



## Technical Report #2

# WPPSI-IV Special Group Study: Children With Hearing Differences Who Utilize Spoken Language and Have Assistive Technology

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## Introduction

Children with hearing differences<sup>1</sup> account for slightly over one percent of children receiving special education services in the United States (U.S. Government Accountability Office, 2011), with some studies noting that as many as 14.9 percent of all U.S. children have a hearing difference when including children with unilateral, partial frequency, and mild hearing loss (Niskar et al., 1998). A hearing difference is a multifaceted phenomenon, and clinicians working with children with hearing differences must be aware of the heterogeneity of this population with regard to relevant factors, such as the age of onset of hearing loss, form(s) of communication, early language access, degree of hearing loss, use of assistive technology, and co-morbid conditions. Given the diversity within the population of individuals with hearing differences, interpreting assessment results requires great care and understanding of the individual child. Examiner knowledge and careful consideration of the potential impact that each of the above factors has on the child's development is important.

Consideration of the child's language and communication preferences and abilities is imperative for administration and interpretation of intellectual assessment measures. There is a wide variety of preferred communication methods among children with hearing differences (Costa, Day, & Raiford, 2015). As noted above, the population of children with hearing differences is a dynamic group that includes individuals with a range of hearing levels, educational backgrounds, and language considerations. Some children with hearing

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<sup>1</sup> With respect to the variation of terminology used with this population (e.g., deaf, hard-of-hearing, hearing loss), the term "hearing differences" is utilized throughout this article to serve as a neutral placeholder, and it is meant to be inclusive of all perspectives and identities (i.e., cultural and medical) of this population. It defines an altered sensation of the physical act of hearing; this, in itself, is not a deprivation, but a difference.

differences communicate using more than one method of communication, while other children have a clearly identified preferred primary language or communication method, and some have limited proficiency in any form of communication. The primary communication modalities/methods include American Sign Language (ASL), listening and spoken language, Cued Speech, and total communication, as well as a combination of two or more of these approaches. It is critical to note that within each of these categories, variability exists.

When evaluating a child's WPPSI-IV test results, a strong understanding of the child's language and communication competency is critical, and test results should be interpreted with caution. Some children may demonstrate strong competency in one or more language and communication modes, while others may still be developing language/communication competency. It is also possible that if the child has cognitive limitations, or was identified with a hearing difference later in development, the child may not have a strong language foundation. Assessment results should be understood and interpreted with an understanding of the expressive and receptive language capabilities of the child.

The current special group study focused on children who use listening and spoken English as a preferred communication modality, and utilize hearing aids and/or cochlear implants. When a child uses solely auditory modalities, spoken language is used without signs, gestures, or other visual representations of the spoken language. Appropriate and consistently functioning technology that allows auditory access to speech sounds, such as hearing aids or cochlear implants, is integral to the success of this communication choice. It should be noted that of the communication modalities listed above, this modality, along with Cued Speech, requires the least amount of modification considerations when administering the WPPSI-IV. For a full review of subtest administration across communication modalities, see Costa, Day, and Raiford (2015).

While children who use auditory/oral modalities generally make use of spoken English, the child's ability to access auditory information should be clarified. This includes gathering background information on the child's hearing history, and requesting the child's most recent audiogram. A child who uses hearing aids or cochlear implants may have auditory access to speech sounds, but may still have difficulty discriminating between soft sounds (e.g., C vs. 3). In addition, the child may be taxed in detecting and understanding the speech of the examiner due to a hearing difference, even with the use of devices, which can result in testing fatigue. It should be noted that even when children with cochlear implants detect sounds in the mild to moderate range, the sounds they hear are limited in frequency resolution due to the constraints of the device and are different than the sounds heard by children fit with hearing aids. Hearing aids amplify sound and use natural hearing pathways, whereas the cochlear implant determines what signal will be sent to the brain for sound perception. Finally, test performance may be impacted by the child's speech, regardless of language modality used. It should be noted that the *presence* of an audiological device (i.e., cochlear implant or hearing aid) does not guarantee that the child has full access to spoken language.

In general, interpretation of all results should be approached with caution and understood within the context of the child, their language abilities and exposure, developmental history, and any modifications of the test (if applicable). Examiners must remain cognizant of the possibility that the presence of even a slight hearing difference, regardless of communication modality, may result in environmental conditions that impede incidental learning. For example, compared to a child with typical hearing, a deaf or hard of hearing child may have comparatively limited access to their environment, which reduces exposure and learning opportunities in their everyday life. This is especially relevant for children who were later

identified as having a hearing difference. It is important to carefully consider one's history in an attempt to distinguish between performance related to cognitive functioning and those aspects of performance that reflect the environmental circumstances for the child.

Published literature on general outcomes for children with hearing differences has been highly variable, with the majority of the published research for children who utilize listening and spoken language focused on language outcomes. For children who utilize cochlear implants and hearing aids, variability of performance has been attributed to several factors. Children with cochlear implants have demonstrated varying degrees of speech comprehension and understanding (Dettman, Pinder, Briggs, Dowell, & Leigh, 2007; Geers, Tobey, Moog, & Brenner, 2008; Holt & Svirsky, 2008; Nicholas & Geers, 2007); and language outcomes are influenced by age of implantation, degree of residual hearing prior to implantation, maternal sensitivity, and socioeconomic status (Niparko et al., 2010; Quittner et al., 2013). For children with hearing aids, early identification, early intervention, and level of hearing difference are all significant factors to consider in terms of language and overall outcomes (Sininger, Grimes, & Christensen, 2010; Yoshinaga-Itano, Sedey, Coutler, & Mehl, 1998). For both groups, nonverbal cognitive abilities also appear to mediate language outcomes (Geers et al., 2008; Mayne, Yoshinaga-Itano, & Sedey, 2000). As noted, language development must be understood for each child, as it will highly influence the results of standardized testing, and examiners must make an effort to understand how the child's language impacts results on cognitive measures.

In terms of previously published literature on the cognitive profiles of children with hearing differences who utilize cochlear implants and hearing aids, variability has also been reported. While many of the published studies recognize the difficulty of generalization for this heterogeneous population, the trends in the literature report lower scores on measures of verbal abilities, including the Verbal Comprehension Index (VCI) (Geers & Moog, 1989; Geers & Sedey, 2011), and working memory tasks, including the Working Memory Index (WMI) (Burkholder & Pisoni, 2003; Geers & Sedey, 2011). It is believed that working memory is critical to the development of spoken language (Gupta & MacWhinney, 1997), and correlations have been found between working memory and language development in children with hearing differences (Hansson, Forsberg, Löfqvist, Mäki-Torkko, & Sahlén, 2004; Pisoni & Geers, 2000). While lower working memory skills have been primarily shown in children with cochlear implants (Pisoni & Cleary, 2003), some differences have been reported in children with hearing aids, and less profound levels of hearing sensitivity (Stiles, McGregor, & Bentler, 2011).

Given the large number of confounds and variability that can exist within this population, the current study aimed to limit the scope of the collected data to a more homogeneous population, controlling for some known factors that can lead to variability in outcomes. Children in the current study were all fit with assistive listening devices that allowed for access to sound, and have been regularly monitored to ensure auditory access to spoken language. The sample collected is a sample of convenience, and all included children attended an independent school for children with hearing differences in the mid-Atlantic part of the United States at the time of testing. The school is an inclusive education program for children birth to third grade that provides specialized services and support, including audiology and speech and language interventions. Classrooms are designed specifically to meet the needs of any child with a hearing difference, including classroom amplification, acoustic modifications, and smaller class sizes. While this study was intended to collect data on a specific subset of the general deaf and hard of hearing population, it should be noted that not all children have access to this level of support, and as a result, the trajectory of the child's language and cognitive development may differ. It is believed that the results of this study likely represent a "best case scenario" of

what is possible for oral children with hearing differences in the context of appropriate access to their environment, supports, and early intervention.

Based on the results of previous research, it was expected that the children in the current study would have significantly lower mean scores than a matched control group for the VCI and WMI.

## Methods

### Measure

The WPPSI-IV is an individually administered, comprehensive clinical instrument for assessing the intelligence of children ages 2 years 6 months through 7 years 7 months (2:6–7:7). It provides primary index scores that represent intellectual functioning in specified cognitive areas (i.e., Verbal Comprehension Index [VCI], Visual Spatial Index [VSI], Fluid Reasoning Index [FRI], Working Memory Index [WMI], and Processing Speed Index [PSI]), a composite score that represents general intellectual ability (i.e., Full Scale IQ [FSIQ]), and ancillary index scores that represent the cognitive abilities in different groupings based on clinical needs (i.e., Vocabulary Acquisition Index [VAI], Nonverbal Index [NVI], General Ability Index [GAI], and Cognitive Proficiency Index [CPI]). All of the WPPSI-IV subtests from the final edition were administered for this special group study.

### Participants

The sample consisted of children with hearing differences who attend an independent, inclusion-model school for children with hearing differences in the mid-Atlantic part of the United States. Dr. Adams Costa recruited the participants as part of routine annual testing. This was a sample of convenience, and included children with hearing loss falling within at least the mild range, and who use either a cochlear implant or hearing aid. None of the children had additional clinical diagnoses. The matched control samples were drawn from the pool of nonclinical children who participated in the standardization of the WPPSI-IV. Pearson's Field Research staff recruited the standardization participants and compensated the children (i.e., their parents/guardians) for their participation. Participants for the matched control sample of nonclinical children were screened for general inclusion criteria used for the WPPSI-IV normative sample listed in chapter 3 of the WPPSI-IV Technical and Interpretive Manual.

### Procedure

The data for children with hearing differences were collected between September 2014 and October 2015. For the sample, a team of two examiners<sup>2</sup> who are trained in both the standard administration of the WPPSI-IV and working with children with hearing differences captured response information by writing the children's responses on the record forms and scoring all items.

The matched control sample was collected between March 2011 and February 2012, concurrent with the WPPSI-IV standardization. For the matched control sample, examiners captured response information in the standard manner used for norming, which includes writing the complete verbatim response to each Verbal Comprehension subtest item and

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scoring all items. A team of several scorers at Pearson rescored all of the protocols. For each protocol, two independent scorers reevaluated all subjectively scored items using the final scoring rules, and an expert scorer or a member of the research team resolved any discrepancies between the two scorers as needed. All subtest raw scores were calculated by Pearson staff using the keyed item scores and the final scoring rules. The final subtest and composite norms were then applied.

## Results

The demographic data for the group of children with hearing differences appear in Table 1.

**Table 1. Demographic Data for Children with Hearing Differences**

<i>N</i>	21
<b>Age</b>	
Mean	4.3
<i>SD</i>	0.9
Range	2–5
<b>Education<sup>a</sup></b>	
0–12 years of school, no diploma	—
High school diploma or equivalent	—
Some college or technical school, associate's degree	4.8
Bachelor's degree	95.2
<b>Race/Ethnicity</b>	
African American	9.5
Asian	4.8
Hispanic	—
Other	4.8
White	81.0
<b>Region</b>	
Midwest	—
Northeast	—
South	100.0
West	—
<b>Sex</b>	
Female	57.1
Male	42.9

*Note.* Except for sample size (*N*) and age, data are reported as percentages. Total percentage may not add up to 100 due to rounding.

<sup>a</sup> Education = parent education level.

For this study, education level was based on the number of years of school completed by the parent(s)/guardian(s). If the child resided with only one parent or guardian, the education level of that parent or guardian was assigned. If the child resided with both parents or with two guardians, the average of both individuals' education levels was used, with partial levels rounded up to the next highest level.

The demographic characteristics of the current sample disproportionately represent children with a parent education level of a bachelor's degree or more; all participants had a parent education level of at least some college. The group also consists largely of children who are White at a greater proportion than the population proportion, with no representation of children

who identify as Hispanic. The sample contains slightly more girls than boys. Within the WPPSI-IV age range of 2:6–7:7, children who are 6–7 are not represented; these children were administered the WISC-V for another study that is currently being collected. All cases were drawn from the South region of the U.S.

The age of identification of hearing loss for the children ranged from birth to 32 months of age, with unaided hearing levels ranging from mild to profound. The etiology of the hearing difference was unknown for 15 cases, the result of postnatal infection in one case, the result of congenital infection in two cases, and hereditary in three cases. The devices utilized for the children varied; eight of the children used behind-the-ear (BTE) hearing aid devices, three children used a Bone Anchored Hearing Aid (BAHA), and eight children used cochlear implant(s) (CI). When amplified, every child in the sample had at least partial access to speech sounds. Auditory access was measured utilizing Articulation Index Scores, which identified the percentage of speech sounds that can be detected when using devices. For the current sample, aided Articulation Index Scores ranged from 50 to 100 percent.

Table 2 presents the mean subtest and composite scores for the children with hearing differences and matched control groups.

None of the mean composite score differences are significantly different between the hearing differences group and the matched control group. The FRI differences show a moderate effect size. Among the primary index scores, the VCI, the WMI, and the FSIQ differences show small effect sizes. All ancillary index scores show small effect sizes. The effect size for the NVI is similar to that of the FSIQ. The VSI and PSI effect sizes are negligible. The hearing differences group mean FSIQ and NVI are slightly higher than the population mean (i.e., 100).

At the subtest level, performances on Similarities, Vocabulary, Comprehension, Picture Concepts, and Zoo Locations are significantly lower among children with hearing differences than in the matched control group. Most group differences for subtests in the Verbal Comprehension domain exhibit moderate to large effects. The exceptions are Information and Picture Naming. Picture Concepts and Zoo Locations, had medium and large effect sizes respectively. The lowest special population group mean scores occurred on Zoo Locations, Vocabulary, and Comprehension, and the highest occurred on Picture Naming, Receptive Vocabulary, and Picture Memory. The hearing differences group mean scores on Animal Coding, Cancellation, and Object Assembly were higher than those of the matched control group, and therefore, these are among six of the negligible effect sizes for subtests. The largest effects occur on Vocabulary, Zoo Locations, Comprehension, Similarities, and Picture Concepts.

**Table 2. Hearing Differences Compared to Matched Controls**

Subtest/ Composite Score	Children With Hearing Differences		Matched Control		Difference	t value	p value	Standard Difference <sup>a</sup>
	Mean	SD	Mean	SD				
IN	10.5	4.2	11.7	2.4	1.19	1.12	NS	0.35
SI	10.1	3.2	12.2	2.0	2.06	2.27	<.05	0.77
VC	8.9	3.5	12.6	2.3	3.63	3.22	<.01	1.23
CO	9.3	3.0	11.9	3.0	2.63	2.18	<.05	0.88
RV	10.8	3.9	11.9	2.9	1.05	1.06	NS	0.31
PN	11.4	3.7	12.0	2.8	0.62	0.59	NS	0.19
BD	10.0	3.3	10.7	2.7	0.67	0.74	NS	0.22
OA	10.7	3.1	10.5	3.4	-0.19	-0.20	NS	-0.06
MR	10.4	1.9	10.6	2.9	0.19	0.20	NS	0.08
PC	9.9	2.9	11.7	1.9	1.75	2.24	<.05	0.71
PM	10.8	2.8	10.9	3.9	0.10	0.09	NS	0.03
ZL	8.6	2.6	10.8	2.3	2.19	3.12	<.01	0.89
BS	9.8	3.0	10.9	3.4	1.06	0.90	NS	0.33
CA	10.1	2.7	9.9	2.8	-0.19	-0.20	NS	-0.07
AC	10.5	3.1	10.0	3.1	-0.50	-0.41	NS	-0.16
VCI	104.4	20.1	110.4	11.0	6.00	1.30	NS	0.37
VSI	102.4	14.4	103.8	15.0	1.38	0.31	NS	0.09
FRI	100.7	11.9	106.4	9.4	5.69	1.53	NS	0.53
WMI	98.3	13.7	104.7	13.3	6.38	1.82	NS	0.47
PSI	100.0	13.3	102.5	16.3	2.50	0.47	NS	0.17
FSIQ	103.9	17.4	108.0	13.4	4.05	0.85	NS	0.26
VAI	105.9	19.7	110.7	13.7	4.81	0.95	NS	0.28
NVI	102.0	14.3	107.3	13.3	5.33	1.25	NS	0.39
GAI	103.9	18.2	108.4	11.6	4.48	0.95	NS	0.29
CPI	98.3	14.2	103.5	14.1	5.19	1.28	NS	0.37

<sup>a</sup>The Standard Difference is the difference of the two test means divided by the square root of the pooled variance, computed using Cohen's (1996) Formula 10.4.

WPPSI-IV abbreviations are: IN = Information, SI = Similarities, VC = Vocabulary, CO = Comprehension, RV = Receptive Vocabulary, PN = Picture Naming, BD = Block Design, OA = Object Assembly, MR = Matrix Reasoning, PC = Picture Concepts, PM = Picture Memory, ZL = Zoo Locations, BS = Bug Search, CA = Cancellation, AC = Animal Coding, VCI = Verbal Comprehension Index, VSI = Visual Spatial Index, FRI = Fluid Reasoning Index, WMI = Working Memory Index, PSI = Processing Speed Index, FSIQ = Full Scale IQ, VAI = Vocabulary Acquisition Index, NVI = Nonverbal Index, GAI = General Ability Index, CPI = Cognitive Proficiency Index.

## Discussion

This study provides data on the performance on cognitive testing of a specific group of children with hearing differences. The population sample consists of young children who use listening and spoken language as a preferred communication modality, and utilize hearing aids and/or cochlear implants to access spoken language. Unlike other studies on cognitive performance of heterogeneous groups of children with hearing differences, the present sample controlled for specific factors known to lead to variability in outcomes for children with hearing differences (i.e., primary communication mode, auditory access to language; and regular access to specialized educational, audiological, and speech and language services). These results replicate previous research on cochlear implant users that demonstrated relatively lower scores on subtests from the Verbal Comprehension domain (Geers & Moog, 1989;

Geers & Sedey, 2011). As noted previously (Costa et al., 2015), for children who have access to sound via assistive technology and for whom spoken English is their primary language, opportunities for incidental learning and exposure to English may differ in important ways from children in the normative sample. Of the verbally-based subtests, the hearing difference sample performed lower on those that required greater language output (e.g., Similarities, Vocabulary, and Comprehension) as compared to those subtests with little to no expressive output (e.g., Information and Picture Naming). This trend of weaker performance on tasks that require sophistication of language skills and greater language output suggest that specific components of language remains an area of development as language skills continue to strengthen.

Interestingly, reviews of research on more heterogeneous samples (e.g., various communication modalities, variable access to early intervention) had Verbal Comprehension scores that averaged one standard deviation below the mean found in the standardized sample (Krouse & Braden, 2011; Maller, 2003). While the differences in the Verbal Comprehension domain for this relatively homogeneous group are important, they are not as large as those seen with more heterogeneous samples.

Previous research has suggested that children with hearing differences demonstrate weaker performance on tests of working memory (e.g., Burkholder & Pisoni, 2003; Geers & Sedey, 2011). Of the two subtests that comprise the Working Memory domain on the WPPSI-IV, this sample had scores that fell significantly lower than the matched control on the Zoo Locations subtest; there was no significant difference between group performances on Picture Memory. Additional research is needed to determine the reason for performance variability within the Working Memory domain. Further, there was one additional subtest from the Fluid Reasoning domain that was also lower for the hearing difference sample (i.e., Picture Concepts). This lowered performance may be related to possible reliance on verbal mediation skills.

Among the index scores, there are a number of small and moderate effects that did not achieve statistical significance. This is not surprising; because the sample was a sample of convenience and relatively small, it would be impractical and would take many years to collect a sample large enough to demonstrate significance for these small and moderate effects. The *p* value merely answers one question: If there is no true difference (i.e., effect) in the population, how likely are the results found in this sample (or in those with more extreme results than these) due to chance sample fluctuation. The observed difference between this sample and the matched control group is not likely the result of happenstance due to the consistency of results across index scores as well as previous research with children with hearing differences.

Again, it should be emphasized that the sample was one of convenience, and included children who were identified with a hearing difference prior to 33 months of age, utilize appropriate and consistently functioning technology, and receive specialized educational and audiological services and supports. Further, the sample was limited to those children whose parents had an education level of at least some college and was largely identify as White. The limited demographic representation of this sample indicates that the results obtained are not generalizable to the entire deaf and hard of hearing population, particularly to those who utilize different forms of communication, did not have early language access, and/or have additional co-morbid conditions. Instead, these results should be regarded as ideal outcomes; these findings shed promising light on what remains possible for those children who communicate orally when provided with optimal early educational and audiological support and early intervention.

# References

- Burkholder, R. A., & Pisoni, D. B. (2003). Speech timing and working memory in profoundly deaf children after cochlear implantation. *Journal of Experimental Child Psychology, 85*, 63–88.
- Cohen, B. H. (1996). *Explaining psychological statistics*. Pacific Grove, CA: Brooks & Cole.
- Costa, E. B. A., Day, L. A., & Raiford, S. E. (2015). *Testing children who are deaf or hard of hearing* (WPPSI–IV Technical Report #1). Bloomington, MN: NCS, Pearson, Inc. [http://images.pearsonclinical.com/images/Products/WPPSI-IV/WPPSI%E2%80%93IV-TechReport\\_1\\_FNL.pdf](http://images.pearsonclinical.com/images/Products/WPPSI-IV/WPPSI%E2%80%93IV-TechReport_1_FNL.pdf)
- Dettman, S. J., Pinder, D., Briggs, R. J., Dowell, R. C., & Leigh, J. R. (2007). Communication development in children who receive the cochlear implant younger than 12 months. *Ear Hear, 28*(Supplement 2), 11S–18S.
- Geers, A., & Moog, J. S. (1989). Factors predictive of the development of literacy in hearing-impaired adolescents. *The Volta Review, 91*, 69–86.
- Geers, A., & Sedey, A. L. (2011). Language and verbal reasoning skills in adolescents with ten or more years of cochlear implant experience. *Ear Hear, 32*(Supplement 1): 39S–48S.
- Geers, A., Tobey, E., Moog, J., & Brenner, C. (2008). Long-term outcomes of cochlear implantation in the preschool years. *International Journal of Audiology, 47*(Supplement 2): S21–S30.
- Gupta, P., & MacWhinney, B. (1997). Vocabulary acquisition and verbal short-term memory: Computational and neural bases. *Brain and Language, 59*, 267–333.
- Hansson, K., Forsberg, J., Löfqvist, A., Mäki-Torkko, E., & Sahlén, B. (2004). Working memory and novel word learning in children with hearing impairment and children with specific language impairment. *International Journal of Language and Communication Disorders, 39*, 401–422.
- Holt, R. F., & Svirsky, M. A. (2008). An exploratory look at pediatric cochlear implantation. *Ear Hear, 29*(4), 492–511.
- Krouse, H. E., & Braden, J. P. (2011). The reliability and validity of the WISC-IV scores with deaf and hard-of-hearing children. *Journal of Psychoeducational Assessment, 29*, 238–248. doi: 10.1177/0734282910383646
- Maller, S. (2003). Intellectual assessment of deaf people: A critical review of core concepts and issues. In: M. Marschark & P. E. Spencer (Eds.), *Oxford handbook of deaf studies, language, and education* (pp. 451–463). New York, NY: Oxford University Press.
- Mayne, A., Yoshinaga-Itano, C., & Sedey, A. (2000). Receptive vocabulary development of infants and toddlers who are deaf or hard of hearing. *The Volta Review, 100*(5), 29–52.
- Nicholas, J. G., & Geers, A. E. (2007). Will they catch up? *Journal of Speech, Language and Hearing Research, 50*(4), 1048–1062.
- Niparko, J. K., Tobey, E. A., Thal, D. J., Eisenberg, L. S., Wang, N., Quittner, A. L., & Fink, N.E. (2010). Spoken language development in children following cochlear implantation. *The Journal of the American Medical Association, 303*(15), 1498–1506.
- Niskar, A., Kieszak, S. M., Holmes, A., Esteban, E., Rubin, C., & Brody, D.J. (1998). Prevalence of hearing loss among children 6 to 19 years of age: The third national health and nutrition examination survey. *The Journal of the American Medical Association, 279*(14), 1071–1075.

- Pisoni, D. B., & Cleary, M. (2003). Measures of working memory span and verbal rehearsal speed in deaf children after cochlear implantation. *Ear and Hearing, 24*, 106S–120S.
- Pisoni, D. B., & Geers, A. E. (2000). Working memory in deaf children with cochlear implants: Correlations between digit span and measures of spoken language processing. *Annals of Otology, Rhinology and Laryngology, 115*, 92–93.
- Quittner, A. L., Cruz, I., Barker, D. H., Tobey, E., Eisenberg, L. S. & Niparko, J. K. (2013). Effects of maternal sensitivity and cognitive and linguistic stimulation on cochlear implant users' language development over four years. *Journal of Pediatrics, 162*(2), 343–348.
- Sininger, Y. S., Grimes, A., & Christensen, E. (2010). Auditory development in early amplified children: Factors influencing auditory-based communication outcomes in children with hearing loss. *Ear Hear, 31*(2), 166–185.
- Stiles, D. J., McGregor, K. K., & Bentler, R. A. (2011). Vocabulary and working memory in children fit with hearing aids. *Journal of Speech, Language, and Hearing Restoration, 51*(1), 154–167.
- U.S. Government Accountability Office. (2011). *Deaf and hard of hearing children: Federal support for developing language and literacy* (GAO-11-357). Retrieved from <http://www.gao.gov/new.items/d11357.pdf>
- Yoshinaga-Itano, C., Sedey, A. L., Coutler, D. K., & Mehl, A. L. (1998). Language of early- and later-identified children with hearing loss. *Pediatrics, 102*(5), 1161–1171.