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Research Article

Emergent Literacy Skills in Preschool Children With Hearing Loss Who Use Spoken Language: Initial Findings From the Early Language and Literacy Acquisition (ELLA) Study

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Purpose: The purpose of this study was to compare change in emergent literacy skills of preschool children with and without hearing loss over a 6-month period.
Method: Participants included 19 children with hearing loss and 14 children with normal hearing. Children with hearing loss used amplification and spoken language. Participants completed measures of oral language, phonological processing, and print knowledge twice at a 6-month interval. A series of repeated-measures analyses of variance were used to compare change across groups.
Results: Main effects of time were observed for all variables except phonological recoding. Main effects of group were observed for vocabulary, morphosyntax, phonological memory, and concepts of print. Interaction effects were observed for phonological awareness and concepts of print.
Conclusions: Children with hearing loss performed more poorly than children with normal hearing on measures of oral language, phonological memory, and conceptual print knowledge. Two interaction effects were present. For phonological awareness and concepts of print, children with hearing loss demonstrated less positive change than children with normal hearing. Although children with hearing loss generally demonstrated a positive growth in emergent literacy skills, their initial performance was lower than that of children with normal hearing, and rates of change were not sufficient to catch up to the peers over time.

Children with hearing loss have poorer long-term reading and writing outcomes than children with normal hearing. At 18 years old, children with hearing loss read at a median third- to fourth-grade level; this achievement level has not increased since the 1970s (Qi & Mitchell, 2012). In addition, Geers and Hayes (2011) reported that generally fewer than half of adolescent cochlear implant users scored within normal limits on measures of reading and writing. Adults with low literacy achievement are less likely to be employed full time than adults with average literacy achievement (Kutner et al., 2007). In fact, after high school, only half of individuals with hearing loss are employed (Newman et al., 2009). It is crucial, therefore, to take steps to optimize language and literacy outcomes for children with hearing loss to ensure academic and occupational success. This study represents one step toward optimizing outcomes for this population by comparing initial change in emergent literacy skills of preschool children with and without hearing loss as a way to identify specific areas in which children with hearing loss may need more intensive explicit intervention.

Emergent Literacy Skills in Children With Normal Hearing

One way to improve long-term language and literacy outcomes is to provide appropriate and effective intervention beginning with emergent literacy skills (National Early Literacy Panel [NELP], 2008). Whitehurst and Lonigan (1998) identified three categories of preschool emergent literacy skills—oral language, phonological processing, and print knowledge—that influence later literacy achievement for children with normal hearing. In this classification system, oral language includes skills such as morphosyntax and vocabulary; phonological processing includes phonological awareness, phonological memory, and phonological recoding (typically measured by rapid naming tasks); and print

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knowledge includes letter name knowledge, letter sound knowledge, and concepts of print and words in print.

Scarborough (2001) proposed a theoretical model that highlighted the importance of the interweaving of the three categories of skills identified by Whitehurst and Lonigan—oral language, phonological processing, and print knowledge—for successful literacy achievement. In this model, phonological processing and print knowledge work together to support word decoding and spelling (Bradley & Bryant, 1983), and oral language skills work together to support comprehension and ideation (Abbott & Berninger, 1993). Importantly, these divisions are not absolute, but rather dynamic. For example, oral language skills, such as morphology, also play roles in word decoding and spelling (Apel, Wilson-Fowler, Brimo, & Perrin, 2012). A large body of research in children with normal hearing supports Scarborough's theoretical model in children with normal hearing. The meta-analysis of the NELP (2008) indicated that oral language, phonological processing, and print knowledge were moderately to strongly correlated with decoding, reading comprehension, and spelling in elementary school for children with normal hearing (see NELP, 2008, for a review of this research).

Emergent Literacy Skills in Children With Hearing Loss

Children with hearing loss exhibit deficits in emergent literacy skills compared to peers with normal hearing. These deficits span the three categories of emergent literacy, although some skills have been reported to be similar to those of children with normal hearing (described below). There is initial evidence that emergent literacy skills predict later reading and spelling for children with hearing loss (Easterbrooks, Lederberg, Miller, Bergeron, & Connor, 2008; Harris & Beech, 1998). Easterbrooks et al. additionally reported that children with hearing loss exhibited growth across a full school year on measures of phonological awareness (except rhyming) and alphabet knowledge, but not vocabulary. However, two primary limitations of this study limit conclusions about initial change in emergent literacy skills of children with hearing loss. First, the sample included preschool, kindergarten, and first-grade students. It is possible that the significant changes observed were driven by the older students and not by the preschoolers. Second, a comparison group of children with normal hearing was not included. More research is needed, therefore, to elucidate the acquisition of emergent literacy skills in children with hearing loss.

Oral Language

Multiple aspects of oral language skills for children with hearing loss who develop spoken language are poorer than their peers with normal hearing. Children with hearing loss are delayed in morphosyntax development compared to children with normal hearing (McGuckian & Henry, 2007). McGuckian and Henry reported that children with hearing loss exhibit a higher error rate in morphosyntax production as well as a different order of acquisition of grammatical morphemes than is observed in children with normal hearing. Children with hearing loss, as a group, are also delayed in vocabulary development compared to children with normal hearing; vocabulary deficits of children with hearing loss include smaller receptive and expressive lexicons as well as deficits in word learning skills. (Lund, 2016; Pittman, Lewis, Hoover, & Stelmachowicz, 2005; Wake, Poulakis, Hughes, Carey-Sargeant, & Rickards, 2005).

Phonological Processing

Likewise, children with hearing loss experience deficits in most areas of phonological processing (Lund, Werfel, & Schuele, 2015). The influence of sensory auditory deficits experienced by children with hearing loss likely inhibits the development of the ability to analyze sounds. In particular, phonological awareness and phonological memory consistently are reported to be lower in children with hearing loss than in children with normal hearing (Ambrose, Fey, & Eisenberg, 2012; Briscoe, Bishop, & Norbury, 2001; Lund et al., 2015; Spencer & Tomblin, 2009). First, the development of phonological awareness in children with hearing loss lags behind their peers with normal hearing (Kyle & Harris, 2011; Most, Aram, & Andorn, 2006; Sterne & Goswami, 2000). Indeed, Easterbrooks et al. (2008) reported that phonological awareness is the hallmark of early literacy deficit for children with hearing loss. In addition, children with hearing loss perform more poorly on measures of phonological memory than children with normal hearing (Briscoe et al., 2001). Finally, unlike phonological awareness and phonological memory, phonological recoding appears to be relatively intact for children with hearing loss (Dyer, MacSweeney, Szczerbinski, Green, & Campbell, 2003; Spencer & Tomblin, 2009).

Print Knowledge

In contrast to oral language and phonological awareness and phonological memory outcomes, two studies provided initial evidence that print knowledge may be a relative strength for children with hearing loss (Ambrose et al., 2012; Easterbrooks et al., 2008). However, these studies focused primarily on alphabet knowledge, not print knowledge as a whole. Werfel, Lund, and Schuele (2015) challenged this conclusion of relative strength. For alphabet knowledge, preschool children with hearing loss were at least commensurate with, and in some cases more advanced than, their peers with normal hearing. However, for conceptual print knowledge, children with hearing loss were substantially below their peers. Thus, conceptual print knowledge can be viewed as an area of substantial deficit for children with hearing loss (Werfel et al., 2015).

Purpose of the Current Investigation

Research has established that, as a group, children with hearing loss who use spoken language exhibit deficits in most of these emergent literacy skills, with exceptions in phonological recoding and alphabet knowledge. To date, most investigations of emergent literacy skills of children with hearing loss have not included more than one time point with the same group of children. When investigations have included more than one time point (e.g., Easterbrooks et al., 2008), these studies have not included a comprehensive assessment of each type of emergent literacy skill or a comparison group. Understanding the development of these early skills and how they relate to later language and literacy achievement will provide foundational knowledge that can guide early intervention for children with hearing loss. This work is a first step toward establishing longitudinal research that will help to identify areas of particular weakness and/or areas in which children with hearing loss experience less change. This knowledge can inform the need for explicit intervention in some areas of emergent literacy for this population. The purpose of this study, therefore, was to compare change over a 6-month period in emergent literacy skills of preschool children with and without hearing loss.

Method

All study procedures were approved by the University of South Carolina Institutional Review Board. The current study represents initial findings of the Early Language and Literacy Acquisition study.

Participants

Participants included 19 preschool children with hearing loss and 14 preschool children with normal hearing. Children with hearing loss were recruited through speech-language pathologists and audiologists, as well as social media (e.g., parent groups for children with hearing loss). Children with normal hearing were recruited through preschools and social media.

Children with hearing loss were eligible to participate if they had been diagnosed with permanent hearing loss by an audiologist, used amplification and spoken language, and did not have additional diagnoses known to affect language and literacy acquisition (e.g., autism and Down syndrome). Children with normal hearing were eligible to participate if they had no diagnoses known to affect language and literacy acquisition and passed a bilateral hearing screening prior to study participation. In addition, children in both groups identified English as the language spoken at home at least 75% of the time. All participants had nonverbal intelligence within the average range, as measured by the Primary Test of Nonverbal Intelligence (Ehrler & McGhee, 2008). Table 1 displays demographic information about participants. The groups did not differ by age or nonverbal intelligence; however, the group of children with normal hearing had higher maternal education on average than the group of children with hearing loss, although means for both groups corresponded with "some college." Children with hearing loss additionally had lower overall language scores and articulation scores than children with normal hearing, as measured by the Test of Early Language Development–Third Edition (Hresko, Reid, & Hammill, 1999) and the Arizona Articulation Proficiency Scale–Third Edition (Fudala, 2000).

For children with hearing loss, average age at identification was 5.57 months (*SD* = 10.06 months, range 0–36 months). Average age at amplification was 11.46 months (*SD* = 11.49 months, range 1.5–36 months). Nine children with hearing loss utilized bilateral cochlear implants, five utilized bilateral hearing aids, two utilized bone anchored hearing aids, and three were bimodal (one cochlear implant, one hearing aid). Level of hearing loss ranged from moderate to profound; for children who used hearing aids, level of hearing loss ranged from moderate to profound. All children with hearing loss received speech-language intervention services per parent report.

Measures

Participants completed an assessment battery that included measures of emergent literacy—oral language, phonological processing, and print knowledge. Measures were administered following published administration protocols.

Oral Language

Two areas of oral language, morphosyntax and vocabulary, were measured.

Morphosyntax. The Rice/Wexler Test of Early Grammatical Impairment (TEGI; Rice & Wexler, 2001) measures children's production of morphosyntax. The

Table 1. Demographic information by group.

	CHL		CNH			
Measure	*M* (*SD*)	Range	*M* (*SD*)	Range	*p*	*d*
Age at Time 1 (in months)	51.95 (4.67)	45–62	49.93 (4.67)	45–61	.229	0.43
Maternal education (in years)	15.14 (2.51)	12–20	16.77 (1.54)	14–20	.033	0.78
Nonverbal intelligence	109.53 (13.67)	88–137	112.86 (11.31)	93–131	.463	0.27
Overall language (TELD-3)	87.84 (24.99)	41–125	110.50 (14.96)	74–130	.003	1.10
Articulation (Arizona)	82.05 (10.34)	55–97	96.00 (13.33)	64–114	.002	1.17

Note. CHL = children with hearing loss; CNH = children with normal hearing; TELD-3 = Test of Early Language Development–Third Edition; Arizona = Arizona Articulation Proficiency Scale–Third Edition.

TEGI screener was used in this study. Two subtests contribute to the screener probe score: Past Tense and Third Person Singular.

On the TEGI Past Tense subtest, children viewed two pictures. The first picture depicted a child performing an action (e.g., jumping), and the second picture depicted the child after the action was complete. The examiner described the first picture using the present progressive form of the target verb (e.g., *jumping*), then asked the child to describe the second picture in which the action had been completed. The subtest contains prompts for 10 regular and eight irregular past tense verbs. For regular verbs, child responses were coded as correct (e.g., He jumped.), incorrect (e.g., He jump), unscorable (e.g., He was jumping), or no response. For irregular verbs, child responses were coded as correct (e.g., She wrote her name), overregularization (e.g., She writed her name), incorrect (e.g., She write her name), unscorable (e.g., She is writing), or no response. The Past Tense probe score is calculated by summing the child's correct and overregularized productions and dividing by the sum of correct, overregularized, and incorrect productions to calculate the percentage of responses that contain past-tense marking. Test–retest reliability is .82.

On the TEGI Third-Person Singular subtest, the child viewed one picture of a person (e.g., police officer). The Third-Person Singular subtest contains 10 items. The examiner said, for example, "Here is a police officer. Tell me what a police officer does." The child was required to respond with a subject and verb. Child responses were coded as correct (e.g., He helps me cross the street.), incorrect (e.g., He help me cross the street.), unscorable (e.g., He is helping me cross the street.), or no response. The Third-Person Singular probe score is calculated by dividing the number of correct productions by the sum of the child's correct and incorrect productions to calculate the percentage of responses that contain third-person singular marking. Test–retest reliability is .92. The morphosyntax variable used in the analysis was calculated by averaging the Past Tense and Third-Person Singular probe scores. Nine children with hearing loss and 11 children with normal hearing completed the morphosyntax measure at both times; children with final consonant deletion of /s/ and /z/ or /t/ and /d/ measured by the TEGI Phonological probe cannot complete the measure, accounting for the missing data.

Vocabulary. The additional oral language measures assessed children's vocabulary skills. The Expressive One-Word Picture Vocabulary Test–Fourth Edition (Brownell, 2011) was used to measure expressive vocabulary. Children viewed a colored picture and were asked to label the object. Test–retest reliability is .93–.97. The Peabody Picture Vocabulary Test–Fourth Edition (Dunn & Dunn, 2007) was used to measure receptive vocabulary. Children viewed a page with four colored pictures and were asked to point to the picture that matches the word the examiner says. Test–retest reliability is .91–.94. The raw score on the Expressive One-Word Picture Vocabulary Test–Fourth Edition formed the expressive vocabulary variable used in the analysis. Nineteen children with hearing loss and 13 children with normal hearing completed the expressive vocabulary measure at both times; one child with normal hearing was missing the data point at Time 1 due to time constraints of the research session. The raw score on the Peabody Picture Vocabulary Test–Fourth Edition formed the receptive vocabulary variable used in the analysis. All participants contributed to the receptive vocabulary analysis. Raw scores were used rather than standard scores because raw scores are better able to capture change over the 6-month period.

Phonological Processing

Three measures of phonological processing, phonological awareness, phonological memory, and phonological recoding, were measured.

Phonological awareness. The Phonological Awareness Literacy Screening–Kindergarten (PALS-K; Invernizzi, Juel, Swank, & Meier, 2004) Initial Sounds subtest was used to measure phonological awareness. On the Initial Sounds subtest, children were shown a picture of a target word and were asked to select the picture of the word that starts with the same sound as the target word from a field of three (e.g., target: rain; bus, foot, *rake*). The examiner says the target word aloud, as well as the three answer choices. The child selects his or her response by pointing to a picture. The subtest contains 10 items. The phonological awareness variable used in the analysis was the number of correct items. Test–retest reliability is .94. All participants contributed to the phonological awareness analysis.

Phonological memory. Phonological memory was assessed using the Gathercole and Adams (1993) digit span task. The digit span task requires the child to repeat random strings of digits. Beginning at two digits, the child is asked to repeat two strings of digits of each length. Testing is discontinued when a child cannot repeat two strings of digits of a certain length out of three attempts. Following scoring procedures from Gathercole and Adams, the phonological memory variable used in the analysis was the highest number of digits on which the child was able to repeat two of three strings. Nineteen children with hearing loss and 13 children with normal hearing contributed to the phonological memory analysis; one child with normal hearing did not complete the task at Time 2 due to experimenter error.

Phonological recoding. Phonological recoding was measured using a rapid naming task. The rapid naming task was adapted from Catts (1993). The child viewed a page with 30 colored pictures of animals in six rows of five animals each. The five animals were cow, dog, pig, bear, and mouse. One of each animal appeared on each row in a randomized order. The child was instructed to name the animals in each row in order as fast as they could. If the child had difficulty following the rows, the examiner used his or her finger to guide the child through the rows. A predetermined scoring rule was that any attempt that included more than two errors would be excluded from the analysis; there were no instances that required exclusion. The phonological recoding variable was the number of seconds to name all 30 animals. Alternate forms reliability calculated at Time 2 within this sample was .83. Eighteen children with hearing loss and 13 children with normal hearing contributed to the phonological recoding analysis; one child with hearing loss and one child with normal hearing could not name at least one of the animals at Time 1.

Print Knowledge

Four areas of print knowledge, letter name knowledge, letter sound knowledge, concepts of print, and concepts of written words, were measured.

Letter name knowledge. Letter name knowledge was measured using the Uppercase Letter Names subtest of the PALS-K. The child viewed a page with 26 uppercase letters and was asked to provide the name of each letter. Test–retest reliability is .92. The letter names variable was the number of letters correctly named (max 26). All participants contributed to the letter name knowledge analysis.

Letter sound knowledge. Letter sound knowledge was measured using the Letter Sounds subtest of the PALS-K. The child viewed a page with 23 uppercase letters and three uppercase digraphs (i.e., CH, TH, SH) and was asked to provide the sound that each letter made. One practice item was administered before beginning the subtest items. Only short vowel sounds were counted as correct; if a long vowel sound was provided for a vowel, the examiner asked the child, "What other sound can this letter make?" Test–retest reliability is .88. The letter sounds variable was the number of correct letter sounds provided (max 26). All participants contributed to the letter sound knowledge analysis.

Print concepts. Conceptual print knowledge was measured using the Print Concepts subtest of the Preschool Print and Word Awareness Test (Justice & Ezell, 2001). The examiner read a book with the child and embedded questions about the print. For example, the examiner asked the child to show her the front of the book and where to start reading and explain why words were in speech bubbles in the illustration, among other prompts. Interrater reliability is .99. The print concepts variable was the number of points earned during the book reading (max 18). All participants contributed to the print concepts analysis.

Words in print. Conceptual written word knowledge was measured using the Words in Print subtest of the Preschool Print and Word Awareness Test. The examiner read a book with the child and embedded questions about written words. For example, the examiner asked the child to show her the first word on a page, count the number of words on a sign, and point to words as she read, among other prompts. Interrater reliability is .99. The words in print variable was the number of points earned during the book reading (max 12). All participants contributed to the words in print analysis.

Procedure

The data reported herein are part of a larger longitudinal study of the development of early language in literacy skills in preschool children with and without hearing loss. The larger study will follow children for a period of 2 years, with assessment occurring every 6 months. This study presents findings from the first 6-month period. Children participated in research assessment sessions twice. Time 1 testing occurred at study entry, and Time 2 testing occurred approximately 6 months after Time 1 testing. Alternate forms were used for all phonological processing measures as well as alphabet knowledge measures.

For each time point, children participated in one or two assessment sessions, depending on behavior and attention. Order of administration was randomized for each participant. Assessments were administered by the author, who is a certified speech-language pathologist, or a trained lab member (lab manager or speech-language pathology master's students). Lab members were trained in the following way: (a) lab members read test manuals or journal articles for each assessment; (b) lab members practiced administration of assessments with each other; (c) lab members observed administration of assessments by the author either live or via video recording; and (d) lab members administered assessments while the author observed. Total testing time was approximately one to two hours hr. Assessment took place individually in a quiet room.

Analysis

All tests were scored by one lab member and checked item-by-item for accuracy by another. Reliability scoring occurred in the lab from audio and/or video files. Disagreements were rare and, when they occurred, were resolved by consensus of the two scorers, resulting in 100% reliability of test scoring. Study data were managed using REDCap electronic data capture tools hosted at the University of South Carolina (Harris et al., 2009). REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies.

A series of repeated-measures analyses of variance was used to compare change across groups. In each analysis of variance, one of the variables described above served as the dependent variable, time served as the within-subject variable, and group served as the between-subjects variable. Listwise deletion was used to handle missing data; only participants with both data points for each variable were included in that model.

Results

Descriptive statistics of study measures are displayed in Tables 2 and 3. Table 2 displays descriptive scores on each study measure at Time 1 by group. Table 3 displays descriptive scores on each study measure at Time 2 by group. Note that, although standard scores are reported in these tables, only the scores described in the measures section above were used in the following analyses.

Oral Language Skills

Main effects of time and group were observed for morphosyntax, $F(1, 18) = 13.95$, $p = .002$, $\eta_p^2 = .437$, and $F(1, 18) = 10.46$, $p = .005$, $\eta_p^2 = .367$, respectively. Likewise,

Table 2. Descriptive statistics of Time 1 study measures by group.

	CHL			CNH				
Measure	***n***	***M* (*SD*)**	**Range**	***n***	***M* (*SD*)**	**Range**	***p***	***d***
Morphosyntax	10	40.65 (32.76)	0–92	12	79.96 (19.03)	25–100	.005	1.47
Expressive vocabulary raw	19	45.11 (18.06)	1–80	13	60.85 (10.24)	37–72	.008	1.07
Expressive vocabulary SS	19	95.32 (18.51)	55–130	13	113.54 (12.68)	91–127	.004	1.15
Receptive vocabulary raw	19	61.74 (26.08)	10–114	14	81.50 (12.50)	55–101	.008	0.97
Receptive vocabulary SS	19	93.47 (21.59)	46–136	14	112.07 (12.20)	90–128	.007	1.06
Phonological awareness	19	4.21 (2.42)	1–9	14	3.79 (2.01)	1–7	.596	0.18
Phonological memory	19	2.79 (0.98)	1–5	14	3.64 (0.84)	2–5	.013	0.93
Phonological recoding	18	57.50 (16.55)	37–85	13	61.38 (19.13)	37–94	.550	0.22
Letter name knowledge	19	15.58 (9.27)	1–26	14	19.71 (7.03)	8–26	.155	0.50
Letter sound knowledge	19	7.79 (8.27)	0–23	14	8.21 (6.94)	0–17	.877	0.06
Print concepts	19	6.00 (3.35)	0–12	14	7.21 (2.55)	2–12	.265	0.41
Words in print	19	2.21 (2.46)	0–7	14	4.64 (2.87)	1–11	.014	0.91

Note. CHL = children with hearing loss; CNH = children with normal hearing; SS = standard score.

main effects of time and group were observed for expressive vocabulary, $F(1, 30) = 47.58$, $p < .001$, $\eta_p^2 = .613$, and $F(1, 30) = 6.92$, $p = .013$, $\eta_p^2 = .187$, respectively. Finally, main effects of time and group were observed for receptive vocabulary, $F(1, 31) = 63.71$, $p < .001$, $\eta_p^2 = .673$, and $F(1, 31) = 8.71$, $p = .006$, $\eta_p^2 = .219$, respectively. Interaction effects were not significant for any oral language variable (p = .290, .359, .490; η_p^2 = .062, .028, .015, respectively). See Figure 1.

Phonological Processing Skills

An interaction of Time × Group was observed for phonological awareness, $F(1, 31) = 7.49$, $p = .010$, $\eta_p^2 = .195$. A main effect of group was not observed for phonological awareness ($p = .368$, $\eta_p^2 = .026$). Main effects of time and group were observed for phonological memory, $F(1, 30) = 12.15$, $p = .002$, $\eta_p^2 = .288$, and $F(1, 30) = 6.53$, $p = .016$, $\eta_p^2 = .179$, respectively. Interaction of Time × Group was not significant ($p = .592$, $\eta_p^2 = .010$). Finally, there were no effects of time or group for phonological recoding (p = .060, .094; η_p^2 = .116, .094, respectively). See Figure 2.

Print Knowledge

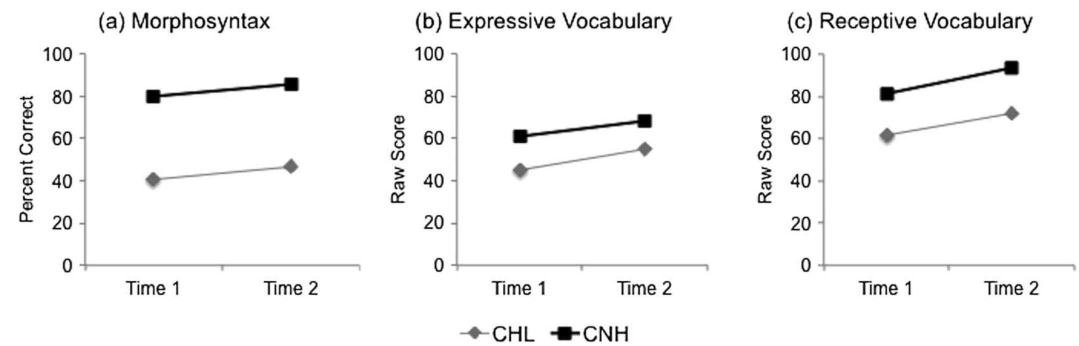
A main effect of time was observed for letter name knowledge, $F(1, 31) = 17.26$, $p < .001$, $\eta_p^2 = .358$. Main effect of group and interaction of Time × Group were not significant (p = .139, .749; η_p^2 = .069, .003, respectively). Likewise, a main effect of time was observed for letter sound knowledge, $F(1, 30) = 22.17$, $p < .001$, $\eta_p^2 = .417$. Main effect of group and interaction of Time × Group were not significant (p = .571, .178; η_p^2 = .010, .058, respectively). An interaction effect of Time × Group was observed for print concepts, $F(1, 31) = 4.75$, $p = .037$, $\eta_p^2 = .133$. Finally, main effects of time and group were observed for words in print, $F(1, 31) = 5.05$, $p = .032$, $\eta_p^2 = .140$, and $F(1, 31) = 8.00$, $p = .008$, $\eta_p^2 = .205$, respectively. Interaction effects were not significant ($p = .670$, $\eta_p^2 = .006$). See Figure 3.

Table 3. Descriptive statistics of Time 2 study measures by group.

	CHL			CNH				
Measure	***n***	***M* (*SD*)**	**Range**	***n***	***M* (*SD*)**	**Range**	***p***	***d***
Morphosyntax	14	46.65 (33.34)	0–97	12	85.81 (8.18)	84–100	.001	1.61
Expressive vocabulary raw	19	55.00 (18.44)	13–91	14	68.50 (11.38)	41–86	.022	0.88
Expressive vocabulary SS	19	98.47 (18.22)	55–133	14	112.93 (12.96)	89–137	.017	0.91
Receptive vocabulary raw	19	72.11 (22.77)	22–115	14	93.86 (12.88)	68–108	.003	1.18
Receptive vocabulary SS	19	95.42 (17.41)	57–127	14	113.79 (11.67)	96–130	.002	1.24
Phonological awareness	19	4.63 (2.95)	1–10	14	6.50 (2.57)	2–10	.067	0.68
Phonological memory	19	3.32 (0.89)	1–4	13	4.00 (0.82)	3–6	.035	0.79
Phonological recoding	19	56.68 (21.15)	34–107	14	52.86 (14.89)	33–79	.567	0.21
Letter name knowledge	19	19.00 (7.43)	2–26	14	22.64 (5.40)	8–26	.130	0.56
Letter sound knowledge	19	10.37 (8.41)	0–23	14	12.93 (6.55)	1–22	.333	0.34
Print concepts	19	7.37 (4.03)	2–14	14	10.50 (2.74)	6–16	.018	0.91
Words in print	19	3.58 (2.67)	0–9	14	5.57 (2.65)	2–11	.042	0.75

Note. CHL = children with hearing loss; CNH = children with normal hearing; SS = standard score.

Figure 1. Change in oral language skills by group. CHL = children with hearing loss; CNH = children with normal hearing.



Discussion

The purpose of this study was to compare change across a 6-month period in emergent literacy skills of preschool children with and without hearing loss. Children with hearing loss performed more poorly than children with normal hearing on most measures of oral language, phonological memory, and conceptual print knowledge; exceptions included letter name knowledge, letter sound knowledge, and phonological recoding. In addition, children exhibited positive change in most skills over the 6-month period; the exception was phonological recoding. Two interaction effects were present. For phonological awareness and concepts of print, children with hearing loss demonstrated less positive change than children with normal hearing.

Although children with hearing loss generally demonstrated positive change in emergent literacy skills, their initial performance was lower than that of children with normal hearing, and rates of change were not sufficient to catch up to their peers over time. These findings are particularly interesting when interpreted in light of the intervention received; all children with hearing loss in this study were receiving speech-language services, per parent report. Thus, it appears that current practices in early intervention do not readily lead to lessening the magnitude of deficit for this population. Instead, it is possible that explicit instruction in particular skills is needed to accelerate the positive change observed in 4-year-old children with hearing loss.

Oral Language

Children with hearing loss had lower initial performance on all oral language measures compared to children with normal hearing. The differences between groups were large. Cohen's *d* effect sizes indicated large group differences at both times. In addition, morphosyntax appeared to be the measure with the largest group differences at both times. At Time 2, no child with normal hearing scored below 84% correct on the morphosyntax measure, whereas some children with hearing loss still scored 0%. These results are consistent with previous findings concerning the level of oral language skills of preschool children with hearing loss (e.g., Lund, 2016; McGuckian & Henry, 2007). Both groups demonstrated positive change in oral language skills over time; however, there was no interaction of Group × Time. Thus, the rate of change for morphosyntax and vocabulary in children with hearing loss appears to be similar to that of children with normal hearing over the time period of this

Figure 2. Change in phonological processing skills by group. CHL = children with hearing loss; CNH = children with normal hearing.

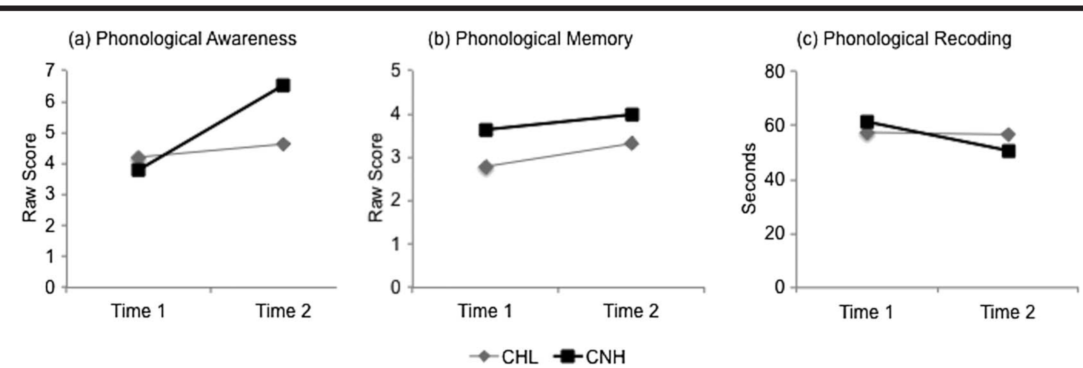
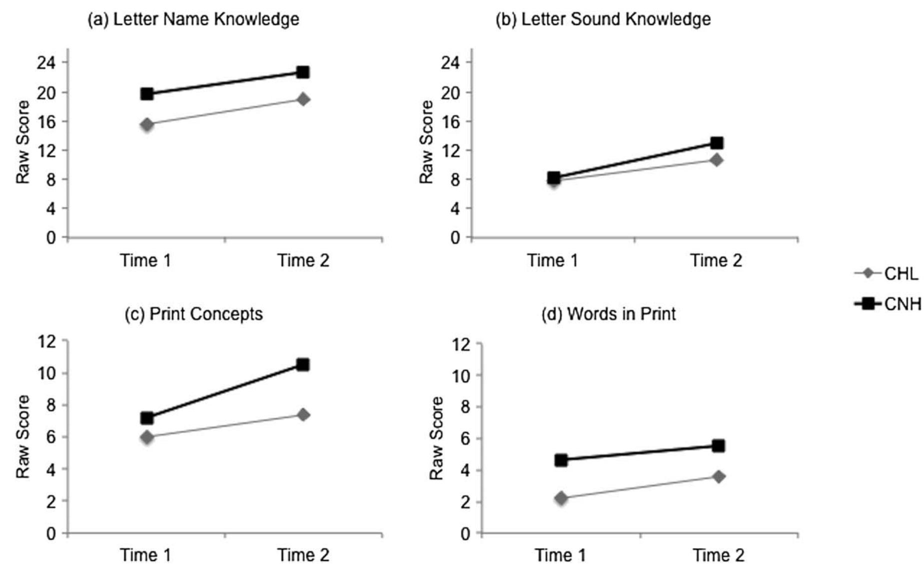


Figure 3. Change in print knowledge skills by group. CHL = children with hearing loss; CNH = children with normal hearing



study. This similar rate of change for children with hearing loss and children with normal hearing on oral language skills is insufficient to close the gap in performance, but it is sufficient to keep the gap from widening. Future research should explore treatment methods that are effective to accelerate the oral language development of children with hearing loss in order to close this gap in performance.

Phonological Processing

In contrast to oral language, the performance of children with hearing loss differed in comparison to that of children with normal hearing on some, but not all, measures of phonological processing. First, children with hearing loss did not differ from children with normal hearing at Time 1 on phonological awareness. This finding was somewhat surprising given previous works that consistently showed lower phonological awareness performance of children with hearing loss compared to children with normal hearing (e.g., Easterbrooks et al., 2008; Lund et al., 2015). The children in this study were younger than the samples for most other studies of phonological awareness, and the children with normal hearing did not score, on average, above chance on the phonological awareness measure; this methodological difference may explain the disparate finding. Another potential explanation is differences in phonological awareness tasks. Easterbrooks et al. used a variety of phonological awareness tasks; however, Lund et al. used the exact task used in this study and observed differences between groups. Therefore, the first explanation is favored. Although there was no difference between groups in performance at Time 1, children with normal hearing demonstrated positive change in phonological awareness from Time 1 to Time 2, whereas children with hearing loss did not. That is, children with normal hearing appeared to begin to develop initial sound awareness during the 6 months between testing times, but the children with hearing loss overwhelmingly remained at below-chance performance levels. Researchers have previously reported that phonological awareness represents a particular area of deficit for children with hearing loss (e.g., Easterbrooks et al., 2008), and the present finding, considered fully, is consistent with this conclusion. This finding indicates an area of emergent literacy in which effective emergent literacy intervention for children with hearing loss is vital.

Second, children with hearing loss performed lower than children with normal hearing on phonological memory but demonstrated positive change over time. This rate of change, however, did not differ from the rate of change for children with normal hearing; thus, children with hearing loss perform more poorly initially than children with normal hearing and do not exhibit sufficient rates of change in phonological memory to catch up with their peers with normal hearing over time. The rate of change does not appear, however, to result in larger gaps in performance between the two groups over time, at least in the time period measured in this study.

Finally, consistent with previous research, children with hearing loss did not differ from children with normal hearing on performance or growth rate on phonological recoding. Phonological recoding, the rapid retrieval of phonological information from long-term memory stores, appears to be an area of emergent literacy that is not affected by hearing loss.

Print Knowledge

Print knowledge also differed across component skills for children with hearing loss. Consistent with previous literature, there were no group differences on letter name knowledge or letter sound knowledge. Both groups demonstrated positive change in each of these skills. These findings add to an existing research base supporting the conclusion that alphabet knowledge is an area of strength for children with hearing loss (e.g., Ambrose et al., 2012; Easterbrooks et al., 2008). Conceptual print knowledge findings, however, suggest that children with hearing loss perform more poorly than children with normal hearing on this category of print skills. The findings of this study confirm earlier findings of Werfel et al. (2015). In addition, children with hearing loss exhibited slower rates of change than children with normal hearing on print concept knowledge. As with phonological awareness, future research is needed to develop and validate effective early intervention in the area of print concept knowledge.

Clinical Implications

The findings of the current study have several important clinical implications. First, because children with hearing loss have lower initial skill in most areas of emergent literacy, it is vital that early interventionists closely monitor emergent literacy acquisition for this population. Second, early intervention should contain a substantial focus on scaffolding development of many emergent literacy skills for which children with hearing loss need an accelerated rate of change compared to their peers with normal hearing, particularly oral language skills. Third, the findings provide information for clinicians about which emergent literacy skills to expect children with hearing loss to have the most difficulty with relative to their peers with normal hearing, namely phonological awareness and conceptual print knowledge. Treatment plans should be developed with these particular difficulties in mind, devoting sufficient resources to scaffold these skills in particular. Evidence supporting the use of systematic, explicit phonological awareness intervention for children with hearing loss exists (Werfel, Douglas, & Ackal, 2016; Werfel & Schuele, 2014). Although interventions specific to conceptual print knowledge have not been evaluated for children with hearing loss, ample evidence supports the use of print referencing (Justice & Ezell, 2004) to improve this skill in children with normal hearing, including a variety of groups of children with communication disorders (for a review, see Breit-Smith, Justice, McGinty, & Kaderavek, 2009). More work is needed to determine its effectiveness for children with hearing loss and what, if any, modifications should be made specific to this population.

Limitations and Future Directions

As with all studies, the present findings should be interpreted with the study's limitations in mind. First, the group of children with hearing loss only included children who were developing listening and spoken language skills and used sign language minimally or not at all. Thus, findings should not be applied to populations beyond the one described herein. In addition, amplification types of children with hearing loss varied. Finally, the sample size of this study is relatively small.

Future research should confirm these findings with larger, amplification-specific groups of children with hearing loss as well as expand studies to include groups of children with hearing loss who use different communication modalities. In addition, children with hearing loss did not differ from children with normal hearing on some emergent literacy measures, including phonological recoding, letter name knowledge, and letter sound knowledge. The mechanisms by which these skills are intact for children with hearing loss are not well understood, however. Future research should seek to elucidate how these emergent literacy skills remain intact in preschool children with hearing loss, whereas other emergent literacy skills, often closely related to these skills, are affected.

Next Steps

These findings represent the initial findings of the Early Language and Literacy Acquisition (ELLA) study. Additional participants continue to be recruited and will be followed over a total period of 2 years. The eventual aim of this longitudinal study is to evaluate the relation of each of the emergent literacy skills described herein to initial reading and writing skills of children with and without hearing loss. This analysis will provide valuable information on how emergent literacy skills influence later reading and writing for children with hearing loss as well as if these relations differ from those observed in children with normal hearing. The findings will inform clinical practice in two important ways. First, this line of research may be able to identify early predictors of reading and writing difficulties for children with hearing loss, allowing for earlier identification of children who will need additional intervention in this area. Second, this line of research will identify areas of particular need for children with hearing loss to inform clinical practice in selecting intervention target.

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