see empirical studies supporting the notion that some CHL experience more fatigue than children with normal hearing (CNH).

The purpose of this paper is to enhance the awareness of fatigue in school-age CHL among educational audiologists. To this end, an overview on the topic of fatigue in CHL is provided including its importance, definitions, consequences, and preliminary findings from a large-scale study at Vanderbilt University. In addition, we discuss the role of the educational audiologist in the identification and management of CHL who are fatigued. Research on fatigue in CHL is lacking and the importance of, and need for, scientific exploration in this area is emphasized.

Key Words:
fatigue
hearing loss
children
salivary cortisol
listening effort
fatigue measures

Introduction

Fatigue is common in our society and experienced by virtually everyone. Not only is fatigue frequently observed among community-based populations, it is one of the more common complaints noted by persons with disabilities and chronic health illnesses. Hence, the subject of fatigue has received increased attention in the healthcare arena over the past several decades. Fatigue is reported to accompany numerous chronic health conditions, such as multiple sclerosis, cancer, obesity, diabetes, heart disease, systemic lupus erythematosus, and related autoimmune disorders (Daniel, Brumley, & Schwartz, 2013; Eddy & Cruz, 2007; Freal, Kraft & Coryell, 1984; MacAllister, et al., 2009; Varni, Burwinkle, Katz, Meeske, & Dickinson, 2002; Varni, Burwinkle, & Szer, 2004; Varni, Limbers, Bryant & Wilson, 2010; Whitehead, 2009). The effects of fatigue in adults and children are multiple and significant. In adults, the consequences of fatigue are known to impact adversely on work performance and life quality (Hetu, Riverin, Lalande, Getty & St-Cyr, 1988; Kramer, Kapteyn, & Houtgast, 2006). Fatigue in children with chronic illnesses is associated with reduced academic performance, school absences, limited daily activities, increased stress, and negative effects on quality of life (Beebe, 2011; Bess & Hornsby, 2014; McCabe, 2009; Ravid, Afek, Suraiya, Shahar, & Pillar 2009; Stoff, Bacon, & White, 1989). Thus, fatigue appears to be a common problem with significant consequences for individuals with a wide range of chronic health conditions. Despite its ubiquitous nature and potential impact on quality of life, our understanding of fatigue in persons with hearing loss is limited.

The purpose of this publication is to enhance the awareness of fatigue in school-age children with hearing loss (CHL) and to offer an overview of the topic. To this end, we review relevant definitions, concepts, and consequences of fatigue; preliminary findings from fatigue-related research; and the role of educational audiologists when serving fatigued CHL.

The Concept of Fatigue

Fatigue has been described as "one of the most puzzling enigmas in all of psychology" (Matthews, Desmond, Neubauer, & Hancock, 2012). It is a construct that has been the subject of research for more than 100 years; yet, in many ways, it still remains a mystery. Although we all know how fatigue feels because we have experienced it, we cannot reach a consensus on its definition. Fatigue has been viewed as both a symptom and a disease (Deluca, 2005). As a symptom, it appears in the presence of many medical conditions. As a disease, unexplained fatigue occurs among individuals in the absence of a medical diagnosis. Indeed, our understanding of the basic mechanisms of fatigue is limited. Suffice it to say, fatigue is a complicated and multifaceted construct that is poorly understood by the public and scientists alike.

The definition of fatigue varies somewhat depending on who is describing the construct (e.g., layperson versus psychologist) and the specific area of fatigue in which an individual is interested (e.g., fatigue in patients with cancer versus muscle-fatigue in professional athletes). Thus, it is not surprising that no consensus on the definition of fatigue has been reached among the scientific communities. It is understood, however, that fatigue occurs in both the physical and mental/cognitive domains, and is often described as a mood state—a feeling of tiredness, sleepiness, exhaustion, or lack of energy. Although CHL may also experience physical fatigue, such as body tiredness from prolonged physical exercise, our primary focus is the cognitive fatigue that may result from listening to a teacher's speech and other children in a noisy environment. Because cognitive fatigue is thought to bring about a general feeling of weariness or tiredness, we often hear teachers of CHL share comments, such as "my students are exhausted at the end of the school day."

Another factor relevant in the discussion of fatigue is the concept of stress. Anecdotal reports and qualitative research suggest a linkage between demanding speech processing in daily living and a resultant increase in stress and fatigue experienced by persons with hearing loss (Hornsby, Werfel, Camarata & Bess, 2014; Ross, 2012). Like fatigue, stress is difficult to define even though it is a constant factor in our modern lives. Stress can be defined as an internal or external threat that influences an individual's state of being (Middlebrooks & Audage, 2008). Some stress is normal and is essential for survival. For example, stress helps children develop the skills they need to cope with new and potentially threatening situations. Too much stress, however, can serve as a disruption to performance, which can lead to feelings of fatigue, lack of energy, irritability, demoralization, and hostility (Hockey, 2013; McEwen, 1998). Moreover, prolonged stress is capable of affecting one's health by causing emotional distress and can lead to a variety of physiological changes (e.g., increased heart rate, elevated blood pressure, variations in stress hormone levels; McEwen, 1998; Middlebrooks & Audage, 2008; Sapolsky, 2004). In sum, fatigue can be viewed as a direct outcome to the presence of sustained stress activity. Recently, fatigue was described as "a stress-related disorder" (Kocalevent, Hinz, Brahler & Klapp, 2011). Hence, the constructs of fatigue and stress are highly associated, and these two entities often overlap (Kocalevent et al., 2011; Magbout-Juratli, Janisse, Schwartz & Arnetz, 2010; Olsen, 2007).

Hearing Loss, Mental Effort, and Fatigue

The exertion of mental energy needed to attend to and understand a spoken message has been described as listening effort (Bess & Hornsby, 2014; Hicks & Tharpe, 2002; Hornsby, 2013; McGarrigle, et al., 2014). The magnitude of listening effort required in this situation may depend on many factors, including the students' degrees of hearing loss, their cognitive and attentive capabilities, and the classroom acoustics. Importantly, to offset deficits in audibility due to hearing loss, children and adults with hearing loss must increase their mental effort, more so than persons without hearing loss, when attempting to detect, process, and respond to auditory stimuli (Hicks & Tharpe, 2002; McCoy, et al., 2005). Lewis and colleagues (2014) recently reported that, while CHL showed similar abilities to recognize speech in a noisy classroom environment, they performed poorer than children with normal hearing (CNH) on more challenging tasks of comprehension that required additional cognitive effort. These results suggest that CHL expend greater amounts of listening effort during typical classroom listening and that this increased effort may result in difficulties in higher-order learning tasks.

It is generally assumed that increased listening effort is associated with subjective reports of fatigue in adults with hearing loss in everyday settings (Edwards, 2007; Zekveld, Kramer, & Festen, 2011). Likewise, teachers and parents have long speculated that CHL may also be at increased risk for fatigue. Research related to fatigue in CHL, however, is sparse and consists mainly of pilot studies and anecdotal reports (Bess, Dodd-Murphy, & Parker, 1998; Noon, 2013; Ross, 2012). Only recently have we begun to see scientific evidence in support of these anecdotal beliefs (Bess & Hornsby, 2014; Gustafson, Delong, Werfel & Bess, 2013; Hicks & Tharpe, 2002; Hornsby, 2013; Hornsby et al., 2014; Rentmeester, Shuster, Hornsby & Bess, 2013). One can intuitively reason that CHL could be mentally and physically exhausted as a result of listening intently to the teacher and other children in a noisy classroom environment throughout the school day. The additional attention, concentration, and effort needed to overcome a communication-based deficit while listening and processing speech in noise results in increased reports of stress and fatigue compared to CNH (Bess & Hornsby, 2014; Bess & Hornsby, in press). Moreover, the increased listening effort, stress, and fatigue during school could jeopardize the ability to learn in a noisy classroom, thus increasing the risk for problems in school. Individuals with additional handicapping conditions, as commonly found in CHL, are especially vulnerable to fatigue and its negative consequences (Hardy & Studenski, 2010). Mark Ross, a well-recognized pediatric audiologist with a significant bilateral hearing loss, described his own fatigue in the following way, "I can attest to the fatigue caused by prolonged intensive listening in noise through hearing aids. It seemed like the listening efforts were diverting some of my cognitive resources; so much effort was being devoted to getting the signal, that I sometimes missed part of the message" (Ross, 2012). Such a comment offers anecdotal evidence for an adult with hearing loss experiencing fatigue after sustained difficult listening in a noisy, reverberant environment. No doubt, CHL will also experience fatigue in similar listening situations, even if they are wearing hearing aids.

A Conceptual Model Linking Hearing Loss to Fatigue and School Performance

A simplified conceptual model linking CHL to listening effort, stress, fatigue, and school performance is shown in Figure 1. This model posits that CHL experience breakdowns in communication, especially in the area of speech understanding, when listening in noisy, reverberant classroom conditions. The more noise and reverberation in the classroom, the more difficult speech understanding becomes. These difficulties are thought to occur even if CHL are wearing hearing aids, implants, and/or other assistive devices.

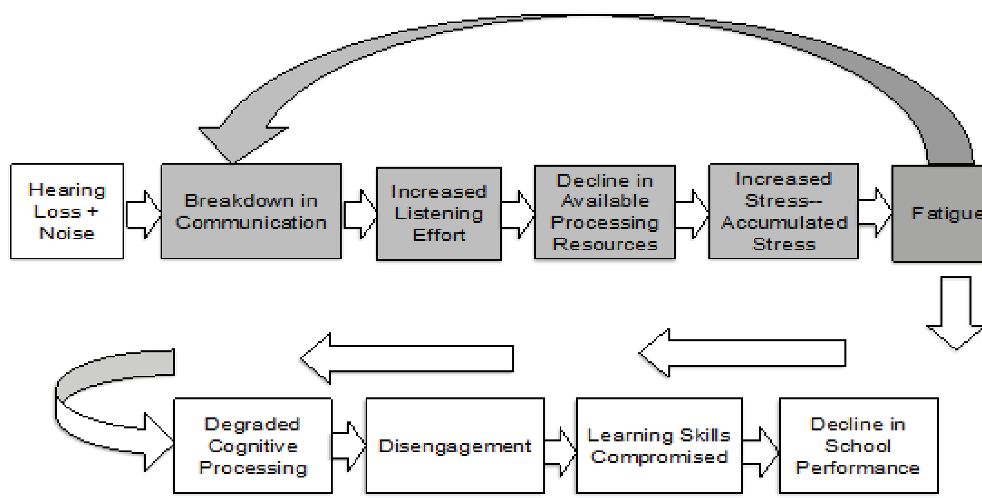


Figure 1. Conceptual model linking hearing loss to fatigue and school performance. The shaded areas represent events that occur repeatedly throughout the school day (From Bess & Hornsby, in press).

This breakdown in speech understanding brings about increased listening effort, which in turn results in a reduction in available processing capacity that might otherwise be used for other purposes, such as memory recall. Even if the speech signal is made sufficiently loud and clear to afford correct identification, CHL need to invest more cognitive resources to detect, process, and understand speech than listeners with normal hearing—a concept sometimes referred to as the effortfulness hypothesis (McCoy et al., 2005; Rabbitt, 1966, 1968, 1991). In this conceptual model, the process depicted in the shaded areas of Figure 1 occurs repeatedly throughout the day, resulting in increased listening effort, accumulated stress, and fatigue. Eventually, a point is reached in which the listening effort, accumulated stress, and fatigue are no longer manageable and the child's cognitive processing begins to falter. The continued effort to "keep up" may be replaced by a strategy of low engagement or even disengagement (Hockey, 2013). In other words, the child gives up and the combination of effort, stress, hearing-related fatigue, degraded cognitive processing, and/or disengagement impacts negatively on the behavioral skills essential for learning in school.

We thus find that fatigue is a problematic, somewhat elusive, concept that is frequently observed in both adults and children. Moreover, children with chronic health conditions, including CHL, appear to be at increased risk for fatigue; and such fatigue could impact negatively on learning and academic performance. Interestingly, some of the early research on fatigue in the 1890s took place in the school setting. This research focused on determining the ideal length of a school day—with the goal of ending daily instruction before children developed fatigue-related declines in school performance (Ackerman, 2011). More than 100 years later, we find ourselves revisiting the issues of fatigue in schools, especially as it relates to CHL. What follows is a synopsis of preliminary findings from recent fatigue-related research in CHL and the role of educational audiologists in the management of CHL who are fatigued.

Review of Studies on Fatigue in CHL

Much of the information reviewed herein is preliminary data from a large-scale study on listening effort and fatigue in school-age CHL at the Vanderbilt Bill Wilkerson Center. As noted earlier, parents and teachers often report that CHL are at increased risk for fatigue. How do they arrive at such a conclusion? Primarily through anecdotal observation and listening to children describe fatigue in their own words. CHL may express concerns about their tiredness, sleepiness, drowsiness or malaise; and, they may not want to participate in physical activities.

Such subjective reporting of one's mood or feelings represents the primary means to assess fatigue in children and adults. Self-report questionnaires have been developed for both children and adults to assess cognitive and physical fatigue. Comprehensive reviews of subjective measures of fatigue can be found elsewhere and are beyond the scope of this paper (McGarrigle, et al., 2014; Christodoulou, 2007). Briefly, these tests are simple, cost effective, easy to administer, and contain high face validity. Well-standardized fatigue scales typically contain multiple domains that represent such dimensions as physical fatigue, sleep/rest fatigue, and cognitive fatigue. Subjective fatigue scales can be used to identify the presence and severity of fatigue; they can also be used to assess the effectiveness of intervention strategies on fatigue. Many fatigue scales are available for the adult population; however, few such scales exist for children—and, no scales have been developed for fatigue related to hearing loss. Because CHL are at increased risk for fatigue, the need for a fatigue scale designed specifically for this population is paramount. An example of a short, five-item, self-report fatigue scale designed for children is shown in Appendix A. This experimental questionnaire was developed for research purposes to assess hearing-related fatigue following sustained and demanding listening tasks.

One of the early studies to report on fatigue in CHL using subjective self-report measures was that of Bess and co-workers (1998). They assessed functional health status in a group of school-age children with minimal hearing loss and CNH using the COOP Adolescent Chart Method (Nelson, et al., 1987). The COOP is a reliable and valid office-based screening tool for functional health. The tool is based on a five-point scale, with five representing the greatest dysfunction. Bess and coworkers found that children with minimal hearing loss reported significantly more dysfunction than CNH on two subtests of the COOP related to fatigue - stress and energy. In contrast, Hicks and Tharpe (2002) used the same instrument, but did not find any differences between CHL and an age-matched group of CNH. Methodological differences, such as sample size, hearing aid use, and type of hearing loss (unilateral versus bilateral hearing loss), may have accounted for the discrepancies between the two data sets. Another possibility is that the COOP, which is only a screening tool, lacked the required sensitivity for detecting fatigue.

To date, only one study has examined fatigue in school-age CHL using a standardized and validated self-report measure, the PedsQL Multidimensional Fatigue Scale (PedsQL MFS; (Varni et al., 2002; Varni, Burwinkle, & Szer, 2004). The PedsQL MFS consists of three different fatigue domains: cognitive fatigue, sleep/rest fatigue, and general fatigue. A total fatigue score can also be obtained from the three subscales. Hornsby and coworkers (2014) reported that school-age CHL experienced significantly more fatigue across all fatigue domains than an age-matched group of CNH (see Figure 2). Surprisingly, CHL reported more fatigue on the PedsQL MFS than children with other health conditions, such as cancer, rheumatoid arthritis, diabetes, and obesity (Berrin, et al., 2007; Marcus, et al. 2009; Varni et al., 2002; Varni et al., 2010). It is noteworthy that the PedsQL MFS was not developed for CHL; hence, the scale does not include items specific to fatigue associated with hearing related difficulties. A fatigue scale derived from the experiences of CHL and their parents might produce even larger differences between CHL and CNH. Also important to note in work reported by Hornsby and colleagues (2014) is the wide range of fatigue scores reported by CHL. Some children reported scores within the range of scores reported by CNH, while others reported substantially more fatigue. Clearly, additional work is needed to improve our understanding of factors that mediate and modulate fatigue in CHL.

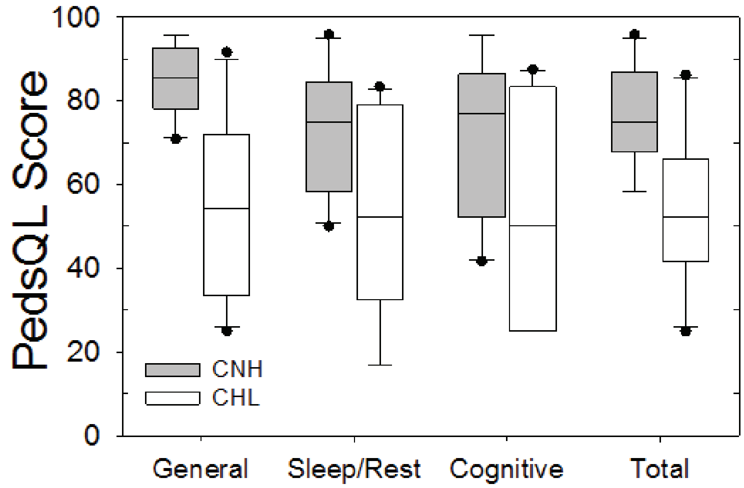


Figure 2. PedsQL-MFS ratings from CHL (white boxes) and CNH (grey boxes). Lower values reflect more fatigue. Middle lines represent median fatigue ratings, boxes show 25th to 75th percentile range, whiskers indicate the 10th and 90th percentiles, filled circles represent individual data points above and below the 90th and 10th percentiles (Adapted from Hornsby, B.W.Y., Werfel, K., Camarata, S. & Bess, F.H. (2014). Subjective fatigue in children with hearing loss: Some preliminary findings. *American Journal of Audiology*).

Another method for measuring fatigue is to examine whether cognitively demanding and sustained listening tasks leads to increases in fatigue over time. Rentmeester and colleagues (2013) reported preliminary findings from our Vanderbilt study using this approach. Their preliminary data demonstrated that subjective fatigue increases in CHL and CNH during prolonged and demanding listening tasks (2.5 to 3 hours) that are similar to a classroom environment. CHL show this increase in subjective fatigue whether or not they are using hearing aids during the tasks. To monitor subjective fatigue, the five-item questionnaire discussed above was used (see Appendix A). The fatigue scale was administered six times over the course of the demanding listening tasks. A mean fatigue score was calculated by averaging responses across the five items. Figure 3 (modified from Rentmeester et al., 2013) illustrates mean fatigue scale ratings for CNH and CHL with and without the use of personal hearing aids during the prolonged listening tasks. Average subjective fatigue scales could range from zero, indicating no fatigue, to four, indicating considerable fatigue. The ratings are based on the average rating across the five fatigue questions and are plotted as a function of measurement time point.

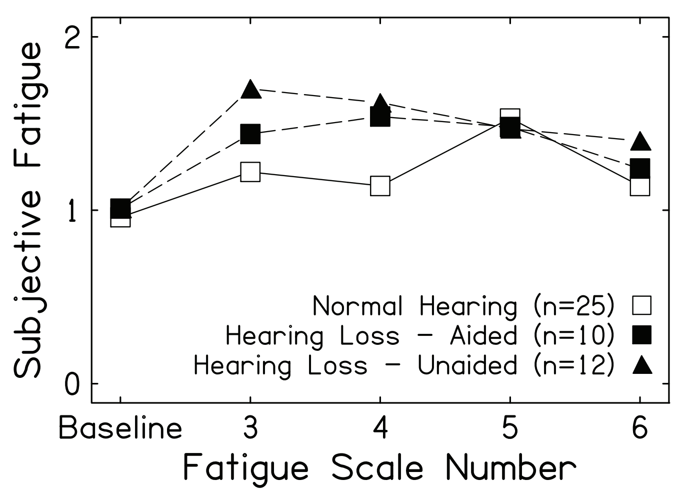


Figure 3. Fatigue scale ratings of CHL (with and without hearing aids) and CNH during a series of demanding and prolonged listening tasks as a function of measurement time point. Modified from Rentmeester et al. (2013).

A baseline score was established by averaging ratings of the first and second administration of the fatigue scale, given that the children were not required to complete demanding auditory tasks that involved sustained listening effort until shortly after the second rating scale. At the third administration of the fatigue scale, however, there were clear differences in reported fatigue scores between CNH, CHL wearing hearing aids, and CHL who were not wearing hearing aids. The unaided CHL showed the greatest amount of fatigue at this point, followed by the aided CHL. The CNH reported the least amount of fatigue following the prolonged listening tasks. Interestingly, during the final two fatigue scale administrations near the end of the tasks, the differences between CHL and CNH lessened. Such a finding is consistent with the idea that both CHL and CNH reached a tipping point. That is, the effort required to perform the sustained tasks was likely replaced by a strategy of low engagement (Bess & Hornsby, in press; Hockey, 2013) .

An important limitation of subjective fatigue scales is that they do not provide us with information about the potential mechanisms underlying the fatigue experience. In recent years, several different physiological measures have been proposed to assess cognitive fatigue—some of these measures include event-related potentials (ERP; Murata, Uetake, & Takasawa, 2005), skin conductance (Segerstrom & Nes, 2007), functional magnetic resonance imaging (fMRI; Lim, et al., 2010), and salivary cortisol levels (Hicks & Tharpe, 2002). In the Vanderbilt study on listening effort and fatigue, we have used the biochemical marker cortisol to measure stress and expenditure of energy throughout the school day. Here, we report information on salivary cortisol as a potential physiological index of fatigue. Those readers interested in other physiological methods for measuring fatigue are referred to other resources (Deluca, 2005; Matthews et al., 2012; McGarrigle et al., 2014).

Estimates of cortisol levels in the body can be obtained a variety of ways including samples of hair, urine, blood and saliva. While multiple methods are available, obtaining cortisol estimates via saliva samples offers several advantages (Inder, Dimeskit & Russel, 2012; Turpeinen & Hämäläinen, 2013). Salivary cortisol measures are simple, noninvasive, easy to administer, and can be collected in a naturalistic environment such as a classroom or playground. Hence, this physiologic technique appears to be especially useful for children—even infants and toddlers are able to provide salivary cortisol samples suitable for laboratory analysis (Gunnar, 1992). To collect a saliva sample, cotton pads are rolled in the child's mouth for about 2-3 minutes. Once the pad is saturated, it is coded, refrigerated, and sent to a laboratory for analysis.

The ability to function when fatigued is, in itself, stressful and requires additional energy resources compared to a non-fatigued state. Responding and adapting to stressful events is one of the important roles of the hypothalamic-pituitary-adrenal (HPA) system. When a stressful event occurs the hypothalamus is activated, setting off a chain of physiologic events that leads to the production of cortisol. Under normal conditions, stress leads to an increase in cortisol, which causes the body to prepare for handling the stressful event. Typically, cortisol increases during the night and levels rise sharply soon after awakening – this increase in cortisol level upon wakening is termed the cortisol awakening response (CAR; Fries, Dettenborn, & Kirschbaum, 2009; Wilhelm, Born, Kudielka, Schlotz & 2007). Following the CAR is a steady decline of cortisol levels throughout the day. Alterations in this typical daily profile may occur when individuals experience unusual stress or fatigue (Deluca, 2005; Kumari, et al., 2009; Schlotz, Hellhammer, Schulz & Stone, 2004; Whitehead, Perkins-Porras, Strike, Magid & Steptoe, 2007).

For instance, lower-than-normal cortisol levels have been observed in individuals with chronic fatigue syndrome (Fries, Hesse, Hellhammer, & Hellhammer, 2005; Jerjes, Cleare, Wessely, Wood & Taylor, 2005; Roberts, et al., 2010), a disabling stress-related disease with a primary fatigue symptomatology (Crofford & Demitrack, 1996; Parker, Wessely, & Cleare, 2001). CHL who are stressed and/or fatigued may also show alterations (e.g., lower or higher cortisol levels) in the activity of the HPA system. To explore relationships between hearing loss, stress, and fatigue, Hicks & Tharpe (2002) collected salivary cortisol samples twice a day in ten CHL and ten CNH. The first sample was collected near the beginning of the school day (approximately 9:00 a.m.) and the second sample was taken at the end of the school day (approximately 2:00 p.m.). No significant differences in cortisol values were observed between the two groups at either time point. Several factors may contribute to this finding including the sampling protocol (the small number of samples taken in the day), the small number of children studied, and the potential influence of hearing aids worn by the children. Of course, it is also possible that no differences in salivary cortisol levels exist between these two populations.

The Vanderbilt study on listening effort and fatigue is seeking to further characterize and understand variations of cortisol levels in CHL when compared to those of CNH. Like individuals with chronic fatigue syndrome, CHL who are stressed and/or fatigued might exhibit blunted cortisol values; however, it is also possible that CHL might exhibit elevated levels of salivary cortisol. Preliminary work by Gustafson and coworkers (2013) found that some CHL exhibited higher CARs than CNH, especially at the time point of awakening. Examples of cortisol profiles obtained in a group of CNH and four CHL are shown in Figure 4.

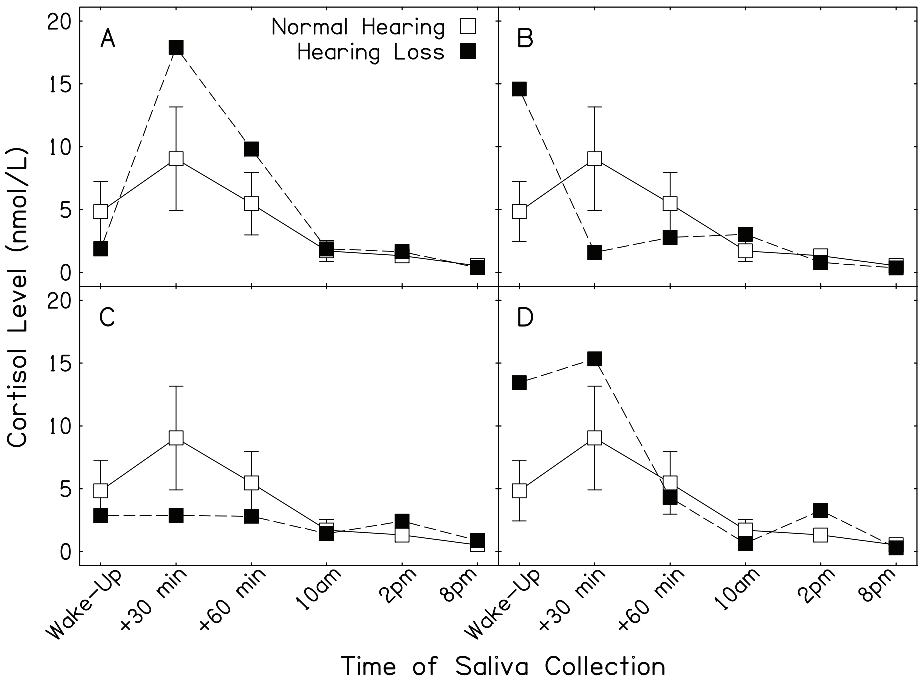


Figure 4. Mean cortisol levels (±1 standard deviation) obtained at all times of collection for CNH (open squares) and case examples of CHL (solid squares). Elevated cortisol values at early morning (awakening and 30 min post awakening) are associated with chronic stress, perceived stress, anxiety, and worrying about the burdens of the upcoming day. Blunted values (flat responses) are associated with an inability to mobilize sufficient energy to cope with the challenges of daily life activities.

It can be seen that the CNH (shown by the white squares) exhibit a normal diurnal pattern, with elevations in cortisol levels within the first hour of awakening followed by a decline in cortisol levels throughout the day. The CARs of the four CHL, however, show marked deviations from the profile of CNH. The CHL in panels A, B, and D show variations in elevated CARs, which have been associated with chronic social stress, perceived stress, and worrying about the burdens of the upcoming day (Wust, Federenko, Hellhammer & Kirschbaum, 2000; Wust, et al., 2000). Thus, diurnal cortisol patterns in at least some CHL demonstrate abnormalities consistent with the presence of increased stress levels. Sustained heightened stress levels may put CHL at increased risk for fatigue (Fries et al., 2005; Hellhammer & Wade, 1993). Alternatively, the hearing impaired child depicted in panel C shows blunted cortisol levels similar to those seen by individuals with chronic fatigue syndrome. Blunted values (flat responses) are associated with an inability to mobilize sufficient energy to cope with the challenges of daily life activities (Kudielka, Hellhammer, & Wust, 2009).

Although salivary cortisol appears to have potential for assessing stress and fatigue in school-age children limitations to this approach do exist. Some of the challenges to salivary cortisol measurement include 1) the costs and time required for laboratory analysis; 2) the need to control for multiple factors that can influence cortisol responses (e.g., food or drink, atypical class classroom excitement or stress, medications that might alter HPA axis; 3) the potential for contaminated data if sampling protocols are not strictly followed; and, 4) the need for multiple daily measurements to improve reliability. Despite these limitations, saliva measures provide a reliable estimate of cortisol levels and appear particularly useful for monitoring natural diurnal cortisol patterns in children (Gunnar, 1992; Kirschbaum & Hellhammer, 1999).

Identification and Management of Fatigue: The Role of Educational Audiology

CHL appear to be at increased risk for cognitive fatigue. Consequently, educational audiologists will be expected to play an increasingly important role in the identification and management of CHL who exhibit increased listening effort, stress, and subsequent fatigue in school. Perhaps the simplest way to identify children at risk for fatigue is to be alert for symptoms commonly associated with fatigue in children such as tiredness, sleepiness in the morning, inattentiveness, mood changes, and changes in play activity (e.g. decrease in stamina; Bess & Hornsby, 2014; Bess & Hornsby, in press; Hornsby et al., 2014; Rentmeester, Shuster, Key, Hornsby & Bess, 2014). Although empirical evidence is limited, it is believed that certain sub groups of CHL are at greater risk for fatigue and warrant closer surveillance in school. These groups include children with additional handicapping conditions (Bess &

Hornsby, in press; Hardy & Studenski, 2010), children who do not utilize hearing assistive technology (see Figure 3), children who are identified late, and children with moderate to severe degrees of hearing loss. Children suspected of fatigue should be given a subjective fatigue evaluation to confirm the presence of fatigue and to better understand the intensity and characteristics of the symptoms (Hornsby, et al., 2014; Varni, Burwinkle, & Szer, 2004; Hockenberry, et al., 2003; Varni, et al., 2002). Evidence-based intervention strategies are not yet available for CHL identified with fatigue. Until such evidence emerges, a few obvious and sensible steps are suggested—they focus on amplification, classroom strategies, and education of service providers.

Amplification. Problems relating to listening effort and fatigue might be minimized through the use of hearing technology such as advanced signal processing and/or the use of hearing assistance technology systems (Hornsby, 2013). Therefore, the identification of those CHL who are at increased risk for fatigue may be useful in the hearing aid selection and/or fitting process. Hearing aid prescription in children typically involves the selection and fitting of hearing aids that will afford the best opportunity for improved speech understanding through increased access to the auditory signal. Advanced signal processing programs such as digital noise reduction and directional microphones are widely available in even entry-level hearing aids, and aim to lessen the negative impacts of background noise on speech understanding and overall listening comfort. While directional microphones have been shown to improve children's speech understanding in noise (Crukley & Scollie, 2014), this technology is not generally appropriate for younger CHL, as the successful use of directional microphones requires the child to appropriately orient their head toward the speaker of interest and away from the prominent noise source (Ching, et al., 2009; Ricketts, Galster, & Tharpe, 2007; Ricketts & Picou, 2013).

Other hearing aid signal processing strategies that are readily activated in children's hearing aids (e.g., digital noise reduction, frequency lowering) have only a minimal effect on speech understanding (McCreery, Venediktov, Coleman & Leech, 2012; Pittman, 2011). However, research has shown that the use of digital noise reduction technology might reduce listening effort in adults (Sarampalis, Kalluri, Edwards & Hafter, 2009) and children (Gustafson, McCreery, Hoover, Kopun & Stelmachowicz, 2014). Thus, in addition to optimizing speech understanding and comfort, an alternative approach to fitting children with hearing aids might include procedures to determine whether a given hearing aid technology minimizes listening effort and hearing-related fatigue under adverse listening conditions.

Finally, although recent evidence suggests that properly fitted hearing aids, in both adults and children, can make a difference by reducing listening effort and cognitive fatigue (Hornsby, 2013; Rentmeester et al., 2014), not all CHL wear their hearing aids and/or use FM systems in the classroom. Gustafson and coworkers (2013) reported that younger CHL (7-10 years) are more likely to be consistent users of hearing aids and FM systems in the school setting than older CHL (11-12 years), irrespective of the severity of hearing loss. Table 1 shows these data in addition to data collected since 2013. For each day observed, we recorded if the child was utilizing hearing assistive technology in the classroom (personal hearing aids, personal FM, or sound field FM) at 10:00 am and 2:00 pm. Shaded boxes indicate device use during the time of observation. Note that device use is reduced in older children and that this pattern is not driven by degree of hearing loss. These observations of device-use in school-age CHL expand on recent data reported for younger CHL (<7 years of age) using data logging technology which show that daily hearing aid use time increases with more severe degrees of hearing loss and for older children (Jones, 2013; Munoz, Preston, & Hicken, 2014; Walker, et al., 2013). Together, this may suggest that CHL show increases in daily device use until early school-age when they are faced with the challenge of listening in noisy classroom environments and increased social awareness at which time device use becomes less consistent (Hornsby, 2004; Jones, 2013). The importance of CHL wearing properly fitted amplification devices throughout the school day cannot be overemphasized; however, further research is needed to better understand the causes and implications of inconsistent device use during various stages of childhood.

Table 1 . Observed hearing assistive technology use on two typical school days in children with mild- to- moderate hearing loss.

Child-Specific Information			Day 1				Day 2			
			AM		PM		AM		PM	
Study Participant	Age (years)	bPTA (dB HL)	HA	FM	HA	FM	HA	FM	HA	FM
HL1	6.7	18								
HL2	6.9	30	■	■	■	■			■	■
HL3	7.4	30	■	■	■	■	■		■	
HL4	7.8	53	■		■		■		■	
HL5	7.8	42	■	■	■		■	■	■	■
HL6	8.2	47	■	■	■	■	■	■	■	■
HL7	9.2	10		■		■				
HL8	9.3	63	■	■	■	■				
HL9	9.4	52	■		■		■		■	
HL10	10.1	47	■	■	■		■		■	■
HL11	10.2	37	■		■		■			
HL12	10.3	47								
HL13	10.4	35	■	■	■	■	■	■	■	■
HL14	10.5	42	■		■		■		■	
HL15	10.6	35	■		■		■		■	
HL16	10.7	41	■		■		■		■	
HL17	11.3	30								
HL18	11.5	42	■	■	■		■	■	■	
HL19	11.7	28								
HL20	11.8	23								
HL21	12.0	10		■			■		■	
HL22	12.6	30								
HL23	12.7	33	■				■			
HL24	12.8	28				■				
HL25	12.8	10								
HL26	12.9	37								

Note. Shaded boxes indicate the use of hearing technology at the time of observation. This table does not distinguish between children using personal or sound field FM systems. HA: hearing aid(s); FM: personal or sound field frequency modulation system; bPTA: better-ear pure-tone average for 0.5, 1, and 2 kHz.

Classroom strategies. It is not unreasonable to expect that CHL who are fatigued will be presented with unique listening and learning challenges, especially when attention and concentration are needed to deal with the demands of verbal comprehension in a noisy classroom. Classroom strategies might include recommending preferential seating to minimize environmental distracters, slowing the pace of a lesson to allow for additional processing time, limiting the duration of lessons when the primary content is auditory, and providing small group instruction as often as possible. It is important to note that preferential seating assignments benefiting CHL might not always be at the front of the classroom. Sources of classroom noise (e.g., fish tank pumps, windows, hallway doors) and the location of the primary speaker should be considered when selecting seating assignments for CHL. Of course, the use of a personal FM system partially reduces the difficulties of combating the variable noise sources and speaker locations in a typical classroom. Other strategies might include utilizing breaks as a means to transition between activities, arranging the day so that the most demanding listening tasks occur earlier when children have more resources to cope with these tasks, and scheduling those tasks that require fewer listening resources to occur later in the day. Parents and other family members may also benefit from this knowledge by structuring time away from the classroom to allow for periods of relaxation and rest. Clearly, additional research is needed to systematically examine any potential benefits of these strategies and to provide an evidence-based protocol for minimizing effects of fatigue in CHL.

Education. Most general education teachers and health care professionals are unaware that CHL can be at increased risk for fatigue and that such fatigue imposes negative psychosocial and educational consequences. In fact, general education teachers feel ill-prepared to deal with children who have chronic health conditions (Clay, Cortina, Harper, Cocco & Drotar, 2004). Therefore, it would seem beneficial to initiate educational programs designed to target teachers, physicians, and family members regarding fatigue in CHL. Such awareness programs might include information about fatigue and its consequences, symptoms associated with fatigue, and guidelines for identification and management. To be sure, educational programs should emphasize the importance of CHL wearing their prescribed amplification devices in the school setting. Enhanced awareness and knowledge of all professionals who serve CHL should ultimately result in improved services for this population.

Educational audiologists also can play a role in educating the child and family. Recall from the salivary cortisol data (Figure 4) that several CHL may exhibit elevated cortisol levels potentially indicating perceived stress and worrying about the burdens of the upcoming day. Because we understand that stress is an antecedent to fatigue, appropriate health care providers might assist children who are stressed, and their parents, by helping them to learn coping skills, to relax, to avoid high fat diets, and to recognize the beneficial effects of exercise (McEwen, 1998; Ratey, 2008).

Closing Remarks

Cognitive fatigue has long been the subject of interest to health professionals, scientists, and the public at large. Interestingly, the concept of fatigue in school-age children was one of the very first areas of scientific inquiry, dating back to the 1890s. In the 1920s and '30s, researchers explored fatigue in school-age children with varying levels of intelligence, probed the effects of fatigue on children in the classroom, and examined fatigue associated with such factors as school transportation and general health (Ackerman, 2011; Kefauver, 1928). However, research interest in fatigue waned following the 1930s, and it was not until the 1980s that we began to witness a resurgence of research in this area. The increased interest in fatigue came about as a consequence of the emergence of new models and theories of cognitive processing, attention, and motivation, as well as the development of new behavioral and physiological tools for assessment and inquiry (Ackerman, 2011). Even though fatigue in school-age children appeared to be one of the first areas of inquiry, contemporary research on fatigue in children has lagged behind fatigue research in the adult population. Today, research on fatigue in CHL is almost nonexistent.

The purpose of this overview has been to heighten the awareness and importance of fatigue in school-age CHL among educational audiologists. The topic is complex, but important and deserving of our attention; especially for audiologist's working in the schools. Fatigue is prevalent in CHL and the negative consequences of fatigue are multiple and significant. Indeed, fatigue can place some children at increased risk for learning difficulties in school. The need for additional research is crucial, as we lack information on true prevalence, consequences, mechanisms, identification, and intervention strategies. The creation of a fatigue scale designed specifically for CHL is an important first step in the development of intervention strategies.

The final message then, is that fatigue may be a contributing factor to the longstanding psycho-educational problems associated with hearing loss in children. A consideration of the construct of fatigue is increasingly important in the identification and management of CHL.

Acknowledgements

The authors would like to thank the graduate students from the Department of Hearing and Speech Sciences, Vanderbilt Bill Wilkerson Center, who assisted in subject recruitment and data collection including Elizabeth Boedeker, Tonia Davis, Hilary Davis, Andy DeLong, Emily Fustos, Amanda Headley, Lindsey Rentmeester, Amelia Shuster, and Krystal Werfel. We would also like to thank Nick Bennett, Caralie Focht, and Quela Royster, who assisted with data collection and processing. The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R324A110266 (Bess, PI) to Vanderbilt University; by an NICHD Grant P30HD15052 to the Vanderbilt Kennedy Center for Research on Human Development; and by a Vanderbilt Institute for Clinical and Translational Research grant (UL1 TR000445 from NCATS/NIH). The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

References

Ackerman, P. L. (Ed.). (2011). *Cognitive Fatigue: Multidisciplinary Perspectives on Current Research and Future Applications* (1st ed.). Washington DC: American Psychological Association.

Beebe, D. W. (2011). Cognitive, behavioral, and functional consequences of inadequate sleep in children and adolescents. *Pediatric Clinics of North America, 58*(3), 649-665. doi: 10.1016/j.pcl.2011.03.002

Berrin, S. J., Malcarne, V. L., Varni, J. W., Burwinkle, T. M., Sherman, S. A., Artavia, K., & Chambers, H. G. (2007). Pain, fatigue, and school functioning in children with cerebral palsy: a path-analytic model. *Journal of Pediatric Psychology, 32*(3), 330-337. doi: 10.1093/jpepsy/jsl017

Bess, F. H., Dodd-Murphy, J., & Parker, R. A. (1998). Children with minimal sensorineural hearing loss: prevalence, educational performance, and functional status. *Ear and Hearing, 19*(5), 339-354.

Bess, F. H., & Hornsby, B. W. Y. (2014). Commentary: listening can be exhausting—fatigue in children and adults with hearing loss. *Ear and Hearing, 35*(6), 592-599. doi: 10.1097/AUD.0000000000000099

Bess, F. H., & Hornsby, B. W. Y. (in press). The complexities of fatigue in children with hearing loss. *Perspectives on Hearing and Hearing Disorders in Childhood*.

Ching, T. Y., O'Brien, A., Dillon, H., Chalupper, J., Hartley, L., Hartley, D., & Hain, J. (2009). Directional effects on infants and young children in real life: Implications for amplification. *Journal of Speech, Language, and Hearing Research, 52*, 1241-1254.

Christodoulou, C. (2007). The assessment and measurement of fatigue. In J. DeLuca (ed.), *Fatigue as a window to the brain*. Cambridge, MA: The MIT Press.

Clay, D. L, Cortina, S., Harper, D. C., Cocco, K. M., & Drotar, D. (2004). Schoolteachers' experiences with childhood chronic illness. *Children's Health Care. 33*, 227–239.

Crofford, L. J., & Demitrack, M. A. (1996). Evidence that abnormalities of central neurohormonal systems are key to understanding fibromyalgia and chronic fatigue syndrome. *Rheumatic Diseases Clinics of North America, 22*(2), 267-284.

Crukley, J., & Scollie, S. D. (2014). The effects of digital signal processing features on children's speech recognition and loudness perception. *American Journal of Audiology, 23*(1), 99-115. doi: 10.1044/1059-0889(2013/13-0024)

Daniel, L. C., Brumley, L. D., & Schwartz, L. A. (2013). Fatigue in adolescents with cancer compared to healthy adolescents. *Pediatric Blood & Cancer, 60*(11), 1902-1907. doi: 10.1002/pbc.24706

Deluca, J. (2005). *Fatigue as a Window to the Brain* (J. Deluca Ed.). Cambridge, Massachusetts: The MIT Press.

Eddy, L., & Cruz, M. (2007). The relationship between fatigue and quality of life in children with chronic health problems: a systematic review. *Journal for Specialists in Pediatric Nursing, 12*(2), 105-114. doi: 10.1111/j.1744-6155.2007.00099.x

Edwards, B. (2007). The future of hearing aid technology. *Trends in Amplification, 11*(1), 31-45. doi: 10.1177/1084713806298004

Freal, J. E., Kraft, G. H., & Coryell, J. K. (1984). Symptomatic fatigue in multiple sclerosis. *Archives of Physical Medicine and Rehabilitation, 65*(3), 135-138.

Fries, E., Dettenborn, L., & Kirschbaum, C. (2009). The cortisol awakening response (CAR): facts and future directions. *International Journal of Psychophysiology, 72*(1), 67-73. doi: 10.1016/j.ijpsycho.2008.03.014

Fries, E., Hesse, J., Hellhammer, J., & Hellhammer, D. H. (2005). A new view on hypocortisolism. *Psychoneuroendocrinology*, 30(10), 1010-1016. doi: 10.1016/j.psyneuen.2005.04.006

Gunnar, M. R. (1992). Reactivity of the hypothalamic-pituitary-adrenocortical system to stressors in normal infants and children. *Pediatrics, 90*(3 Pt 2), 491-497.

Gustafson, S., Delong, A., Werfel, K., & Bess, F. H. (2013). *Classroom Noise and Fatigue in Children with Normal Hearing and Children with Hearing Loss.* Paper presented at the American Speech -Language-Hearing Association, Chicago Il.

Gustafson, S., McCreery, R., Hoover, B., Kopun, J. G., & Stelmachowicz, P. (2014). Listening effort and perceived clarity for normal-hearing children with the use of digital noise reduction. *Ear and Hearing, 35*(2), 183-194. doi: 10.1097/01.aud.0000440715.85844.b8

Hardy, S. E., & Studenski, S. A. (2010). Qualities of fatigue and associated chronic conditions among older adults. *Journal of Pain and Symptom Management, 39*(6), 1033-1042. doi: 10.1016/j.jpainsymman.2009.09.026

Hellhammer, D. H., & Wade, S. (1993). Endocrine correlates of stress vulnerability. *Psychotherapy and Psychosomatics, 60*(1), 8-17.

Hetu, R., Riverin, L., Lalande, N., Getty, L., & St-Cyr, C. (1988). Qualitative analysis of the handicap associated with occupational hearing loss. *British Journal of Audiology, 22*(4), 251-264.

Hicks, C. B., & Tharpe, A. M. (2002). Listening effort and fatigue in school-age children with and without hearing loss. *Journal of Speech, Language, and Hearing Research, 45*(3), 573-584.

Hockenberry, H.J., Hinds, P.S., Barrera, P., Bryant, R., Adams-McNeill, J., Hooke, C, … Manieuffel, B. (2003). Three instruments to assess fatigue in children with cancer: The child, parent, and staff perspectives. *Journal of Pain and Symptom Management. 25*(4): 319-328.

Hockey, R. (2013). *The Psychology of Fatigue* (1st ed.). New York, USA: Cambridge University Press.

Hornsby, B. W. (2004). Amplification Issues and Considerations in the Teenage Population. *Sig 9 Perspectives on Hearing and Heariing Disorders in Childhood, 14*((2)), 5. doi: 10.1044/hhdc14.2.8

Hornsby, B. W. (2013). The effects of hearing aid use on listening effort and mental fatigue associated with sustained speech processing demands. *Ear and Hearing, 34*(5), 523-534. doi: 10.1097/AUD.0b013e31828003d8

Hornsby, B. W., Werfel, K., Camarata, S., & Bess, F. H. (2014). Subjective fatigue in children with hearing loss: some preliminary findings. *American Journal of Audiology, 23*(1), 129-134. doi: 10.1044/1059-0889(2013/13-0017)

Inder, W. J., Dimeski, G., & Russell, A. (2012). Measurement of salivary cortisol in 2012–laboratory techniques and clinical indications. *Clinical endocrinology, 77*(5), 645-651.

Jerjes, W. K., Cleare, A. J., Wessely, S., Wood, P. J., & Taylor, N. F. (2005). Diurnal patterns of salivary cortisol and cortisone output in chronic fatigue syndrome. *Journal of Affective Disorders, 87*(2-3), 299-304. doi: 10.1016/j.jad.2005.03.013

Jones, C. (2013). *Fitting and usage of hearing instruments in pediatrics.* Paper presented at the Sound Foundations for Early Amplification, Chicago. http://phonakchicago2013.com/web/download/christine_jones.pdf

Kefauver, G. N. (1928). The relative influence of fatigue on pupils with different levels of mentality. *Journal of Educational Psychology, 19*, 5. doi: 10.1037/h0075021

Kirschbaum, C., & Hellhammer, D. H. (1999). Noise and Stress-Salivary Cortisol as a Non-Invasive Measure of Allostatic Load. *Noise Health, 1*(4), 57-66.

Kocalevent, R.D., Hinz, A., Brahler, E., & Klapp, B.F. (2011). Determinants of fatigue and stress. *BMC Research Notes*, 4, 238-242.

Kramer, S. E., Kapteyn, T. S., & Houtgast, T. (2006). Occupational performance: comparing normally-hearing and hearing-impaired employees using the Amsterdam Checklist for Hearing and Work. *International Journal of Audiology, 45*(9), 503-512. doi: 10.1080/14992020600754583

Kudielka, B. M., Hellhammer, D. H., & Wust, S. (2009). Why do we respond so differently? Reviewing determinants of human salivary cortisol responses to challenge. *Psychoneuroendocrinology*, *34*(1), 2-18. doi: 10.1016/j.psyneuen.2008.10.004

Kumari, M., Badrick, E., Chandola, T., Adam, E. K., Stafford, M., Marmot, M. G., … Kivimaki, M. (2009). Cortisol secretion and fatigue: associations in a community based cohort. *Psychoneuroendocrinology, 34*(10), 1476-1485. doi: 10.1016/j.psyneuen.2009.05.001

Lewis, D. E., Valente, D. L., & Spalding, J. L. (2014). Effect of Minimal/Mild Hearing Loss on Children's Speech Understanding in a Simulated Classroom. *Ear and Hearing*. doi: 10.1097/AUD.0000000000000092

Lim, J., Wu, W., Wang, J., Detre, J. A., Dinges, D. F., & Rao, H. (2010). Imaging brain fatigue from sustained mental workload: An ASL perfusion study of the time-on-task effect. *NeuroImage, 49*, 3426–3435.

MacAllister, W. S., Christodoulou, C., Troxell, R., Milazzo, M., Block, P., Preston, T. E., … Krupp, L. B. (2009). Fatigue and quality of life in pediatric multiple sclerosis. *Multiple Sclerosis, 15*(12), 1502-1508. doi: 10.1177/1352458509345902

Marcus, S. B., Strople, J. A., Neighbors, K., Weissberg-Benchell, J., Nelson, S. P., Limbers, C., … Alonso, E. M. (2009). Fatigue and health-related quality of life in pediatric inflammatory bowel disease. *Clinical Gastroenterology and Hepatology, 7*(5), 554-561.

Matthews, G., Desmond, P. A., Neubauer, C., & Hancock, P. A. (Eds.). (2012). *The Handbook of Operator Fatigue* (1st ed.). Burlington, Vermont, USA: Ashgate Publishing Company.

McCabe, M. (2009). Fatigue in children with long-term conditions: an evolutionary concept analysis. *Journal of Advanced Nursing, 65*(8), 1735-1745. doi: 10.1111/j.1365-2648.2009.05046.x

McCoy, S. L., Tun, P. A., Cox, L. C., Colangelo, M., Stewart, R. A., & Wingfield, A. (2005). Hearing loss and perceptual effort: downstream effects on older adults' memory for speech. Quarterly Journal of Experimental Psychology. *A: Human Experimental Psychology, 58*(1), 22-33. doi: 10.1080/02724980443000151

McCreery, R. W., Venediktov, R. A., Coleman, J. J., & Leech, H. M. (2012). An evidence-based systematic review of frequency lowering in hearing aids for school-age children with hearing loss. *American Journal of Audiology, 21*(2), 313-328. doi: 10.1044/1059-0889(2012/12-0015)

McEwen, B. S. (1998). Protective and damaging effects of stress mediators. *New England Journal of Medicine, 338*(3), 171-179. doi: 10.1056/NEJM199801153380307

McGarrigle, R., Munro, K. J., Dawes, P., Stewart, A. J., Moore, D. R., Barry, J. G., & Amitay, S. (2014). Listening effort and fatigue: what exactly are we measuring? A British Society of Audiology Cognition in Hearing Special Interest Group 'white paper.' *International Journal of Audiology, 53*(7), 433-440. doi: 10.3109/14992027.2014.890296

Middlebrooks, J. S., & Audage, N. C. (2008). The effects of childhood stress on health across the lifespan. Centers for Disease Control and Prevention, Atlanta, GA: U.S. Department of Health and Human Services.

Munoz, K., Preston, E., & Hicken, S. (2014). Pediatric hearing aid use: how can audiologists support parents to increase consistency? *Journal of the American Academy of Audiology*, *25*(4), 380-387. doi: 10.3766/jaaa.25.4.9

Murata, A., Uetake, B., & Takasawa, Y. (2005). Evaluation of mental fatigue using feature parameter extracted from event-related potential. *International Journal of Industrial Ergonomics. 35*:761–770

Nelson, E.C., Wasson, J.H., Johnson, D., & Hays, R. (1996). Dartmouth COOP function health assessment charts: Brief measures for clinical practice. In B. iSpilker (Ed), *Quality of Life and Pharmacoeconomics in Clinical Trials, (2nd Ed)* Lippincott-Raven Publishers: Philadelphia.

Nelson, E. C., Wasson, J., Kirk, J., Keller, A., Clark, D., Dietrich, A., … Zubkoff, M. (1987). Assessment of function in routine clinical practice: Description of the COOP Chart Method and preliminary findings. *Journal of Chronic Diseases. 40*(Suppl. 1):555–635.

Noon, L. (2013). The Impact of Concentration Fatigue on Deaf Children Should Be Factored In. Blog post retrieved on 11/20/2013 from: http://limpingchicken.com/2013/06/28/ian-noon-concentration-fatigue/.

Parker, A. J., Wessely, S., & Cleare, A. J. (2001). The neuroendocrinology of chronic fatigue syndrome and fibromyalgia. *Psychological Medicine, 31*(8), 1331-1345.

Pittman, A. (2011). Children's performance in complex listening conditions: effects of hearing loss and digital noise reduction. *Journal of Speech, Language, and Hearing Research, 54*(4), 1224-1239. doi: 10.1044/1092-4388(2010/10-0225)

Rabbitt, P. (1966). Recognition: Memory for words correctly heard in noise. *Psychonomic Science, 6*(8), 1.

Rabbitt, P. (1968). Channel capacity, intelligibility and immediate memory. *Quarterly Journal of Experimental Psychology, 20*, 7.

Rabbitt, P. (1991). Mild hearing loss can cause apparent memory failures which increase with age and reduce with IQ. *Acta Otolaryngologica (Stockh). Suppl. 476*, 9.

Ratey, J. J. (2008). Spark: *The Revolutionary New Science of Exercise and the Brain* (1st ed.). New York, USA: Little, Brown and Company.

Ravid, S., Afek, I., Suraiya, S., Shahar, E., & Pillar, G. (2009). Kindergarten children's failure to qualify for first grade could result from sleep disturbances. *Journal of Child Neurology, 24*(7), 816-822. doi: 10.1177/0883073808330766

Rentmeester, L., Shuster, A., Hornsby, B. W., & Bess, F. H. (2013). *Measures of fatigue in children with and without hearing loss.* Paper presented at the American Speech-Language-Hearing Association, Chicago, IL.

Rentmeester, L., Shuster, A., Key, A., Hornsby, B. W., & Bess, F. H. (2014). *Objective measures of fatigue in children with and without hearing loss* Paper presented at the American Academy of Audiology, Orlando, FL.

Ricketts, T., Galster, J., & Tharpe, A. M. (2007). Directional benefit in simulated classroom environments. *American Journal of Audiology, 16*(2), 130-144. doi: 10.1044/1059-0889(2007/017)

Ricketts, T. A., & Picou, E. M. (2013). Speech recognition for bilaterally asymmetric and symmetric hearing aid microphone modes in simulated classroom environments. *Ear and Hearing, 34*(5), 601-609. doi: 10.1097/AUD.0b013e3182886d1e

Roberts, A. D., Charler, M. L., Papadopoulos, A., Wessely, S., Chalder, T., & Cleare, A. J. (2010). Does hypocortisolism predict a poor response to cognitive behavioural therapy in chronic fatigue syndrome? *Psychological Medicine, 40*(3), 515-522. doi: 10.1017/S0033291709990390

Ross, M. (2012). [Personal communication.].

Sapolsky, R. M. (2004). *Why Zebras Don't Get Ulcers* (3rd ed.). New York, USA: St. Martin's Press.

Sarampalis, A., Kalluri, S., Edwards, B., & Hafter, E. (2009). Objective measures of listening effort: effects of background noise and noise reduction. *Journal of Speech, Language, and Hearing Research, 52*(5), 1230-1240. doi: 10.1044/1092-4388(2009/08-0111)

Schlotz, W., Hellhammer, J., Schulz, P., & Stone, A. A. (2004). Perceived work overload and chronic worrying predict weekend-weekday differences in the cortisol awakening response. *Psychosomatic Medicine, 66*(2), 207-214.

Segerstrom, S. C., & Nes, L. S. (2007). Heart rate variability reflects self-regulatory strength, effort, and fatigue. *Psychological Science, 18*(3), 275-281. doi: 10.1111/j.1467-9280.2007.01888.x

Stoff, E., Bacon, M. C., & White, P. H. (1989). The effects of fatigue, distractibility, and absenteeism on school achievement in children with rheumatic diseases. *Arthritis Care and Research, 2*(2), 49-53.

Turpeinen, U., & Hämäläinen, E. (2013). Determination of cortisol in serum, saliva and urine. *Best Practice & Research Clinical Endocrinology & Metabolism, 27*(6), 795-801.

Varni, J. W., Burwinkle, T. M., Katz, E. R., Meeske, K., & Dickinson, P. (2002). The PedsQL in pediatric cancer: reliability and validity of the Pediatric Quality of Life Inventory Generic Core Scales, Multidimensional Fatigue Scale, and Cancer Module. *Cancer, 94*(7), 2090-2106.

Varni, J. W., Burwinkle, T. M., & Szer, I. S. (2004). The PedsQL Multidimensional Fatigue Scale in pediatric rheumatology: reliability and validity. *Journal of Rheumatology, 31*(12), 2494-2500.

Varni, J. W., Limbers, C. A., Bryant, W. P., & Wilson, D. P. (2010). The PedsQL multidimensional fatigue scale in pediatric obesity: feasibility, reliability and validity. *International Journal of Pediatric Obesity, 5*(1), 34-42. doi: 10.3109/17477160903111706

Walker, E. A., Spratford, M., Moeller, M. P., Oleson, J., Ou, H., Roush, P., & Jacobs, S. (2013). Predictors of hearing aid use time in children with mild-to-severe hearing loss. *Language, Speech, and Hearing Services in Schools, 44*(1), 73-88. doi: 10.1044/0161-1461(2012/12-0005)

Whitehead, D. L., Perkins-Porras, L., Strike, P. C., Magid, K., & Steptoe, A. (2007). Cortisol awakening response is elevated in acute coronary syndrome patients with type-D personality. *Journal of Psychosomatic Research, 62*(4), 419-425. doi: 10.1016/j.jpsychores.2006.11.005

Whitehead, L. (2009). The measurement of fatigue in chronic illness: a systematic review of unidimensional and multidimensional fatigue measures. *Journal of Pain and Symptom Management, 37*(1), 107-128. doi: 10.1016/j.jpainsymman.2007.08.019

Wilhelm, I., Born, J., Kudielka, B. M., Schlotz, W., & Wust, S. (2007). Is the cortisol awakening rise a response to awakening? *Psychoneuroendocrinology, 32*(4), 358-366. doi: 10.1016/j.psyneuen.2007.01.008

Wust, S., Federenko, I., Hellhammer, D. H., & Kirschbaum, C. (2000). Genetic factors, perceived chronic stress, and the free cortisol response to awakening. *Psychoneuroendocrinology, 25*(7), 707-720.

Wust, S., Wolf, J., Hellhammer, D. H., Federenko, I., Schommer, N., & Kirschbaum, C. (2000). The cortisol awakening response - normal values and confounds. *Noise and Health, 2*(7), 79-88.

Zekveld, A. A., Kramer, S. E., & Festen, J. M. (2011). Cognitive load during speech perception in noise: the influence of age, hearing loss, and cognition on the pupil response. *Ear and Hearing, 32*(4), 498-510. doi: 10.1097/AUD.0b013e31820512bb

Appendix A. A self-report scale for assessing a child's current (right now) level of fatigue.

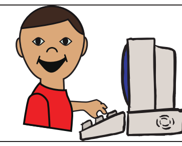
How do you feel RIGHT NOW?

1. I feel tired.

Please circle one for each statement.

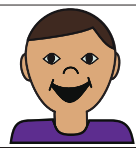
Not at All	A little	Some	Quite a bit	A lot
0	1	2	3	4

2. It is easy for me to do these things.



Please circle one for each statement.

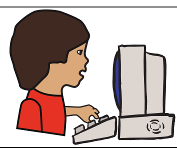
Not at All	A little	Some	Quite a bit	A lot
0	1	2	3	4



3. My head hurts.

Please circle one for each statement.

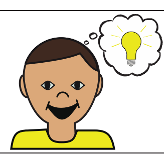
Not at All	A little	Some	Quite a bit	A lot
0	1	2	3	4



4. It's hard for me to pay attention.

Please circle one for each statement.

Not at All	A little	Some	Quite a bit	A lot
0	1	2	3	4



5. I have trouble thinking.

Please circle one for each statement.

Not at All	A little	Some	Quite a bit	A lot
0	1	2	3	4

Shift Happens: Evolving Practices in School-Based Audiology

Cheryl DeConde Johnson
The ADEvantage Consulting, Leadville, CO

Lisa Cannon
Denver Public Schools, Denver CO

Anne Oyler
American Speech-Language-Hearing Association, Rockville, MD

Jane Seaton
Seaton Consultants, Athens, GA

Donna Smiley
The EARS Program, Arkansas Children's Hospital, Little Rock, AR

Carrie Spangler
University of Akron, Akron, OH

Public education initiatives such as Common Core State Standards, Response to Intervention, Multi-Tiered Systems of Support, Universal Design for Learning, and the 21st Century Learning Framework are influencing school-based audiology practices. As a result of these programs, technological advancements, and increased focus on evidenced-based practice and student outcomes, school-based audiologists need to shift how they work and the services they provide. While making these changes, they must continue to meet the requirements of IDEA and other federal and state mandates. In this article we discuss current policy initiatives and the unique audiological contributions of school-based audiologists and explore use of a workload approach and other practical strategies to facilitate shifting and evolving roles of educational audiologists.

Key Words:
Common Core State Standards
Disruptive Education
Multi-Tiered Systems of Support
Response to Intervention
School-Based Audiology
Universal Design for Learning
21st Century Learning

Explanation of terms used in this article:

Educational Audiology: *Audiology services that support children and youth, especially those who are deaf, hard of hearing, deaf-blind, or have other auditory impairments, in their educational environments.*

Educationally Significant Hearing Loss: *Any hearing loss that potentially interferes with access to classroom instruction and impacts a child or youth's ability to communicate, learn, and develop peer relationships (Johnson & Seaton, 2012)*

School-Based Audiology: *Educational audiology services that are delivered in a school or other educational setting by an educational audiologist (Johnson & Seaton, 2012; Richburg & Smiley, 2012).*

Interprofessional Collaborative Practice: *Multiple health workers from different professional backgrounds who collaborate to provide comprehensive services by working with patients, their families, caregivers and communities to deliver the highest quality of care across settings (WHO, 2010).*

Self-Determination: *A combination of attitudes and abilities that lead people to set goals for themselves and to take the initiative to reach these goals (PACER Center, www.pacer.org).*

Introduction

Educational audiologists understand the major role that advocacy plays in our profession. As a relatively new and highly specialized service in the school setting, school-based audiologists spend a lot of time explaining what we do and why. We point to federal regulations, such as the Individuals with Disabilities Education Act (IDEA 2004), that set the parameters of our practice and to the state laws and local policies that have further shaped individual job descriptions and workloads. Interpretation of these laws over the years has resulted in considerable variability of daily practices among school-based audiologists. As a result of guidance by our professional associations and leaders in educational audiology, we have a solid collection of best-practice guidelines to keep us aligned and moving in a common direction (EAA, 2009a, 2009b; ASHA 2002). However, a "shift" in practice is necessary to continue advocating for our profession in a manner that is relevant and influential with administrators and educators, to improve programs and services to students and, ultimately, their outcomes.

The priorities within our professional practices are influenced by reforms in public education across the country. Since the 2001 passage of No Child Left Behind (NCLB), schools and states have been held increasingly more accountable for all student performance including that of students with disabilities. Initiatives to improve instructional practices have had a major impact as well. For example, Response to Intervention (RtI), Multi-Tiered System of Supports (MTSS), and Universal Design for Learning (UDL) promote the use of effective, accessible and differentiated curricula, the use of data-driven instructional practices, and greater collaboration among general and special education personnel (RTI Action Network, n.d.; National Center for Learning Disabilities, n.d.; National Center on Universal Design for Learning, 2012). New technologies and digital innovations both provide opportunities and drive change at a pace that is difficult for educators and schools to manage. Disruptive Education is a term that describes how a new educational technology and/or theory unexpectedly displace an established technology and/or theory, reshaping the learning landscape (Christensen, 2008). The 21st Century Learning Framework and the adoption of Common Core State Standards (CCSS) introduced a more rigorous set of expectations for student learning, significantly impacting the way teachers teach as well as the way that they are evaluated and compensated (Wiener, 2013). Since 2009, many states have taken accountability further by enacting legislation that holds educators to strict, performance-oriented criteria that tie student learning outcomes to personnel evaluations and ultimately job retention (National Council on Teacher Quality, 2013). As this trend continues, school-based audiologists are increasingly aware of and involved in implementing programs that link our services to student performance.

Impact of Current Federal, State and Local Initiatives on School-Based Audiology Practice: Common Core State Standards, Response to Intervention/Multi-Tier System of Supports, Accommodations, Expanded Core Curricula, and Access Skills

As we shift our workload to fill a growing need for audiology services that support students in general education settings, familiarity with general education curricula and standards at state and local levels and other pertinent educational trends is essential. Individualized Education Program (IEP) goals and services increasingly target outcomes that are based on these state and local standards while still providing for individual student needs under special education legislation (IDEA 2004). These initiatives provide a structure to monitor and support the students on 504 Plans as well as those without a 504 Plan or IEP. Data summarized in Table 1 from the Departments of Education in Colorado, Washington, and Iowa (personal communications, CO: June 1, 2005; WA: August 5, 2012; IA: October 4, 2012) reveal that about half of the students in these states received services through special education and relatively few children received services under a 504 plan. As the last column shows, the percentage of students who are deaf and hard of hearing and educated without any formal support services is significant in each state.

Table 1. Service profile of students who are deaf and hard of hearing.

State	% IEP	%504 Plan	% no services
Colorado (2005)	43%	2%	55%
Washington (2012)	57%	17%	26%
Iowa (2012)	54%	No data available	46%

Source: Personal Communication (CO: June 1, 2005; WA: August 5, 2012; IA: October 4, 2012).

Common Core State Standards

The Common Core State Standards (CCSS) were developed by a consortium of state education chiefs and governors with input from teachers, parents, school administrators, and experts from across the country. Now adopted by 43 states, these standards include a set of college- and career-ready learning goals and expectations for English language arts/literacy and mathematics. Stated another way, the standards identify what students should know and be able to do at each grade level to ensure success in their post-graduation world.

Curricula, materials, and much of the content for the CCSS may vary depending on state standards and requirements, but, typically, the student skills needed for achieving positive outcomes do not. The CCSS require that students systematically acquire knowledge through reading, writing, speaking, and listening. In addition, the 21st Century Learning Framework recommended skills in creativity, critical-thinking, communication, and collaboration are interwoven throughout the standards.

Response to Intervention, Multi-Tier System of Supports, and Universal Design for Learning

Response to Intervention (RtI) and Multi-Tier System of Supports (MTSS) provide another avenue in general education for facilitating access to classroom instruction. Schools are beginning to use the term MTSS because it represents a more comprehensive framework of effective instruction, behavior supports, and intervention for all students. Further, MTSS has a stronger and more general goal of prevention as compared to RtI's primary focus targeted to students with learning disabilities. In addition, MTSS is designed to provide multiple levels of support for all learners (struggling through advanced), with a greater focus on collaboration among all school personnel including school leaders and parents (Hoover & Patton, 2008; Hurst, 2014; National Center on Learning Disabilities, n.d.).

Universal Design for Learning (UDL) provides school systems with a set of curricular design principles that support flexible approaches to, and accommodations for, instruction and assessment that can be customized for individual student needs. Technology is central to this educational framework, but emphasis is on the goal to create environments where everyone will have the opportunity to become expert learners, and the use of personal and assistive technologies (e.g., cochlear implants, personal FM) is promoted "...even during activities where other students may not use any technologies at all" (National Center on Universal Design for Learning, 2012).

Accommodations

With the increasing number of learners who are deaf and hard of hearing participating in general education (many without an IEP or formal 504 plan), school-based audiologists must find ways to shift their workload to include more time for consultation and collaboration with classroom teachers and other educational personnel. Many staff members are unfamiliar with the barriers to classroom instruction that can occur as a consequence of partial, absent, or distorted hearing. As a result, they also are unaware of teaching strategies and accommodations for improving access to communication in educational environments. Knowledge and expertise in technology and other accommodations to facilitate access for classroom instruction and assessment has been a consistent focus within the practice of educational audiology. As development and availability of technology continues to grow and goals for student outcomes evolve, the need to stay informed has never been more critical. Knowledge of your state's requirements related to accommodations for assessment and classroom instruction is essential. Key questions to be answered include the following:

- Has your state adopted the CCSS?
- If your state has adopted the CCSS, what assessments are being used to measure student performance? Currently, core assessments are being developed, but states have the option to use alternate assessments, including those they may have used previously.
- Are these assessments based on UDL?
- What type of disruptive technology and hybrid teaching is being implemented in your state or school district?
- Does your state require that accommodations for assessment only include those used for classroom instruction? Some states (e.g., GA) require that students demonstrate need for, and benefit from, accommodations for instruction before these accommodations are permitted for use during assessments.
- Does your state have a list of "approved accommodations?" If so, can you easily access this list (e.g., links under general education, assessments, special education)? Accommodations that benefit students with hearing challenges often are already adopted and, therefore, easier to specify for individual students.
- If a desired accommodation is not on your state list, what is the process for approval? As technology advancements emerge, the school-based audiologist may be the most appropriate team member to recommend additions to the accommodation list.
- Finally, what is the process for *documenting* need for and benefit from a recommended accommodation for an individual student? What are the expected student outcomes? If the recommended accommodation involves technology, what funding sources might be utilized, and how quickly can the technology be available for the student?

Familiarity with terminology used to describe assessment and instruction can enhance collaboration among traditional service providers under IDEA and general education personnel. Educational audiologists will need to familiarize themselves and their colleagues with relevant words and phrases that may have become second nature to our communication but are new vocabulary for others. Examples include, but are not limited to, the following:

- **Accommodations** do not reduce learning expectations; they allow students with challenges access to the same learning opportunities as their typical peers. Accommodations must be documented on the IEP or 504 Plan and should be monitored to ensure they are implemented with fidelity. Documentation of evidence validating the benefit of the accommodation may also be required (Thompson, Morse, Sharpe, & Hall, 2005).
- **Access skills** are skills that need to be addressed through IEP goals to enable full participation in the student's educational program (Colorado Department of Education, 2012).
- **Modifications** or alterations refer to practices that change or reduce learning expectations (Thompson et al, 2005).
- **Standard administration** refers to testing conditions in which the procedures and directions included in the administration manual are followed exactly (Georgia Department of Education, 2013).
- **Conditional administration** refers to testing conditions in

which more expansive accommodations are used to provide access for students with more severe disabilities (Georgia Department of Education, 2013).

Expanded Core Curricula and Access Skills

For many students with disabilities, including those with hearing challenges, achieving successful outcomes necessitates goals and standards beyond those included in the CCSS. A movement to develop and implement an expanded core curriculum (ECC) was first initiated for students with visual challenges (Florida Resource Materials and Technology Center, n.d.; Perkins School for the Deaf and Blind, n.d.). With support from the deaf education National Agenda (2005), states including WI and IA began to apply the ECC concept to their programs for students who are DHH (Iowa Department of Education, 2013). Ultimately, Iowa adopted and disseminated a formal ECC document that has since been adopted or cited as a recommended resource by a number of other states (e.g., FL, GA, IL, KY, PA, TX, WI).

The Colorado Department of Education (2012) developed a slightly different approach based on access skills that apply to all students with disabilities to address the underlying skills necessary to access the general education curriculum as well as life outcomes, career, and community membership and participation. Regardless of the approach, expanded core curricular topics and access skill areas are unique for each individual and are designed to supplement, not supplant, core academic standards addressed in the general education curricula. These ECC and access skill areas often represent the specialized instruction and support services that are the basis for the IEP and instruction from a specialist in deaf education or related field, such as audiology. The main focus is to facilitate access to general education content with the goal of improved student outcomes. Examples of common ECC areas identified by Iowa and Florida, and Access Skills in Colorado are shown in Table 2.

Table 2. Selected ECC/Access Skill content areas.

Iowa ECC	Florida ECC	Colorado Access Skills
• Audiology • Career Education • Communication • Family Education • Functional Skills for Educational Success • Self-Determination & Advocacy • Social-Emotional Skills • Technology	• Knowledge of Hearing Loss • Language and Accommodations--http://rmtcosbd.org/glossary/supports-services-and-accommodations-worksheet-for-students-who-are-deaf-or-hard-of-hearing • Personal and Interpersonal Skills • Self-Determination • Self-Advocacy--http://rmtcosbd.org/glossary/self-advocacy • Transition--http://rmtcosbd.org/glossary/transition • Deaf Culture and Heritage	• Communication and Basic Language Skills • Decision-making and Problem-solving • Self-advocacy/Self-determination • Physical • Inter-Intra-personal • Organization • Technology • Career Development

Immediate Need

As we have described, the field of education is changing and this is having an impact on school-based audiology services. Central to this are budget constraints, a growing population of students to serve (due to EHDI, RTI/MTSS) and the need for school-based professionals to document outcomes/ benefits of their services. Audiologists must be prepared to articulate their value, demonstrate their role in student outcomes and maximize their efficiency in order to serve children in special and general education.

Articulating our Value for Improved Student Outcomes

In the current educational landscape, where schools are on a continuous journey to improve student performance and educational outcomes with fewer resources and greater accountability, school-based audiologists need to clearly define how we add value to student learning and outcomes. Ask a school-based audiologist if what they do is important, and they will say yes. Ask school personnel and parents of learners who are deaf and hard of hearing if the school-based audiologist is an important member of the school team and, mostly likely, they too will say yes. If we rephrase the question to both groups and ask: "How does the work of the school-based audiologist contribute to improved student outcomes?" it might be more difficult to provide substantive answers.

School-based audiologists have the skills and knowledge to provide comprehensive audiology services onsite to students in academic settings. These services, as delineated in IDEA (2004), include identification of students with hearing loss, determination of the degree and nature of the hearing loss (diagnostic evaluation), habilitation for children with hearing loss, hearing loss prevention education, counseling students, families and school personnel about the hearing loss, and the selection, fitting, verification, and validation of hearing instruments including group amplification systems. A few examples of the roles/duties that school-based audiologists perform with a brief explanation of how these tasks contribute to improved student outcomes follows. School-based audiologists are encouraged to use these examples as springboards for crafting their own job task/workload analysis specific to the roles/responsibilities that they have within their practice settings.

Identification and diagnosis of hearing status and subsequent implications. A major component of student learning occurs verbally. If students are unable to access verbal input, educational progress is negatively impacted. These students often perform poorly on standardized assessments of curricular material as a result of limited access to instruction in the classroom. As instruction increasingly focuses on analytical thinking and problem solving and learning becomes more active through group and cooperative activities (e.g., flipped classrooms, integrated multimedia and other disruptive education practices), deaf and hard of hearing learners may be left behind because they may not adequately hear, process, and respond to the information presented at the expected pace. School-based audiologists impact student outcomes by identifying, quantifying and intervening to accommodate for hearing challenges. Audiologists have unique skills to evaluate auditory function and classroom listening to guide interventions that will assist students to have better access to classroom instruction.

State education agencies are required to have policies and procedures in place to identify children with disabilities and to determine whether or not those children are in need of special education or additional supports for equal access to classroom information (IDEA, 2004; ADA 1990; Rehabilitation Act of 1973; Section 504.). Hearing screening is usually considered a routine part of state and local "child find" efforts but these practices vary widely from state to state with different policies and professionals responsible for conducting them. For example, in the state of Arkansas, school nurses are responsible for hearing screening. However, some children with developmental or behavioral challenges are unable to participate in a "routine" hearing screening protocol that might be carried out by a non-audiologist. Furthermore, once basic hearing screening has been completed, children who do not pass the screening need further evaluation. School-based audiologists employ their expertise by using specialized equipment and techniques to screen and evaluate students to ultimately rule out or confirm the presence of a potentially educationally significant hearing loss (ESHL). These school-based services are valuable to students, their families, and school personnel because they are provided within the school district, are specific to the educational setting, reduce time away from instruction and provide opportunities for school-based interprofessional collaboration.

When hearing loss is present, there is ample evidence to support that early identification and intervention results in better developmental outcomes than if the hearing loss is identified late (Holt & Svirsky, 2008; Moeller, 2000; Nicholas & Geers, 2006). These studies, however, focus on young children (under 3 years of age). Ongoing surveillance of developmental outcomes for all children with hearing loss, whether identified early or late, is needed to document language, communication, social and academic performance and support students accordingly. On average, only 38.5% of children exiting Part C are determined to be eligible for Part B services (US Department of Education, 2014). Because the preschool years are a particularly vulnerable period, in part due to more formal classroom learning settings and increased demands for attention and language proficiency in group learning environments, the opportunities for children who are deaf and hard of hearing to fall behind is great. Therefore comprehensive audiological (including speech in noise, classroom acoustics, functional listening), and speech-language (including receptive and expressive language, pragmatic language, vocabulary) assessments are necessary to assure deficits are identified and appropriate services are available to support these children. If we do not recognize this vulnerability and adequately support these children, we, and the school system, will fail our children by beginning a cycle of limited educational access and increasing academic difficulties and delays.

Hearing assistance technology (HAT). School-based audiologists are essential to the selection and management of appropriate HAT, a role that is unique to our professional scope of practice. For deaf and hard of hearing learners with audibility goals, it is our responsibility to provide them auditory access to the same learning opportunities as their hearing peers and consequently help improve their educational outcomes. In the previous example, we are reminded that classroom instruction is primarily delivered in an auditory-oral mode requiring good access to the auditory input. In most cases, hearing aids or cochlear implants alone do not provide adequate auditory access in a classroom setting. Classroom barriers to auditory access include varied distances from the talker (e.g., the teacher and other classmates), excessive background noise and reverberation of the auditory signal, and soft or unintelligible speech from the talker. Research evidence supports the premise that students do perform better on tasks of speech understanding when utilizing hearing assistance technology in addition to their personal hearing instruments (Anderson & Goldstein, 2004; Schafer & Thibodeau, 2006; Schafer, Thibodeau, Whalen, & Overson, 2007; Thibodeau, 2010; Wolfe, et al., 2013).

The role of school-based audiologists in coordinating HAT with the school's media and technology is critical as hybrid models of disruptive education continue to redefine our educational systems. One example of hybrid disruptive education is blended classrooms (i.e., utilizing "brick and mortar" schools and online learning). Blended-learning programs are classified as rotation models if they involve students within a given course or subject rotating on a fixed schedule or at the teacher's discretion between learning modalities, at least one of which is online learning (Christensen, 2013). School-based audiologists need to observe the structure of the learning environment, including classroom acoustics and implications for learning, combined with knowledge and expertise in HAT to provide students with appropriate solutions to adapt to blended classroom learning. They not only need to ensure that the teacher's voice is providing an appropriate speech-to-noise ratio, but also to help identify the best way for students to actively engage in small group discussions with peers and computer-based instruction (e.g., computerized standardized testing, flipped classroom learning, supplemental instructional learning modules). School-based audiologists are the professionals positioned to be innovators who are knowledgeable about current classroom acoustic accessibility and can leverage online technologies to create powerful new hybrids to better serve students with hearing loss (Spangler, 2014).

Careful and thoughtful selection, fitting and management of HAT must take into account the student's auditory abilities, amplification preferences, and communication access needs in association with classroom acoustics and instructional methodologies. With full auditory access to spoken information in the classroom, including multimedia, students will realize greater benefit from their education. These improvements may be evidenced in better performance on standardized tests and achievement of language, communication, academic, and social outcomes that are directly impacted by access to auditory information.

Self-Determination. A primary goal of school-based audiology services is to prepare learners to become independent, responsible citizens with the knowledge and self-advocacy skills to effectively address the communication needs associated with their particular hearing status. As school-based audiologists, our unique position results in being able to follow students throughout their school career in long-term relationships through which we can guide and support these skills from school entry until high school graduation.

The role of self-determination toward achieving life goals has received increasing attention, particularly with students with disabilities for whom specific support is often necessary. According to Weymeyer, Palmer, Agran, Mithaug, and Martin (2000), self-determination focuses on setting goals, making decisions and choices, solving problems, and self-advocating. Unique to this model is the shift from teacher-directed and teacher-driven instruction to student-directed teaching practices. Audiologists can support learners in this model through self-assessments to help identify communication challenges and facilitating learning activities to increase knowledge of hearing loss-related problems, disability rights, technology solutions, and understanding the implications of using, or not using, various accommodations.

Educational framework. As with other health professions, audiology is a field with sub-specialties. An audiologist working in a school setting should possess and utilize a different skill set from the audiologist who is working in a clinical practice. Audiologists in clinical settings fulfill an important service for students and complement the school-based audiology services. A school-based audiologist needs to have expertise in how hearing loss affects listening, communication and learning, how hearing assistance technology and other access technologies should be used in an academic setting, and classroom acoustics. In addition, school-based audiologists are called upon to interpret and apply education specific laws and regulations (e.g. IDEA and Section 504) as they relate to deaf and hard of hearing learners. Often clinic-based audiologists verify the appropriateness of personal hearing instruments for a student's hearing loss; however, the school-based audiologist needs to extend the evaluation to include validation of the effectiveness of the amplification (personal instruments and HAT) in the actual classroom. In order to substantiate our added value to student outcomes, results of hearing evaluations must be connected to the student's functional learning environments including student counseling and relevant teacher consultation. School-based audiologists should continuously document and describe what they do on a day-to-day basis that contributes to improved outcomes for the students. Communication, collaboration, and ongoing education with other school professionals and administrators are strategies for illustrating these values. As members of interprofessional academic teams, we must be vigilant for opportunities to demonstrate our contributions to student outcomes.

Managing Change by Working More Efficiently

In order for school-based audiologists to expand their services to support students with hearing challenges in their access to general education, a shift in the role perception and funding of these services may be required. Additional time, knowledge and skill is needed to collaborate with a greater variety of school personnel and to shift focus to facilitate students' self-determination and self-advocacy skills related to their individual needs in their schools and communities. In planning for the future, a workload approach can be helpful in moving beyond the role of related service provider for individual students who are deaf or hard-of-hearing (a.k.a. caseload approach) to that of a consultant and collaborator who serves as a member of school or district-wide teams. Facilitating communication access for students with hearing challenges and enabling successful outcomes on standards and performance measures used with all students remains central to this approach.

Workload Analysis. The shift towards increased accountability and attention to student outcomes provides an opportunity for school-based audiologists to document the value of their services for students with hearing loss. However, the demands on our time may stretch us thin as workloads expand to include initiatives such as RtI, MTSS and UDL in general education settings in addition to the services already provided to students on IEPs as required under IDEA. With renewed national attention on student outcomes and professional performance, it is more critical than ever that school-based audiologists be able to define their roles and document the value of their services.

A key step in documenting our value and the outcomes of our services is the development of a clear and thorough description of our workload. Workload is impacted by a number of variables including student population, administrative and supervisory duties, the types of services provided, and how and where they are delivered. When measuring workload, the full range of duties and activities that fill each day and week must be considered. These activities change over time during the course of the school year and will require periodic reevaluation. Obvious tasks such as direct student contact are part of the analysis, but we need to consider time spent collaborating with general education and special education staff, communication with parents, indirect services to students, meetings, documentation, and travel time as well.

Factors Impacting Increased Workload. Larger workloads are increasingly common across the education workforce. The overall economy of the country contributes to layoffs and restructuring and ultimately pushes employers to ask workers to do "more with less" in order to stretch limited financial resources.

In addition to those seen in the overall workforce, several factors have contributed to increasing workloads within school-based audiology. Students with multiple disabilities and complex academic and communication needs often require the expertise of a pediatric/school-based audiologist to determine hearing status. If hearing loss is diagnosed in a student with complex issues, the school-based audiologist may need to devote more time educating and supporting other school personnel on the aspects of the student's developmental and academic challenges that are hearing loss related.

The complexity of hearing assistance technology is another factor that is increasing the school-based audiologist's workload. This technology is constantly changing and often lacks the ease of "plug and play." That is to say, even if the school-based audiologist is involved in the selection of the technology, school personnel cannot (and should not) take it out of the box, plug it in and expect it to work. Although we have access to technology that can provide students with exceptional access to auditory input, it must be fitted and used correctly to benefit the student. Improper fitting degrades the auditory input and increases the risk for harm (Eriks-Brophy, Durieux-Smith, Olds, Fitzpatrick, Duquette, & Whittingham, 2006).

Many school-based audiologists do not see students in a single location. Most travel to several buildings within a district or even multiple school districts. Travel time is a factor that often is not taken into consideration when a caseload approach is used. If two educational audiologists both cover student populations of 10,000 total students but Audiologist A's students are in a single district where buildings are in close proximity to each other and Audiologist B's students are spread across multiple districts with buildings located miles apart, the workload will be greater for Audiologist B when all other factors are equal. Travel time decreases the amount of time that school-based audiologists can spend on direct services or in student support services.

As is the case in the overall workforce, decreases in funding and/or stagnation in funding are significant factors that increase the workload for school-based audiologists, or, in some cases, decrease the duties. When IDEA was enacted in 1975, the federal government was to fund 40% of excess educational costs for children with disabilities with the states providing the remaining 60%. To date, the federal share has never exceeded 19% (National Education Association, 2014). This means that states are still required to provide the services required under IDEA, but in actuality they must fund 80%+ of the costs. In many states these extra costs are passed on to local school districts. Not only has the federal government never fully funded IDEA, but in some years, federal funding has decreased while inflation has caused costs to rise. Because of funding shortages, school-based audiology positions are often eliminated as staff retire or leave positions. Without significant advocacy efforts, these cuts will increase the workload for school-based audiologists and/or decrease services provided to students. In some cases the duties are inappropriately shifted to teachers of the deaf and/or speech-language pathologists.

Increasingly school-based audiology services are required to support students in general education settings. Early Hearing Detection and Intervention (EHDI) programs, advancements in technology, parent preferences, and inclusion agendas are among the reasons for this continuing practice. Even though students may not qualify for special education services, we are ethically obligated to serve them through the RTI/MTSS process or a 504 Plan in order to provide access to education through technology and accommodations. While our ethical/moral obligations may clash with perspectives from local administrators, overall, it is positive that school-based audiology services are needed in the general education arena. As a result, our support to students outside of special education continues to shift the workload for school-based audiologists.

Conducting a Workload Analysis. Ideally, the school-based audiologist should establish a workload baseline using past performance. This can be accomplished by documenting day to day work tasks across time. First, a list of expected job tasks for a given position should be created. Using items such as the language in IDEA regarding the definition of audiology services to students with IEPs, documents available from the EAA (2009a; 2009b), a district or program specific job description and the Educational Audiology Workload Analysis Form (Johnson & Seaton, 2010, p. 661), a school-based audiologist should be able to construct a comprehensive list of potential work tasks. The tasks are monitored over a period of time to yield an analysis of how work time is spent. This workload baseline provides a starting point for analyzing tasks that are getting the most attention as well as tasks that are not being covered. Figure 1 illustrates one example of a workload model.

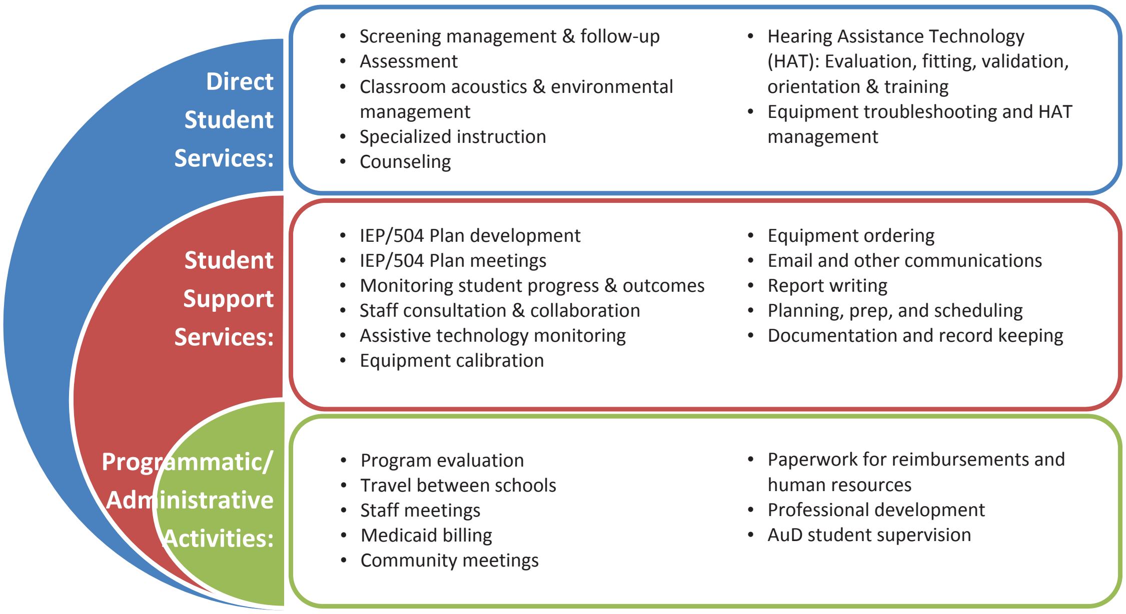


Figure 1. Workload model of school-based audiology duties and activities.

One challenge of many school-based audiologists is school personnel's lack of knowledge regarding the potential contribution that an audiologist brings to the educational setting. Some school personnel may think that school-based audiologists are mostly diagnosticians. This perception ignores the habilitative and collaborative tasks that are essential components of our practice. When school districts attempt to determine the need for more school-based audiology positions, they may suggest eliminating tasks related to consultation, collaboration, habilitation, counseling and prevention in efforts to decrease the need for more positions. It is incumbent on school-based audiologists, as well as our counterparts in clinical settings, to advocate for all aspects and job tasks of service provision necessary for improved student outcomes.

Approaches to Managing Workloads. Strategies for managing workloads include the use of support persons, telepractice, technology and increased collaboration. These tactics may alleviate some of the overload while school-based audiologists shift to a workload approach. Implementation of these strategies will provide opportunities to work more efficiently and effectively.

Support personnel may perform clerical tasks such as managing paperwork, scheduling and email communication. Depending on licensure laws, HIPPA and/or other regulations in your state, audiology assistants or technicians may be used to conduct routine clinical tasks such as hearing screening or monitoring amplification that, with proper training and oversight, do not require the audiologist's on-site expertise. The use of audiology support personnel frees school-based audiologists to attend to tasks that require their expertise. AuD students, whether in formal practicum through their clinical rotations or hired as temporary workers (assistantship), provide effective support to school-based audiologists while being exposed to the practice of audiology in the school setting

State regulations and privacy laws may permit the use of telepractice to increase the efficiency of the school-based audiologist's workload. Telepractice can decrease travel time which in turn increases the amount of time to devote to student support services. Through telepractice, school-based audiologists can increase consultation time with local school personnel thereby positively impacting outcomes for students. Technology may also increase the efficiency of the workload. Computer-based IEP programs, report writing formats, and database management software programs for scheduling, tracking student data, managing equipment, and other performance documentation have the potential to streamline many of our programmatic and administrative tasks. Email communication, texting, on-line meetings and video/audio applications (e.g., Facetime) used for troubleshooting hearing assistance technology are examples of how technology can increase efficiency and effectiveness for the school-based audiologists.

Although it may take more time on the front end, increased levels of collaboration may ultimately pay off in decreased workloads. There are varying degrees of collaboration from merely "networking" to fully integrated collaboration where all members of the educational team work in tandem to improve outcomes for students who are deaf/hard of hearing. As illustrated in Figure 2, networking, which is the lowest level of collaboration, indicates that school personnel know that the other members of the team exist but there is minimal communication and most decisions are made independently (i.e., the silo effect). Coordination of efforts is a mid-level form of collaboration. Communication is frequent and some decisions are shared, but not all. True collaboration means that all members of the educational team see themselves as belonging to one system, communication is frequent and is based on a high level of trust, and all decision are made by consensus (Frey, Lohmeier, Lee, & Tollefson, 2006; Gajda, 2004).

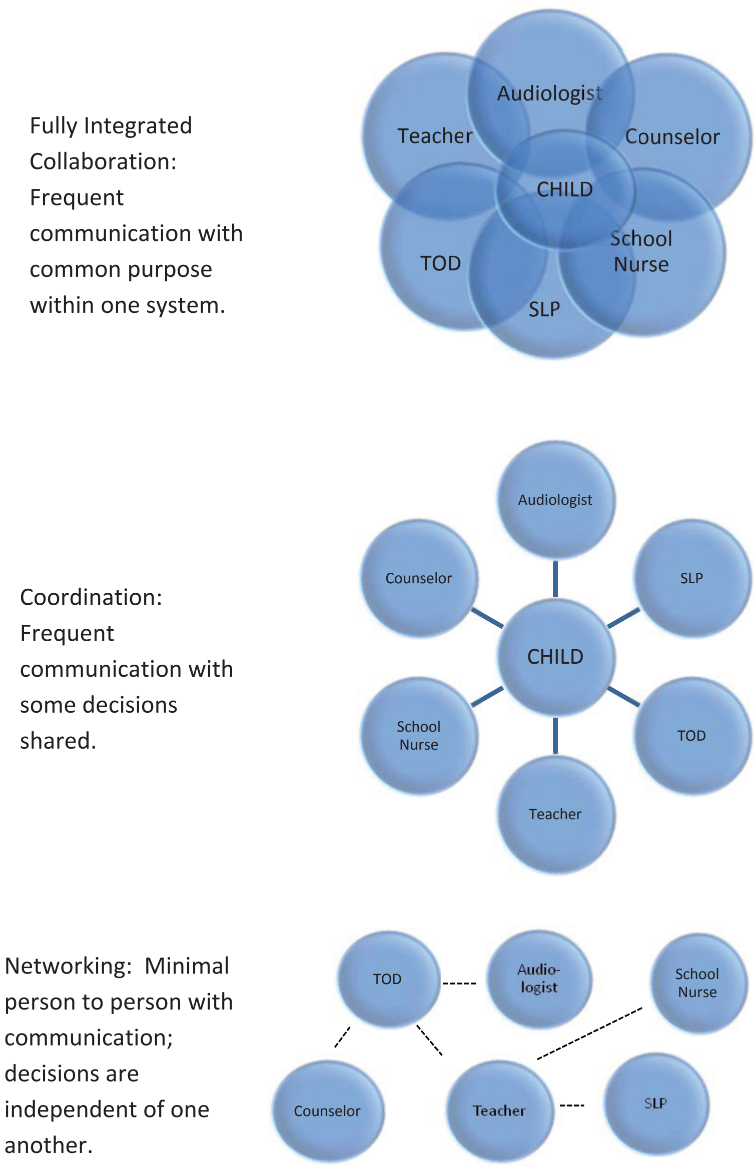


Figure 2. Levels of Collaboration

Evidence-Based Practices, Practice Outcomes and Indicators

Education policy will continue to change as political priorities and budgets steer the course. It is becoming increasingly important that we are able to demonstrate that our services improve student outcomes thereby increasing the likelihood that local districts will meet state and/or national education standards. As classroom teachers are being asked to change the way they think about their practice, it is critical that educational audiologists and other related services professionals examine our own practice standards as they relate to desired outcomes. Through ongoing discussion and a survey of its members, the Educational Audiology Association (EAA) has identified key outcomes, indicators, and measurement strategies to assist educational audiologists in documenting the outcomes and value of their services (EAA 2011). It is time to take that initiative further to develop consensus and collect data to support these efforts.

ASHA describes evidence-based practice (EBP) as an integration of clinical expertise/expert opinion, external scientific evidence, and client/patient/caregiver values (www.asha.org/members/ebp/intro). The key is evidence that the practice being employed produces the intended results. Therefore, it is necessary to validate our work with, and on behalf of, students through data. EBP should also be aligned with desired student outcomes. Individual outcomes should be generated as part of the IFSP/IEP or other planning process to serve as a road map for what students should know and be able to do upon graduation from high school as a result of the specialized support that is provided. Likewise, professional outcomes are needed to identify measurable indicators that represent the results of school-based audiology practices. The Educational Audiology Association (EAA) has undertaken an initiative to identify and reach consensus on outcomes and measurement indicators to address the impact of school-based audiology services (Johnson, 2011). This effort represents a conceptual shift, from a prescriptive approach that identifies and assesses professionally determined key components of services and programming to one that is focused on the outcomes and effectiveness of school-based audiology services. This shift, described in Table 3, alters how audiologists and audiology services have traditionally evaluated their practices.

Table 3. Prescriptive vs Outcome Model of Practices

	Prescriptive Model	Outcomes Model
Focus:	Process	Results
Practices:	Evidence-based (screening, assessment, amplification, counseling, habilitation, hearing loss prevention)	Evidence-based (screening, assessment, amplification, counseling, habilitation, hearing loss prevention)
Evaluation Type:	Quantitative: Number of students who receive services	Results oriented: Qualitative/Quantitative: Number of students who meet outcome/measureable indicators
Evaluation Process:	Practice goals or targets	Outcomes-Indicator benchmarks

Challenges to an Outcomes Approach

One challenge to moving to an outcomes approach is identifying the outcomes and associated indicators that are desired as a result of our educational audiology practices. Other anticipated challenges include:

- Consensus on the outcomes- what are the relevant and meaningful student performance expectations?
- Articulation of the indicators- what are the relevant data points and levels of performance for each outcome and how should each one be measured?
- Feasibility of measurement- how difficult will the indicators be to measure?
- Reporting and use of data- how will data be reported and used?

Proposed Outcomes for School-Based Audiology Services. A group of educational audiologists met during the EAA Conference in Memphis, TN (2011) to address the proposed outcomes and develop indicators. Prior to the conference, a membership survey was undertaken to obtain data on the proposed outcomes. Appendix A contains the 15 proposed outcomes including survey data on importance, satisfaction with implementing each outcome, and feasibility to measure.

Table 4 contains three outcomes and examples of associated indicators. While all indicators specify the number and percent of children and youth who attain the intended outcome, the strategies and evidences for evaluating the indicators include measures such as student performance on assessments, student work, or surveys of interactions with families, community peers and staff. For some outcomes, the indicators target teachers, school staff, and parents. Measurement formulas still need to be developed for each indicator.

Table 4. Proposed indicators for Outcomes 2, 4, and 15.

Outcome	Indicators
2. Children/youth access free audiology services as part of their educational programs.	Number and percent of children/youth who receive audiology services through their school or school-based contract. ● screening ● assessment ● amplification and amplification management ● habilitation ● counseling ● prevention
4. Children/youth receive audiology services that are relevant to the education setting and that accurately identify the parameters associated with the auditory disorder.	Number and percent of children/youth who have an audiological assessment that identifies performance for: ● listening in noise and distance conditions, with and without visual cues, with and without hearing assistive technology (HAT) o Evidence: speech/phoneme perception testing in quiet (50dBHL), soft conversation (35dBHL), and at 50dBHL with 0 or +5dB SNR. o Evidence: perform tests in typical listening mode (aided or unaided) and with HAT. ● functional classroom performance o Evidence: LIFE or similar questionnaire completed at end of reporting period that follows fitting of HAT
15. Young adults are equipped to locate appropriate services post high school for education, employment and life.	Number and percent of young adults at graduation who understand the following IEP objectives: ● their hearing loss including type, degree, configuration, and impact on communication o Evidence: post-test ● ADA and their rights o Evidence: post-test ● how to find an audiologist o Evidence: a written list of potential service providers and contact information produced by the student ● costs and maintenance of personal and assistive hearing technology o Evidence: written statement regarding cost of new hearing aids, necessary follow-up maintenance schedules, and typical timeline for obtaining replacement instruments ● how to navigate systems for independence into adulthood: o Services at post-secondary institution ▪ Evidence: list of services that are available from disability/accessibility services and accurately describe them to teacher, audiologist or case manager o Vocational rehabilitation ▪ Evidence: written information produced by student summarizing meeting with VR counselor regarding potential services and steps to take to access the services o Other state funding agencies ▪ Evidence: written list of potential funding sources produced by student

Benchmarks for meeting the indicators are intended to be developed locally to reflect individual practice situations. When benchmarks are met, the performance data may reinforce existing programs and practices or policies and procedures. If benchmarks are not realized, analysis should be completed to determine reasons for the under-performance. These causes may include a lack of resources to sufficiently provide the practices, poor implementation of practices, or use of inappropriate benchmarks. Like IEPs, annual assessment and review of goals and benchmarks are needed to track progress to reach the intended performance. These performance measures may also impact individual pay-for-performance and other value-added services provided by the educational audiologist as well as the multidisciplinary team that supports learners who are deaf and hard of hearing.

Summary

Is your school-based practice positioned to support the shifts in practice described in this discussion? Do you have:

- ✓ educationally relevant assessment procedures?
- ✓ a comprehensive HAT protocol that considers individual student needs and preferences, multimedia and hybrid classroom learning models, functional performance, and validation evidence?
- ✓ interprofessional collaboration within the school and within your community?
- ✓ an interprofessional collaborative team that works effectively to support students who are deaf/hard of hearing?
- ✓ knowledge of school-wide initiatives impacting current educational practice (CCSS, RtI/MTSS, ECC, UDL, Disruptive Education) and the implication for learners who are deaf and hard of hearing?
- ✓ 21st century learning basics (creativity, critical-thinking, communication, and collaboration) embedded in assessment, habilitation and counseling practices?
- ✓ a workload approach to evaluating how your services and time are allocated?
- ✓ data-based software programs and technology to manage scheduling, student data, equipment and communication with teachers and staff to increase efficiency of your workload?
- ✓ beginning discussions about the desired outcomes of your school-based audiology services or a formal evaluation process in place that is associated with student performance?

School-based audiology is influenced by changing practices in audiology as well as the evolving agendas of public and special education. To effectively meet the needs of our students and function as a member of the school multidisciplinary team, we must be vigilant to these shifts while continuing to advocate for services and supports that provide our students the opportunity to reach the same outcomes as their peers without hearing challenges. Accountability measures are integral to every aspect of this work requiring data that evaluates and supports our practices as they relate to student outcomes and increasing the likelihood that districts meet state and federal standards.

Resource Links

21st Century Learning Framework	www.p2.org
Audiology Assistants: ASHA Portal	http://www.asha.org/Practice-Portal/Professional-Issues/Audiology-Assistants/
Common Core State Standards	www.corestandards.org
Disruptive Education	http://disruption.wpengine.com/wp-content/uploads/2014/06/Is-K-12-blended-learning-disruptive.pdf
FACT Sheet: Creating Hearing Accessible Education through Technology (Spangler, 2014)	http://www.listeningandspokenlanguage.org/uploadedFiles/Professionals/Education_Environment/VV%20Extra_EdTechAccess_FactSheet.pdf
IDEA	http://idea.ed.gov/
Interprofessional Collaborative Practice	http://whqlibdoc.who.int/hq/2010/WHO_HRH_HPN_10.3_eng.pdf?ua=1 http://www.asha.org/Practice/Interprofessional-Education-Practice
Iowa Expanded Core Curriculum for Deaf and Hard of Hearing Students	www.educateIowa.gov/sites/files/ed/documents
Multi-Tiered System of Supports/RtI	http://www.rtinetwork.org/
Universal Design for Learning	www.udlcenter.org http://cast.org/udl/index.html
Telepractice: State Requirements	http://www.asha.org/Advocacy/state/State-Telepractice-Requirements/
Telepractice: ASHA Portal	http://www.asha.org/PRPSpecificTopic.aspx?folderid=8589934956&section=Key_Issues

References

Americans with Disabilities Act of 1990, Public Law 101-336, 42 U.S.C. §12101 et seq. *U.S. Statutes at large, 104*, 327-378.

American Speech-Language-Hearing Association. (2002). *Guidelines for audiology service provision in and for schools* [Guidelines]. Available from www.asha.org/policy.

Anderson, K.L., & Goldstein, H. (2004). Speech perception benefits of FM and infrared devices to children with hearing aids in a typical classroom. *Language, Speech, and Hearing Services in Schools*, 35, 169-184. doi:10.1044/0161-1461(2004/017)

Christensen, C., Johnson, C., & Horn, M. (2008). *Disrupting class: How disruptive innovation will change the way the world learns*. New York: McGraw-Hill.

Colorado Department of Education, (2012). *Access Skills to the Colorado Content Standards.* Denver, CO: Author.

Educational Audiology Association. (2009a). *Recommended professional practices for educational audiology.* Retreived 8/15/14 from http://c.ymcdn.com/sites/www.edaud.org/resource/resmgr/imported/Professional%20Practices_pos09_REVISED.pdf

Educational Audiology Association. (2009b). *School-based audiology services.* Retrieved 8/15/14 from http://c.ymcdn.com/sites/www.edaud.org/resource/resmgr/imported/AdvocacyStatement_1_core.pdf

Eriks-Brophy, A., Durieux-Smith, A, Olds, J., Fitzpatrick, E., Duquette, C., & Whittingham, J. (2006). Facilitators and barriers to the inclusion of orally educated children and youth with hearing loss in schools: Promoting partnerships to support inclusion. *The Volta Review, 106*(1), 53-88.

Florida Resource Materials and Technology Center for the Deaf/Hard of Hearing (RMTC: DHH). Retrieved 8/20/14 from www.retcosbd.org/dhh-expanded-skills

Frey, B., Lohmeier, J.H., Lee, S.W., & Tollefson, N. (2006). Measuring Collaboration Among Grant Partners. *American Journal of Evaluation 27*(3), 383-392.

Gajda, Rebecca (2004). Utilizing Collaboration Theory to Evaluate Strategic Alliances. *American Journal of Evaluation, 25*, 65-77.

Georgia Department of Education (2013). *Accommodations Manual: A guide to selecting, administering and evaluating the use of test administration accommodations for students with disabilities.* Atlanta , GA: Author.

Holt, R.E., & Svirsky, M.A. (2008). An exploratory look at pediatric cochlear implantation: Is earliest always best? *Ear & Hearing, 29*(4), 492-511.

Hoover, J. & Patton, J. (2008). The role of special educators in a multitiered instructional system. *Intervention in School and Clinic, 43*, 195-202.

Hurst, S. (n.d.). What is the difference between RtI and MTSS? Retrieved 7/10/14 from www.readinghorizons.com

Individuals with Disabilities Education Act, 20 U.S.C. § 300.111 (2004).

Iowa Department of Education, (2013). The Expanded Core Curriculum for Students who are Deaf or Hard of Hearing. Des Moines, IA: Author.

Johnson, C.D. (2011). A call for outcomes measurement for school-based audiology services. *Hearing Journal*, 64(10), 30-32

Johnson, C.D. & Seaton, J. (2012). Educational Audiology Handbook. 2nd Ed. Clifton Park, NY: Delmar-Cengage Learning.

Moeller, M.P. (2000). Early intervention and language development in children who are deaf and hard of hearing. *Pediatrics, 106*(3), e43.h10.pdf

National Agenda: Moving Forward on Achieving Educational Equality for Deaf and Hard of Hearing Students (April 2005). Retrieved from www.ceasd.org.

National Center for Learning Disabilities (n.d.) Multi-Tier System of Supports: aka Response to Intervention (RTI). Retrieved 7/10/14 from www.ncld.org/disability-advocacy/where-we-stand-policies/

National Center on Universal Design for Learning (2012). UDI and Technology. Retrieved 9/5/14 from http://www.udlcenter.org/aboutudl/udltechnology

National Council on Teacher Quality (2013). State of the States 2013 Connect the Dots: Using Evaluations of Teacher Effectiveness to Inform Policy and Practice. Retrieved from http://www.nctq.org/reports.do

National Joint Committee on Learning Disabilities (2010). Comprehensive Assessment and Evaluation of Students with Learning Disabilities. Retrieved 8/12/14 from: www.ldonline.org/about/partners/njcld

Nicholas, J.G., & Geers, A.E. (2006). Effects of early experience on the spoken language of deaf children at age 3 years of age. *Ear & Hearing, 27*(3), 286-298.

Pacer Center, Minneapolis, MN. Self-Determination. Retrieved 8/12/14 from www.pacer.org.

Perkins School for the Blind (n.d.). Expanded Core Curriculum. Retrieved 8/20/14 from www.perkins.org/resosources/scout/education/expanded-core-curriculum.html.

Rehabilitation Act of 1973, Section 504, 29 U.S.C. 794 et seq. (1973). US Statutes at Large, 87, 335-394.

Richburg, C.M., & Smiley, D.F. (2012). *School-Based Audiology*. San Diego: Plural Publishing Inc.

RTI Action Network (n.d) Retrieved 9/15/14 from www.rtinetwork.org.

Schafer, E.C., & Thibodeau, L.M. (2006). Speech recognition in noise in children with cochlear implants while listening in bilateral, bimodal, and FM-system arrangements. *American Journal of Audiology*, 15, 114-126. doi:10.1044/1059-0889(2006/015)

Schafer, E.C., Thibodeau, L.M., Whalen, H.S., & Overson, G.J. (2007). Electroacoustic evaluation of frequency-modulated receivers interfaced with personal hearing aids. *Language, Speech, and Hearing Services in Schools, 38*, 315-326. doi:10.1044/0161-1461(2007/034)

Spangler, C. (2014). Positive “disruptions” for a new school year: Accessing educational technology to maximize auditory access and learning for all. Listening and Spoken Language Knowledge Center, AGBell. Retrieved 9/15/14 http://www.listeningandspokenlanguage.org/EdTechAccess/

Thibodeau, L. (2010). Benefits of adaptive FM Systems on speech recognition in noise for listeners who use hearing aids. *American Journal of Audiology, 19*, 36-45. doi:10.1044/1059-0889(2010/09-0014)

Thompson, S., Morse, A., Sharpe, M., & Hall, S. (2005). Accommodations Manual: How to select, administer, and evaluate use of accommodations for instruction and assessment of students with disabilities, 2nd Edition. Washington DC: Council of Chief State School Officers.

U.S. Department of Education (2014). 35th Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Act, 2013. Part C Exit Data, Exhibit 50, p 91.

Wiener, R. (2013). Teaching to the Core: Integrating Implementation of Common Core and Teacher Effectiveness Policies. The Aspen Institute. Retrieved from http://www.aspeninstitute.org/publications/teaching-core-integrating-implementation-common-core-teacher-effectiveness-policies

Weymeyer, M., Palmer, S., Agran, M., Mithaug, D., and Martin, J. (2000). Promoting causal agency the self-determined learning model of instruction. *Exceptional Children, 66*(4), 439-453.

Wolfe, J., Morais, M., Schafer, E., Mills, E., Mülder, H.E., Goldbeck, F., &Lianos, L. (2013). Evaluation of speech recognition of cochlear implant recipients using a personal digital adaptive radio frequency system. *Journal of the American Academy of Audiology, 24*(8), 714-724. doi:10.3766/jaaa.24.8.8

World Health Organization (WHO). 2010. Framework for action on interprofessional education and collaborative practice. Downloadable PDF available at http://www.who.int/hrh/resources/framework_action/en/

Appendix A.

Summary of the EAA Outcomes Measurement Survey (Johnson, 2011) indicating importance, level of satisfaction for implementation, and measurement feasibility. Outcomes reported in the same order of importance or satisfaction indicates the ratings were the same.

Order of Importance	Order of Satisfaction	Outcome	Modal Scores		
			Importance	Satisfaction	Feasibility to Measure
#6	#6	1. Children/youth with auditory disorders are identified at birth or within a reasonable time (60 days) of the onset of the suspected loss/deafness.	80% very important	34.3% Satisfied (25.7% very satisfied)	45.7% somewhat difficult to measure
#3	#1	2. Children/youth access free and appropriate audiology services as part of their educational programs.	91.4% very important	45.7% very satisfied	48.6% Straightforward to measure
#8	#4	3. Children/youth receive audiological evaluations within 30 days of referral from screening.	68.6% very important	34.3% very satisfied	68.6% straightforward to measure
#5	#7	4. Children/youth receive audiology services that are relevant to the education setting and that accurately identify the parameters associated with the auditory disorder.	82.9% very important	51.4% satisfied (20% very satisfied)	51.4% somewhat difficult to measure
#2	#11	5. Children/youth receive the necessary medical attention required to habilitate medically treatable hearing problems in a timely manner.	94.3% very important	48.6% somewhat satisfied (5.7% very satisfied)	48.6% somewhat difficult to measure
#1	#10	6. Teachers, parents, and relevant other professionals understand the communication and learning implications of a child/youth's auditory disorder based on both traditional and functional parameters of assessment.	97.1% very important	48.6% satisfied (8.6% very satisfied)	48.6% difficult to measure
#2	#5	7. Children/youth with auditory disorders are accommodated in the educational setting such that they have the opportunity to fully access all components of their educational environment.	94.3% very important	40% satisfied (28.6% very satisfied)	57.1% difficult to measure
#2	#3	8. Children/youth with auditory disorders have access to appropriate hearing instrumentation, including personal and assistive devices that provide full access to all communication within the learning environment (e.g., teachers, students, themselves), and that function properly on a consistent basis.	94.3% very important	37.1%very satisfied	51.4% straightforward to measure

#5	#2	9. Children/youth have full access to auditory and spoken information in their educational environment regardless of mode of communication.	82.9% very important	40% very satisfied	57.1% somewhat difficult to measure
#6	#4	10. Children/youth with auditory disorders have access to services that promote their ability to communicate with their peers, teachers, and others in their environment.	80% very important	42.9% satisfied (34.3% very satisfied)	62.9% somewhat difficult to measure
#7	#8	11. Children/youth with auditory disorders receive educational support that reflects high academic standards with accountability measures to monitor student learning.	77.1% very important	57.1% satisfied (14.3% very satisfied)	45.7% somewhat difficult to measure
#5	#9	12. Children/youth with auditory disorders have positive self-concepts.	82.9% very important	37.1% somewhat satisfied (11.4% very satisfied)	45.7% difficult to measure
#4	#12	13. Children/youth with auditory disorders are able to advocate for their listening and communication needs.	88.6% very important	48.6% satisfied (2.9% very satisfied)	51.4% somewhat difficult to measure
#6	#8	14. Families are encouraged and supported to fully participate in their child/youth's education.	80% very important	37.1% somewhat satisfied/37.1% satisfied (14.3% very satisfied)	45.7% difficult to measure
#4	#10	15. Young adults are equipped to locate appropriate services post high school for education, employment and life.	88.6% very important	37.1% somewhat satisfied (8.6% very satisfied)	54.3% somewhat difficult to measure

Call for Papers

2015 Journal of Educational Audiology with a new, more inclusive name!

Journal of Educational, Pediatric & (Re)Habilitative Audiology

The Journal of Educational, Pediatric and (Re)Habilitative Audiology is now soliciting manuscripts for 2015 issue (Volume 21). All manuscript submissions will be peer-reviewed and blind. Similar to the 2014 issue, rolling manuscript submissions will be accepted throughout 2015, and if accepted, the article will be formatted and immediately posted to the journal website. This is your chance to get your important educational, pediatric, and (re)habilitative research published in a timely and efficient manner!

JEPRA publishes original manuscripts from a range of authors who work with children and their families in a broad variety of audiological settings. Contributors are not limited to those who work in school settings. We invite authors from educational settings, parent-infant and early intervention programs, clinical settings, hospital settings, and audiologists/clinicians who work with children in related capacities. As the only hearing-related journal dedicated to a pediatric population, the intent is to reflect the broad spectrum of issues relevant to the education and development of children with hearing loss or auditory dysfunction.

Manuscripts may be submitted in one of the following categories:

- Article: a report of scholarly research or study.
- Tutorial: an in-depth article on a specific topic.
- Report: a description of practices in audiology, such as guidelines, standards of practice, service delivery models, survey findings, case studies, or data management.
- Application: a report of an innovative or unique practice, such as a screening program, hearing conservation program, therapy technique or other activity that has been particularly effective.

There are specific manuscript requirements and guidelines for submission posted on the EAA website (www.edaud.org), or you can obtain these documents by contacting the Editor at Erin.Schafer@unt.edu or 940-369-7433. The information in a manuscript may have been presented at a conference or meeting, but not published.

Electronic submissions of manuscripts should be sent via e-mail to the Editor at: Erin.Schafer@unt.edu. Microsoft Word-compatible documents and graphics are preferred.

Guidelines for Authors Submitting Manuscripts - 2015

Journal of Educational, Pediatric & (Re)Habilitative Audiology

A Publication of the Educational Audiology Association

1. Format

All manuscripts must follow the style specified in the Publication Manual of the American Psychological Association (6th edition). Authors should pay special attention to APA style for tables, figures and references. Any manuscript not following the 6th edition format will not be reviewed.

2. Cover Letter

A cover letter should accompany all submissions. The cover letter should contain a statement that the manuscript has not been published previously and is not currently submitted elsewhere. If IRB approval was needed by the sponsoring institution, a statement to that effect should also be included.

3. Author Information Page

The author information page should include the title of the article, complete authors' names and authors' affiliations. This page should include a business address, phone number and email address for the corresponding author.

4. Title Page

This page should contain only the title of the article. No other identifying information should be present.

5. Abstract

The second manuscript page (behind the title page) should contain an abstract not to exceed 250 words.

6. Text

The text of the manuscript should begin on Page 3.

7. Tables, Figures and Other Graphics

Tables, figures and other graphics should be attached on separate pages, and their placement within the manuscript noted (e.g., <<Table 1 here>>). These separate pages should appear after the text and before the acknowledgements.

8. Acknowledgements

Acknowledgements should appear on a separate page after the tables, figures and graphs and before the references.

9. References

All references should follow APA manual guidelines, as noted above. References are to be listed alphabetically, then chronologically. Journal names should be spelled out and italicized, along with volume number. Authors should consult the APA style manual (6th ed.) for the specifics on citing references within the text, as well as in the reference list. All citations in the text need to be listed in the References.

10. Blind Review

All manuscripts will be sent out for blind review. If you have questions about this, please contact the Editor (Erin.Schafer@unt.edu).

11. Submission of Manuscripts

Submissions of manuscripts via e-mail to the Editor, Erin Schafer (Erin.Schafer@unt.edu) are required. Microsoft Word-compatible documents and graphics are preferred. Questions or comments should be directed to the Editor (Erin.Schafer@unt.edu /940-369-7433) or one of the Associate Editors: Cynthia Richburg (cynthia.richburg@iup.edu), Andrew John (Andrew-B-John@ouhsc.edu), Ryan McCreery (Ryan.McCreery@boystown.org) or Claudia Updike (cdupdike@gmail.com).