

# Phonological Awareness: Explicit Instruction for Young Deaf and Hard-of-Hearing Children

Elizabeth M. Miller\*, Amy R. Lederberg, Susan R. Easterbrooks

Georgia State University

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The goal of this study was to explore the development of spoken phonological awareness for deaf and hard-of-hearing children (DHH) with functional hearing (i.e., the ability to access spoken language through hearing). Teachers explicitly taught five preschoolers the phonological awareness skills of syllable segmentation, initial phoneme isolation, and rhyme discrimination in the context of a multifaceted emergent literacy intervention. Instruction occurred in settings where teachers used simultaneous communication or spoken language only. A multiple-baseline across skills design documented a functional relation between instruction and skill acquisition for those children who did not have the skills at baseline with one exception; one child did not meet criteria for syllable segmentation. These results were confirmed by changes on phonological awareness tests that were administered at the beginning and end of the school year. We found that DHH children who varied in primary communication mode, chronological age, and language ability all benefited from explicit instruction in phonological awareness.

Literacy attainment continues to be a critical focus in the research on deaf and hard-of-hearing (DHH) students. This is appropriate as reading proficiency deficits are well documented (Allen, 1986; Dew, 1999; Traxler, 2000). While many researchers have examined existing skills of DHH readers, far fewer have considered actual interventions and their effects on early literacy skills (Luckner, Sebold, Cooney, Young, & Muir, 2005). Early literacy skills (e.g., vocabulary, alphabetic knowledge, and phonological awareness) predict reading adeptness in later years for both hearing and DHH

children (Geers & Hayes, 2011; National Reading Panel [NRP], 2000). Early explicit instruction in alphabet knowledge and phonological awareness has consistently had a positive effect on early literacy ability of hearing readers (National Early Literacy Panel [NELP], 2008). This study focused on the effects of explicit instruction on the acquisition of phonological awareness skills by young DHH children with functional hearing (i.e., the ability to access spoken language through hearing).

Reading is the ability to obtain meaning from print. Print is the visual representation of a spoken language and consists of graphemes (i.e., alphabetic letters) that correspond to the phonemes (i.e., speech sounds) of language. Children who have alphabet knowledge are able to identify the associations between phonemes and graphemes. Effective use of alphabet knowledge requires the alphabetic principle (i.e., understanding the connection of graphemes to spoken language and vice versa; Adams, 1990). Interpretation of the varying combinations of graphemes (i.e., printed words) requires the mental acts of both visual and phonological processing. For hearing children, development of early reading skills, in particular decoding, is dependent upon the alphabetic principle and successful phonological processing (Adams, 1990; Scarborough, 2001). One critical construct of phonological processing is phonological awareness, which is the ability to detect, manipulate, or analyze the phonemic aspects of spoken language (Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993).

\*Correspondence should be sent to Elizabeth M. Miller, Georgia State University, Educational Psychology and Special Education, PO Box 3979, 30 Pryor Street, Atlanta, Georgia (e-mail: [emiller22@gsu.edu](mailto:emiller22@gsu.edu))

## Phonological Awareness

*Hearing children.* Alphabet knowledge and phonological awareness have consistently proven to be strong predictors of successful early reading development in hearing children, maintaining their predictive powers even when intelligence quotient and socioeconomic status are taken into account (NELP, 2008; NRP, 2000). Furthermore, phonological awareness remains relatively stable from the late-preschool period forward (Burgess & Lonigan, 1998; Lonigan, Burgess, & Anthony, 2000; Wagner et al., 1997). Development of phonological awareness follows along a continuum progressing in sensitivity from larger concrete units of sound (i.e., words) to smaller (i.e., syllables) and smaller abstract units (i.e., phonemes; Anthony, Lonigan, Driscoll, Phillips, & Burgess, 2003; Lonigan, 2006). Similarly, strategies to evaluate phonological awareness move from simple tasks using whole words (e.g., rhyme detection) and word parts (e.g., syllable segmentation) to tasks using onset (e.g., initial sound isolation) to more difficult tasks using all the phonemic information in a word (e.g., phoneme segmentation; Pufpaff, 2009). While researchers have shown that the development of phonological awareness is sequential, it does not occur in separate distinct stages but is overlapping in nature, which means children often begin learning new skills prior to mastering earlier skills (Anthony et al., 2003).

*DHH children.* Research regarding the role of phonological awareness as it relates to reading in DHH children has produced conflicting evidence (Mayberry, del Giudice, & Lieberman, 2011). However, few studies involved prereaders and many involved learners who had little or no functional hearing and therefore were developing phonological awareness based primarily on visual and kinesthetic cues such as speechreading, speech production, and alphabet knowledge (Geers & Hayes, 2011; Mayberry et al., 2011). In the last decade, early detection and technological changes have resulted in a greater incidence of DHH children with functional hearing who experience good speech perception (Easterbrooks, Lederberg, Miller, Bergeron, & Connor, 2008; Hyde, Punch, & Grimbeek, 2011). Researchers have found

that DHH children with functional hearing develop spoken phonological awareness (Ambrose, Fey, & Eisenberg, 2012; Guardino, Syverud, Joyner, Nicols & King, 2011; James, Rajput, Brinton, & Goswami, 2008; James et al., 2005; Johnson & Goswami, 2010; Syverud, Guardino, & Selznick, 2009) and that it relates to reading skills (Dillon, de Jong, & Pisoni, 2011; Easterbrooks et al., 2008). For instance, phonological processing skills measured in the early elementary grades predicted literacy ability of DHH high school students with cochlear implants (CIs; Geers & Hayes, 2011). While phonological awareness development is possible in DHH children with functional hearing, researchers have shown that deficits are still prevalent (Mayberry et al., 2011). Difficulties with phonological representations are evident from infancy (Moeller, Tomblin, Yoshinaga-Itano, Connor, & Jerger, 2007) and delays in phonological awareness ability in many DHH children is apparent in the preschool and elementary years (Ambrose et al., 2012; Easterbrooks et al., 2008; James et al., 2005; Spencer & Tomblin, 2009; Webb & Lederberg, 2012). This research suggests that DHH children with functional hearing may benefit from early explicit instruction in phonological awareness.

## Phonological Awareness Instruction

*Hearing children.* As the typical speech stream does not automatically lend itself to distinctly decodable units (Morais, Cary, Alegria, & Bertelson, 1979; Read, Yun-Fei, Hong-Yin, & Bao-Qing, 1986), training in phonological awareness along with the alphabetic principle provides children with the tools needed to access the smaller units vital for decoding. The research regarding phonological awareness training with hearing children in the prereading phase of learning is substantial. In its meta-analysis of 83 studies focused on code-related skills (i.e., alphabet knowledge, phonological awareness, and word decoding) with preschool and kindergarten children, the NELP (2008) reported that children made statistically significant gains in the areas of phonological awareness, alphabet knowledge, oral language, reading and spelling, with the greatest gains in the domain of phonological awareness. Interventions that included both alphabet knowledge and phonological awareness produced the best results.

*DHH children.* In contrast, there are very few studies involving phonological awareness instruction with young DHH children. Researchers have found that DHH school-age students improve their phonological awareness (e.g., rhyme and phoneme segmentation) when taught with reading curricula developed for hearing children supplemented with the visual support of Cued Speech or Visual Phonics (e.g., [Colin, Magnan, Ecalle, & Leybaert, 2007](#); [Narr, 2008](#); [Trezek, Wang, Woods, Gamp, & Paul, 2007](#)). There is only a case study, which suggests DHH preschoolers may benefit from such instruction. Over the course of a six-week intervention, [Smith and Wang \(2010\)](#) found a 4-year-old DHH preschooler with a CI improved her phonological awareness abilities (e.g., identifying beginning consonants and individual phonemes in words).

In this study, we expand beyond this case study to include more young children and measure additional phonological awareness skills. We also used single-case study design to examine if there was a functional relationship between instruction and acquisition, a specific phonological awareness skill. Phonological awareness instruction was embedded within an emergent literacy intervention for young DHH children, developed by the authors, called *Foundations for Literacy* ([Lederberg, Miller, Easterbrooks, & Connor, 2012](#)).

#### Foundations for Literacy Curriculum

We designed *Foundations* as a balanced early literacy program. It is intended to facilitate the development of a range of prereading skills in DHH children. Based upon the Simple View of Reading theory ([Gough & Tunmer, 1986](#)) and other language-based reading theories ([Catts & Kamhi, 2005](#)), *Foundations'* learning objectives target foundational skills necessary for word identification (e.g., alphabetic knowledge and phonological awareness) and language comprehension (e.g., vocabulary and story comprehension). *Foundations* is a multisensory-integrated program that utilizes illustrated stories to introduce grapheme–phoneme correspondences through semantic associations ([Beal-Alvarez, Lederberg, & Easterbrooks, 2011](#); [Bergeron, Lederberg, Easterbrooks, Miller, & Connor, 2009](#)). Language-rich activities, which also target vocabulary

development, reinforce the grapheme–phoneme semantic connection while providing isolated practice of the phonemes. Storybook reading is used to improve vocabulary and narrative understanding. Instruction is individualized to meet individual DHH children's degrees of functional hearing, language, and literacy abilities. *Foundations* is designed to be implemented for 1 hr a day, four days a week, across a school year.

We used a series of iterative design studies over several years to develop *Foundations*. Two research teachers (i.e., teachers who were employed by the research project and differed from the children's classroom teachers) instructed the children, provided feedback to the research team, and gathered curriculum-based data on the effectiveness of instructional strategies. Independent assessors who were not part of the research team administered a battery of assessments in the fall and spring to monitor learning across the school year. We used these data to make evidence-based changes to *Foundations*. During the first three years, the research team implemented a series of single-case studies that showed that instructional strategies embedded within *Foundations* were effective in teaching grapheme–phoneme correspondences ([Beal-Alvarez et al., 2011](#); [Bergeron et al., 2009](#)). During the first and second years, we used curriculum-based assessments to modify and develop phonological awareness instruction.

Development of the instructional process occurred in several stages. First, we examined existing activities developed for hearing children (e.g., [Adams, Foorman, Lundberg, & Beeler, 1998](#); [Florida Center for Reading Research, 2008](#)) to select age-appropriate phonological awareness skills. Specifically, we focused on (a) syllable segmentation (i.e., dividing words into syllables); (b) initial phoneme isolation (i.e., identifying the beginning sound in a word); and (c) rhyme discrimination (i.e., determining which words rhyme). Interventions developed for hearing children were judged to be problematic for DHH children for several reasons; instruction proceeded too quickly for those with weak phonological representations, vocabulary used in activities would be unknown to many children, and instruction had insufficient visual support.

Based on theoretical and empirical work with DHH children, as well as our iterative design studies, we created instructional activities that were specifically

adapted to DHH children's needs and individualized to children's functional hearing and language levels. To accommodate many DHH children's weak language abilities, instructional language needed to engage in phonological awareness activities (e.g., take apart, same, different, word part) was explicitly taught prior to beginning phonological awareness instruction. Instruction focused on developing awareness of the phonological representation of words children already knew by including vocabulary that had been previously learned in language activities. We accommodated children with less well-developed functional hearing through the incorporation of auditory training and visual support techniques for phonological representation. These included acoustic highlighting (i.e., the emphasizing of a particular phoneme in a word); sandwiching (i.e. verbalization of the target word, isolated initial sound, then repetition of the target word, such as *boy*, /b/, *boy*); modeling, the use of closed and open sets (Erber, 1982; McClatchie, & Therres, 2003); and visual representations for syllables and known phonemes (Walker, Munro, & Rickards, 1998). Such support was individualized based on DHH children's functional hearing.

### Current Study

This study took place in the third year of the development of *Foundations* to examine the effectiveness of the phonological awareness instruction component. Research teachers' instruction of the three phonological awareness skills, syllable segmentation, initial phoneme isolation, and rhyme recognition, occurred sequentially during the school year. A multiple baseline across skills single-case design was implemented to examine if a functional relation existed between instruction and acquisition of these skills.

Our research questions were (a) Can DHH preschoolers with functional hearing learn to segment spoken words into syllables? (b) Can they learn to discriminate words that rhyme? (c) Can they learn to isolate the beginning phoneme in words, and if so, do they use their alphabetic knowledge to do so? Specifically, we examined whether children were better able to isolate the initial phonemes in words beginning with known grapheme–phoneme correspondences before they

isolated phonemes in words that begin with untaught grapheme–phoneme correspondences. Research with hearing children (Castles & Coltheart, 2004) that shows the influence of alphabetic knowledge on phoneme isolation would suggest this to be the case. Using visual inspection, we also examined the rate of acquisition of these skills and if individual differences in language, functional hearing, or chronological age affected learning of these skills.

## Method

### Participants and Settings

Criteria for participant selection were (a) a hearing loss with an unaided pure tone average (PTA) of 50 dB or greater in the better ear, (b) no additional documented disabilities, (c) the ability to understand at least some spoken words presented—defined as a score of 3 (some word identification) or 4 (consistent word identification) on the *Early Speech Perception Test* (ESP Test; Moog & Geers, 1990), and (d) chronological age between 3 years 8 months and 5 years 11 months of age as of September 1 of the school year. Classroom teachers sent home parent consent forms to the eight children who met eligibility at two schools. Five of the eight children were included in this study. The three that did not participate included one child whose parents did not consent; one who reached criteria at baseline for all three skills; and one who received a modified version of *Foundations* that did not include phonological awareness due to group assignment by the school.

Table 1 presents a description of the five study participants based on parental and teacher questionnaires, children's audiograms, and standardized tests administered in the fall. We use pseudonyms for the participants.

Research teachers who were members of the *Foundations* team taught children in two groups of three (five research participants plus one nonreported student because of baseline performance). Children were taken from their regular classroom into a separate room for the intervention. One group was in an auditory/oral program, and the other in a local school program where teachers used sign language. The classroom DHH teachers in the signing program were

**Table 1** Demographic information on participants at study onset

Participant	Derek	Harrison	Rebecca	Sawyer	Owen
Age (years.months)	3.9	4.4	3.10	4.9	5.1
Gender	M	M	F	M	M
Mode of instruction	Spoken	Spoken	Spoken	Sign	Sign
Self-contained classroom	Preschool	Preschool	Preschool	Preschool	Kindergarten
Unaided PTA (better ear)	—	—	62	55	—
Amplification (R/L)	CI/CI	CI/CI	HA/HA	HA/HA	—/CI
Early speech perception score	4	4	4	4	3
SS AE(year.month) PPVT-4	106 4.0	83 3.3	99 3.8	80 3.4	83 3.8
SS AE(year.month) EOWPVT	94 3.4	92 3.7	91 3.2	83 3.5	63 2.4
Age identified (month)	7	4	25	11	6
Age amplified (month)	8	7	26	12	12
Age first implanted (month)	20	24	NA	NA	34
Age enrolled in intervention (month)	8	6	27	12	9
Language used at home	English	English	English	English	English
Communication mode at home	Spoken	Spoken	Spoken	Sign/Spoken	Sign/Spoken
Hearing status of mother/father	h/h	h/h	h/h	d/h	h/h

Note. PTA, pure tone average (PTA not available for children with CIs); CI, cochlear implant; HA, hearing aid; SS, standard score; AE, age equivalent; PPVT-4, Peabody Picture Vocabulary Test 4th Ed; EOWPVT, Expressive One Word Picture Vocabulary Test; h, hearing; d, deaf.

observed to use Simultaneous Communication and signing with voice off. Each research teacher was a certified teacher of the deaf with five or more years of experience in the same mode of communication and instruction utilized at the particular school where they taught the intervention. The research teacher in the program utilizing sign language used simultaneous communication of speech and Conceptually Accurate Signed English (CASE). When utilizing CASE, the signer uses the grammatical structure of English and concepts representative of those used in American Sign Language. During phonological awareness activities, the focus was on the phonological structure of spoken words, but instruction was supported by sign as necessary. The research teachers began intervention four to six weeks into the school year and ended one to two weeks prior to the end of the school year. Instructional sessions occurred four days a week for approximately 1 hr.

## Measures

*Baseline and probe assessments.* Once baseline was established and instruction begun, probes were conducted approximately every 8th–12th instructional session; however, the timing and number of probes administered differed between the groups due to school holidays and teacher consistency.

*Syllable segmentation measure.* The teacher said a word and asked the child to say the word slowly and touch a box for each word part or syllable on a piece of paper with a row of six green squares. Each assessment started with one to three practice trials during which the teacher gave corrective feedback. The number of taps was recorded rather than the number of boxes touched to correct for error due to fine motor skills. If a child mispronounced the word but provided the correct number of taps, the item was scored as correct. The 10 test trials included 2 one-syllable words, 2 two-syllable words, 3 three-syllable words, and 3 four-syllable words. Assessments were created with words randomly picked from a bank of words considered typical of a preschooler's vocabulary (e.g., bug, cookie, pajamas, and motorcycle). Noncorrective feedback was given in the form of positive words or phrases (i.e., “Good” or “Okay”) to encourage the child to continue with the task. Training and practice were the same for all assessments.

*Initial phoneme isolation measure.* Assessment for initial phoneme isolation was conducted using a computer and a PowerPoint presentation. Assessments always started with three practice trials followed by 12 test trials. The teacher asked “What is the beginning sound in (spoken word)?” with a blank screen displayed on the computer. Upon answering, the



teacher would click the computer mouse and the child would see a screen containing a picture of the word and the grapheme representing the initial phoneme. Only during the practice trials did the teacher give corrective verbal feedback. The 12 test items consisted of one word that started with each of the following phonemes: /m/, /b/, /t/, /n/, /p/, /s/, /f/, /g/, /sh/, /k/, /l/, and /h/. The children learned grapheme–phoneme correspondences for the first six phonemes listed above during instruction using *Foundations*. These phonemes were taught sequentially, and therefore students knew an increasing number of phonemes as probes were conducted across time. Words were randomly drawn from banks of four words each for each phoneme. All words in the bank were one syllable in form, not used during explicit instruction, but appropriate for preschool children.

*Rhyme recognition measure.* Assessment for rhyme recognition utilized a computer and PowerPoint presentation and was modeled after the rhyme recognition task by Byrne and Fielding-Barnsley (1991). Four pictures appeared on the computer screen with the target picture at the top and two distracters and the correct rhyming word presented in three boxes at the bottom of the screen. The teacher asked a student which picture rhymed with the target word. The teacher then paired the target word with choices sequentially (e.g., “Which of these rhymes with cat? Cat, boy? Cat, wall? Cat, hat?”) Once students responded, the box of the correct answer would spin on the screen for visual reinforcement. The teacher modeled the same single trial and provided the same practice trial for all assessments. She provided explicit verbal feedback only on the practice trials. To create the 12 test trials in the assessment, we randomly chose rhyming pairs from a bank of 50 rhyming pairs typically found in preschool curricula (e.g., man, can, rope, soap, and duck, truck). We chose the distractors randomly from the entire bank of 100 words. A child’s chance of correctly identifying the rhyming word was 33% due to the inclusion of three response options.

*Interscorer reliability.* Trained graduate students served as second observers and scored 20% of the

syllable segmentation, initial sound, and rhyming assessments independently from the research teachers. Interrater reliability averaged 97% across assessments.

*Generalization measures.* As part of the larger *Foundations* project, assessors who were retired teachers of the deaf and independent of the research team administered a battery of language and literacy tests to children at the beginning (pretest) and end (posttest) of the school year. These included the ESP test (Moog & Geers, 1990), *Expressive One Word Picture Vocabulary Test* (EOWPVT; Brownell, 2000), and the *Peabody Picture Vocabulary Test-IV* (PPVT-IV; Dunn & Dunn, 1997) reported in Table 1. The battery also included two phonological awareness tests described below. These tests served as generalization probes for the single-case study. For these tests and the ESP, the directions were presented in sign and spoken language for children who used sign language, with the stimuli presented in spoken language only. Simultaneous communication was used for the vocabulary tests with these children.

The Phonological Awareness Test-2nd Edition (PAT-2) measures phonological awareness in 5- to 9-year-old children and contains subtests that assess a single phonological awareness skill. Webb, Schwanenflugel, and Kim (2004) developed an off-level version of four subtests of the PAT-2 (rhyme recognition, syllable segmentation, initial phoneme isolation, and phoneme blending) for use with hearing 4 year olds. In our study, we administered these same four subtests and followed the modifications for off-level administration developed by Webb and colleagues. These included providing three practice items with feedback, repeating a practice item if children were distracted during testing, and using discontinuation rules. For the syllable segmentation task, we also changed the child response from clapping to touching a dot for each syllable because clapping made it difficult to hear the words. Psychometric analyses by Webb and colleagues (Webb et al., 2004; Webb & Lederberg, 2012) suggest the test performances (measured in raw scores) are valid indicators of hearing and DHH children’s phonological awareness skills. Due to off-level administration, normative data (standard scores,

percentiles) are not available, and results are reported as raw scores.

A brief description of tests follows (see Webb et al., 2004, for more detailed information). Each subtest contained 10 test trials. For the syllable segmentation test, the assessor said “Touch the dot one time for each syllable in the word.” (*Spoken word presented*). For the rhyme recognition subtest, the assessor asked, “Do these words rhyme?” (*A set of two words presented*.) For the initial phoneme isolation subtest, the assessor asked “What is the beginning sound in the word \_\_\_?” (*spoken word presented*). Finally, for the phoneme blending subtest, the assessor asked, “What word do these sounds make?” (*Phonemes of a word presented one at a time*.) The difficulty of trials increased from two phonemes up to five phonemes. All of the stimuli for these four subtests were presented without pictures.

Assessors also administered a rhyme recognition test developed by Byrne and Fielding-Barnsley (1991). It consisted of 10 trials with the target depicted by a line drawing (e.g., a house) with three line drawings (e.g., a mouse, a bed, and a cake) positioned in a line below it. The child had to select the object that rhymed with the target.

### Procedures

The order of conditions was baseline followed by sequential explicit instruction of syllable segmentation, initial phoneme isolation, and rhyme recognition. While intervention occurred in groups, analysis of data involved individual performance because instruction and criteria were based on individual performance. Four subtests of the PAT-2 (Robertson & Salter, 2007), and a rhyme recognition test (Byrne & Fielding-Barnsley, 1991) were utilized as generalization probes.

As is typical in single-case studies, teachers administered all baseline and intervention probes. The first author, who was not a research teacher, created the probes and modeled them after assessments used by other literacy researchers (Phaneuf & Silberg, 2003; Robertson & Salter, 2007). Teachers administered these assessments to children individually, while instruction occurred in small groups.

**Baseline.** Collection of initial baseline data occurred for all three phonological skills during the two weeks

prior to beginning phonological awareness instruction. Additional baseline probes occurred in the week prior to the instruction of a new skill. For initial phoneme isolation, this additional baseline probe was inadvertently missed for two students, Owen and Sawyer.

**Intervention.** Phonological awareness instruction was embedded within the *Foundations* intervention. During the first month of intervention, teachers explicitly taught the vocabulary necessary to understand phonological awareness instruction (e.g., word, sound, and beginning). In subsequent months, teachers taught syllable segmentation, followed by initial phoneme isolation, and then rhyming. Each phonological skill began with three to five weeks of explicit instruction, followed by practice activities. While initial explicit instruction for each phonological awareness skill was separated in time, practice activities for each skill continued after introduction of the next skill with the frequency and type of practice activities based on children’s performance. Because of vacations and school activities, the timing of these phases differed slightly across the two research settings. Because instruction was embedded within *Foundations*, the exact amount of time that teachers implemented phonological awareness activities varied. Coding of videotapes of *Foundations* instruction showed that teachers and students spent between 8 and 9% of instructional time engaged in activities focused on the three phonological awareness skills.

**Syllable segmentation.** Initial explicit instruction of syllable segmentation occurred twice weekly for three consecutive weeks, followed by twice weekly practice activities for five weeks, and then less frequently throughout the school year. Syllables were introduced by clapping “word parts.” Instruction included activities such as dividing two-syllable compound words into two words and tapping the syllables of known vocabulary words. Teachers also spontaneously addressed syllable segmentation during other activities (e.g., during book reading, “Let’s clap the word parts in Ferdinand.”) Once students mastered the task, teachers increased the difficulty of the segmentation task from clapping to counting syllables and producing

the correct number either verbally or by matching a picture of the word to the numeral representing the correct number of syllables.

*Initial phoneme isolation.* Explicit instruction of initial phoneme isolation occurred twice weekly for four consecutive weeks, followed by continued explicit instruction and practice activities for the rest of the school year. Initial phoneme isolation was coordinated with instruction on grapheme–phoneme correspondences. After children learned a grapheme–phoneme correspondence (typically one per week), teachers incorporated words that started with the taught phoneme in initial phoneme isolation instructional activities. Teachers also used graphemes to support learning as illustrated in the following example. Pointing to a pocket chart that displayed the graphemes ‘m’ and ‘e’, the teacher said the two corresponding phonemes. Then, holding up a picture, the teacher named the picture emphasizing the initial phoneme (e.g., “Mmmilk, what is the beginning sound in mmmilk?”). If the child responded with the appropriate (or that child’s consistent approximation) phoneme /m/, the teacher provided positive feedback (e.g., “That’s right. Milk begins with mmm”) giving the child the picture to place in the pocket labeled with the correct grapheme. If the child responded incorrectly, the teacher provided corrective feedback using contrasting choices (e.g., “Listen, /e/, milk,” pause “/m/, milk. What is the beginning sound in mmmilk?”) and gave the child the opportunity to respond correctly and put the picture in the grapheme labeled pocket. Each child received at least two opportunities per session. Each week, the teachers added a new grapheme to the pocket chart after the children learned the grapheme–phoneme correspondence (with a maximum of six graphemes).

After four weeks of explicit instruction, the teacher continued initial phoneme isolation activities the rest of the year. The words used in these activities increased in variety of initial phonemes and included untaught and taught phonemes. The teachers also used practice activities that included isolation of phonemes for pictured words without graphemes displayed and isolation of phonemes through spoken words only (without picture support). Thus, as children’s skills improved, teachers decreased and then removed the

visual supports and provided auditory-only stimuli and spoken-only responses using taught and untaught phonemes.

*Rhyme recognition.* Initial explicit instruction of rhyme recognition occurred twice weekly for four consecutive weeks followed by four weeks of practice activities. Teachers introduced rhyme recognition using a target word and a rhyming word and nonrhyming word as a contrast. The concept of ‘same’ and ‘alike’ had been pretaught. The teacher explained that rhyming words sound alike (the same). The teacher would first model an example and then conclude that the target and rhyming word rhymed (e.g., “Moon, spoon. They sound alike. Moon and spoon rhyme.”) The teacher then would present a target word in two pairs, once with a nonrhyming word and once with a rhyming word (e.g., “Listen! Which words rhyme? Moon, hat? Moon, spoon?”). When the rhyming pairs were presented, pictures of the words were placed face down on the table, and the child was encouraged to listen as the teacher said the pair of words. Only during the feedback phase were the pictures turned over. Additional rhyming activities involved sorting pictures into rhyming families, matching pictures into rhyming pairs, and determining if two words rhymed by answering ‘yes’ or ‘no’. Students who had mastered rhyme recognition had opportunities to generate a rhyme when presented with a target.

*Treatment fidelity.* Graduate students were trained in observing the essential elements of instruction for each phonological awareness skill as listed in Table 2. We conducted fidelity on each phonological awareness skill for 25% or more of instructional time. To determine fidelity, we divided the number of times an essential element was observed in a session by the number of sessions observed. The resulting percentages by skill and program are reported in Table 2. Results show that there was high fidelity except for instruction of rhyme for the signing children where the teacher focused more on the forced choice aspect of instruction.

*Data analysis.* As is characteristic of single-case design, each individual served as his or her own control. Data were graphed and subjected to visual analysis to



**Table 2** Treatment fidelity

Phonological awareness activity	Groups by program		
	Auditory/oral	Signing	Averages
Segmentation			
Teacher models segmenting word into target units (multisyllable compound words; %)	100.00	100.00	100.00
Concurrently, teacher provides visual-kinesthetic representation of segments (pointing to words, pointing to blocks, and clapping; %)	88.89	100.00	94.45
Teacher prompts children to segment words (%)	100.00	100.00	100.00
Child attempts to segment (%)	100.00	100.00	100.00
Teacher gives corrective feedback (%)	100.00	100.00	100.00
Total percentage observed for segmentation (%)	97.78	100.00	98.89
Initial sound isolation			
Teacher models initial sound by producing the word and its initial sound (%)	100.00	100.00	100.00
Teacher prompts children to give initial sound when presented with a word (%)	100.00	100.00	100.00
Child attempts to give initial sound (%)	100.00	100.00	100.00
Teacher gives corrective feedback (%)	100.00	100.00	100.00
Total percentage observed for initial sound (%)	100.00	100.00	100.00
Rhyme recognition			
Teacher models rhyming by presenting words that rhyme (%)	100.00	0.00	50.00
Teacher prompts children to listen or close their eyes and listen (%)	100.00	50.00	75.00
Teacher prompts children to say a rhyming word when presented with a target word and word choices or to say yes or no when given a pair of words and asked if they rhyme (%)	100.00	100.00	100.00
Total percentage observed for rhyming (%)	100.00	50.00	75.00

assess the levels of outcomes, trends, and variability across the baseline and intervention phases (Kazdin, 1982). Mastery criterion for each of the skills was set at 80% of test items for a test probe. For each child, we calculated mean percentage correct during baseline and mean percentage correct on all intervention probes. We also calculated the mean percentage correct for the last three data points as this may be more indicative of the effect of intervention because we expected children would learn these skills slowly. Percent of nonoverlapping data (PND) was also calculated. PND is the percentage of intervention data points falling above the highest baseline data point divided by total number of intervention data points, and it has been interpreted as a way to measure effect size for single-case studies (Scruggs, Mastropieri, & Casto, 1987).

## Results

### Individual Performance

We next describe each child's performance during baseline and intervention. Figures 1–5 display children's performance. The dotted line indicates when intervention was initiated, with baseline probes to the left and

intervention probes to the right. Time was measured as the number of instructional sessions. For each child, we summarize the findings, followed by the detailed results for each phonological awareness skill, including results from the generalization assessments. For initial phoneme isolation, we also report how children performed on taught initial phonemes (defined as words that started with a phoneme that the children knew the corresponding grapheme–phoneme correspondences) compared with words with untaught phonemes.

*Derek.* At study onset, Derek was a 3-year 9-month-old male amplified with binaural CIs, participating in the oral program. His age equivalent for receptive language was 4 years 0 months and 3 years 4 months for expressive language as revealed on the PPVT-4 and EOWPVT, respectively.

*Syllable segmentation.* Visual inspection of Figure 1 shows Derek's performance steadily increased during baseline, and he reached mastery by the first intervention probe, which he maintained throughout the year. His mean baseline performance was 30%. His intervention mean was 82%, with a final mean of 83%

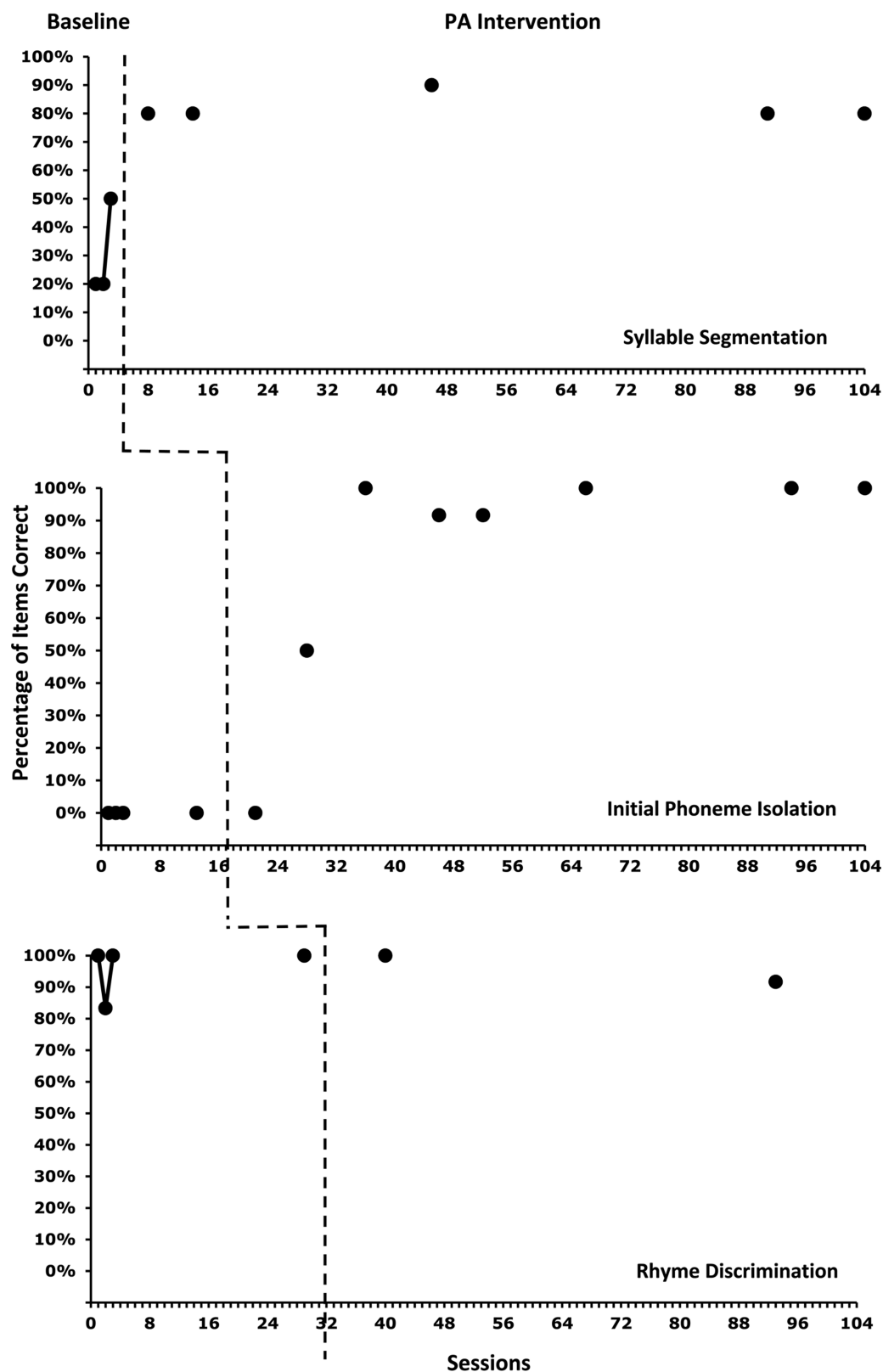


Figure 1 Acquisition of phonological awareness skills by Derek, a bilateral cochlear implant (CI) user, age 3 years and 9 months at study onset with an early speech perception (ESP) score of 4, and who used spoken language to communicate.

across the last three data points. PND was 100%. On the PAT-2 syllable segmentation subtest, Derek increased his scores from 0 at pretest to 9 at posttest, providing further evidence that he learned how to segment words into syllables as a result of the intervention.

*Initial phoneme isolation.* Prior to instruction, Derek was unable to isolate any initial phonemes. After instruction, his performance improved, reaching mastery on the third probe. His mean baseline performance was 0%. His intervention mean was 79%, with a final mean of 100% across the last three data points, indicating he had reached ceiling on this task. PND was 88%. Derek did not show that isolating initial phonemes was easier for taught compared with untaught phonemes. For example, he isolated two of four taught phonemes and four of eight untaught phonemes on the second instructional probe. On the PAT-2 initial phoneme isolation subtest, Derek increased his scores from 0 to 9.

*Rhyme recognition.* Derek was able to recognize rhymes before instruction, with a mean baseline performance of 96% and a 9 on rhyme recognition test. Surprisingly, on the PAT-2 rhyme discrimination test, Derek received a 0 at pretest and only 6 at posttest, which is only slightly above chance.

Visual inspection of Derek's graph (Figure 1) revealed (a) he began learning syllable segmentation during baseline and reached mastery quickly after instruction, (b) a functional relationship existed between instruction and performance on initial phoneme isolation probes, and (c) he had mastery of rhyme recognition at baseline. Derek showed additional evidence of phonological awareness growth on the PAT-2 phoneme blending subtest, with a pretest score of 0 and a posttest score of 6.

*Harrison.* At study onset, Harrison was a 4-year 4-month-old male, amplified with binaural CIs, and participating in the oral program. His age equivalents on the PPVT-4 and EOWPVT were 3 years 3 months and 3 years 7 months respectively.

*Syllable segmentation.* Harrison did not segment syllables at baseline. His performance slowly increased

during instruction, but he did not reach mastery until the last two instructional probes. His mean baseline performance was 10%. His intervention mean was 59% and 77% across his last three data points. Harrison's research teacher reported that Harrison had some difficulty with motor control and his tapping was not always in sync with his speaking of the syllables. During the latter part of the year, the task of identifying the correct number of syllables when presented with a target word appeared to be easier than tapping or clapping for Harrison. On the PAT-2 subtest, Harrison had a pretest score of 0 and a posttest score of 5.

*Initial phoneme isolation.* Harrison was not isolating initial phonemes at baseline, and steadily increased his performance, reaching criterion at the fifth instructional probe. His mean baseline performance was 6%. His intervention mean was 73% with a mean of 94% across the last three data points. PND was 100%. Whether words began with taught or untaught phonemes did not appear to have an influence on Harrison's ability to isolate initial phonemes. In the first two probes, he isolated the initial phonemes of one out of three and one out of four words beginning with taught phonemes and two out of nine and three out of eight words beginning with untaught phonemes. On the third probe, Harrison isolated initial phonemes of five out of five words beginning with taught phonemes and five out of seven words beginning with untaught phonemes. On the PAT-2 subtest, his scores increased from 0 to 9 across the school year.

*Rhyme recognition.* Harrison showed relatively good performance during baseline (mean 64%), and he met rhyme performance criterion by the second instructional probe. His intervention mean was 77%, with a mean of 83% across the last three data points. PND was 50%, which is further indication of some skill level during baseline. The rhyme recognition and PAT-2 rhyme discrimination generalization tests showed that Harrison could recognize rhyme at pretest (scores of 6 and 5, respectively), but there was some improvement at posttest (7 and 9, respectively).

Visual inspection of Harrison's graph (Figure 2) suggested that (a) there were functional relationships between relevant instruction and acquisition of syllable

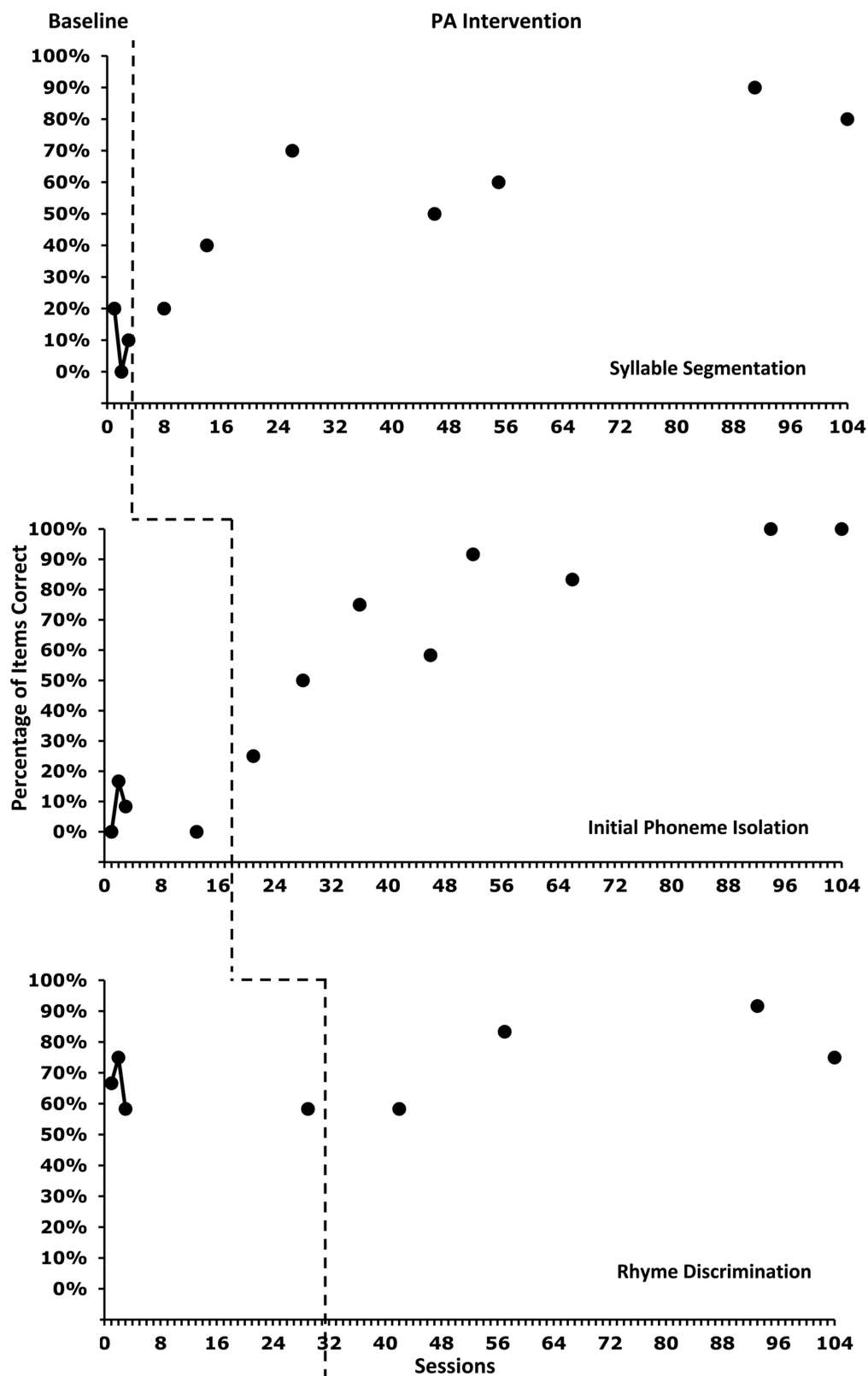


Figure 2 Acquisition of phonological awareness skills by Harrison, a bilateral CI user, age 4 years and 4 months at study onset with an ESP score of 4, and who used spoken language to communicate.

segmentation and initial phoneme isolation, and (b) he began the year showing some ability to recognize rhyme, which only slowly improved with instruction. On the PAT-2 phoneme blending subtest, Harrison had a pretest score of 0 and a posttest score of 1.

*Rebecca.* At study onset, Rebecca was a 3-year 3-month-old female with a PTA of 62, amplified with binaural hearing aids (HAs), and participating in the oral program. Her age equivalents on the PPVT-4 and EOWPVT were 3 years 8 months and 3 years 2 months, respectively.

*Syllable segmentation.* Rebecca reached the criterion of 80% on the second and third baseline probes, showing mastery prior to instruction. She had a mean intervention performance of 84%. The PAT-2 subtest increased from 0 to 10 across the school year.

*Initial phoneme isolation.* Rebecca's baseline performance was unstable, with two probes that showed some skills, while the last baseline probe was 0. With instruction, she steadily and relatively quickly improved her performance, reaching criteria on the fourth probe and maintaining perfect scores for the rest of the year. Mean baseline performance was 33%. Her intervention mean was 73% with a mean of 100% across her last three data points. PND was 71%. Her scores increased across the school year from 0 to 10 the relevant PAT-2 subtest. These results show that Rebecca was able to isolate initial phonemes with a high level of consistency at the end of the year. No effect was seen in her ability to isolate words beginning with taught verses untaught phonemes.

*Rhyme recognition.* Rebecca had unstable and at times good performance during baseline. After instruction, she only slowly improved her performance and did not reach mastery until the end of the school year. Her mean baseline performance was 38%. Her intervention mean was 70% with a mean of 86% across the last three data points. Variability in performance during baseline and the first half of intervention accounted for the low PND score of 60%. The rhyme recognition and PAT-2 rhyme discrimination subtests showed that Rebecca

could recognize rhyme at pretest (scores of 4 and 6, respectively), but there was some improvement at posttest (7 and 9, respectively).

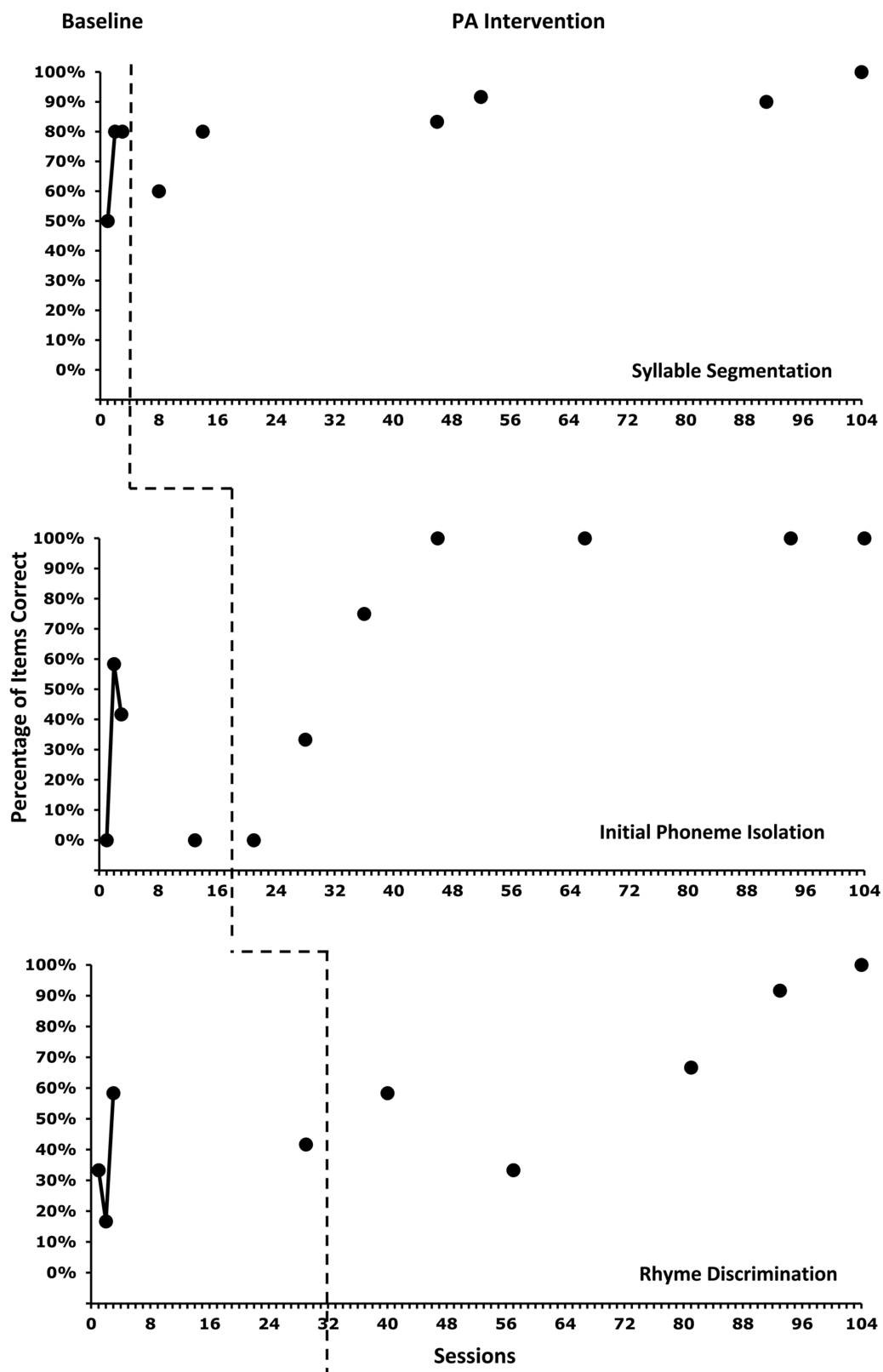
Visual inspection of Rebecca's graph (Figure 3) revealed (a) Rebecca achieved mastery for syllable segmentation during baseline, and (b) some evidence for functional relationships between relevant instruction and performance on initial phoneme isolation and rhyme recognition probes. Rebecca had a score of 0 on both the pretest and posttest on the PAT-2 phoneme blending subtest.

*Sawyer.* At study onset, Sawyer was a 4-year 9-month-old male with a PTA of 55, amplified with binaural HAs, and participating in the sign program. His age equivalents on the PPVT-4 and EOWPVT were 3 years 4 months and 3 years 5 months respectively.

*Syllable segmentation.* Sawyer's performance rapidly increased during baseline but did not reach mastery until the third instructional probe. His mean baseline performance was 34%. His intervention mean was 86% with a mean of 87% across the last three data points. The PND for syllable segmentation was 100%. Pretest to posttest scores on the PAT-2 syllable segmentation increased from 0 to 5, which shows improvement, but was lower than his performance on the syllable segmentation probes.

*Initial phoneme isolation.* Prior to instruction, Sawyer was unable to isolate initial phonemes, with a mean baseline performance 0%. Sawyer increased his performance slowly during intervention, reaching mastery on the fourth intervention probe. His mean intervention performance was 67%, with a mean of 100% across the final three data points. The PND for initial phoneme isolation was 100%. Sawyer initially isolated more taught phonemes than untaught phonemes. On the first two intervention probes, he isolated two of three and three of four phonemes of words beginning with taught phonemes and zero of nine and one of eight of words beginning with untaught phonemes. However, by the third probe, Sawyer isolated three of five taught phonemes and three of seven untaught phonemes, suggesting he had





**Figure 3** Acquisition of phonological awareness skills by Rebecca, a bilateral hearing aid user, age 3 years and 10 months at study onset with an ESP Score of 4, and who used spoken language to communicate.

begun to generalize this skill to untaught phonemes. On the PAT-2, Sawyer increased his scores from 0 to 10 over the school year, reaching ceiling on this test.

*Rhyme recognition.* During baseline, Sawyer consistently scored at chance, with a mean baseline performance of 35%. He reached mastery on the first instructional probe. His mean intervention performance was 97%, with a mean of 95% across the final three data points. The PND for rhyme recognition was 100%. Pretest performance on the generalization tests suggested Sawyer may have started the year with more understanding of rhyme than was revealed during baseline assessments. His pretest scores were 6 on the rhyme recognition test and 7 on the rhyming discrimination subtest of the PAT-2. He scored a 10 on both tests at posttest.

Visual inspection of Sawyer's graphs (Figure 4) revealed that (a) he began to acquire syllable segmentation during baseline, and (b) he showed a functional relationship between relevant instruction and learning to isolate initial phonemes and to recognize rhymes. Sawyer's pretest score on the phoneme blending subtest of the PAT-2 was a 0 and his posttest score was 4 providing further evidence of phonological awareness growth.

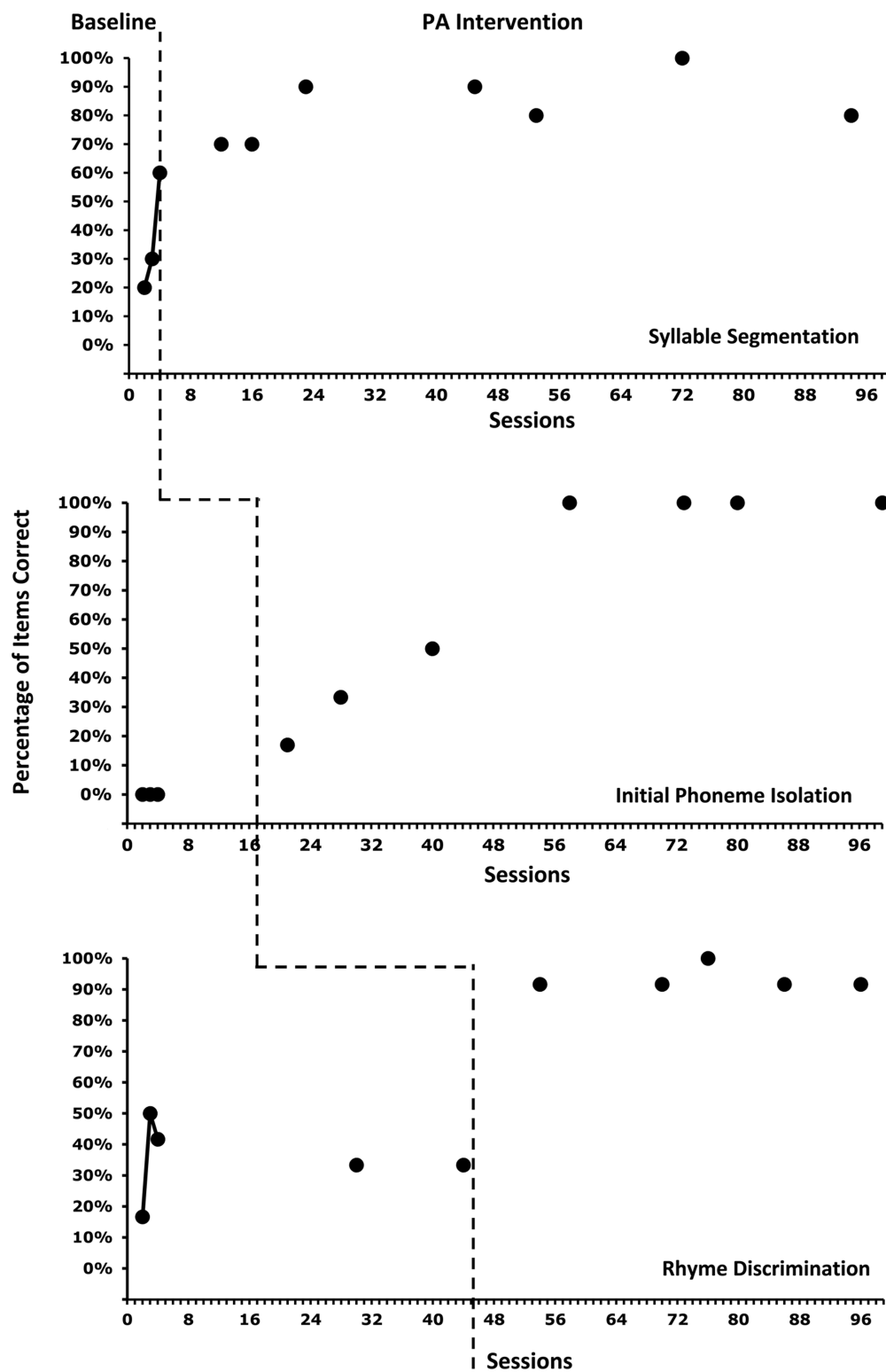
*Owen.* At study onset, Owen was a 5-year 1-month-old male with a PTA of 110, amplified with a single CI, and participating in the sign program. His age equivalents on the PPVT-4 and EOWPVT were 3 years 8 months and 2 years 4 months respectively.

*Syllable segmentation.* Owen consistently scored at 20% during baseline. While performance improved during the instruction phase, he never reached mastery. His baseline mean was 20%. His intervention mean was 39% and a mean of 47% across the final three data points. PND was 86%. His score on the PAT-2 syllable segmentation test improved from 0 to 6, suggesting that he was acquiring this ability. Owen primarily used sign to communicate. His teacher reported that Owen had difficulty repeating multisyllabic spoken words, and that the number of taps often matched his production of the word.

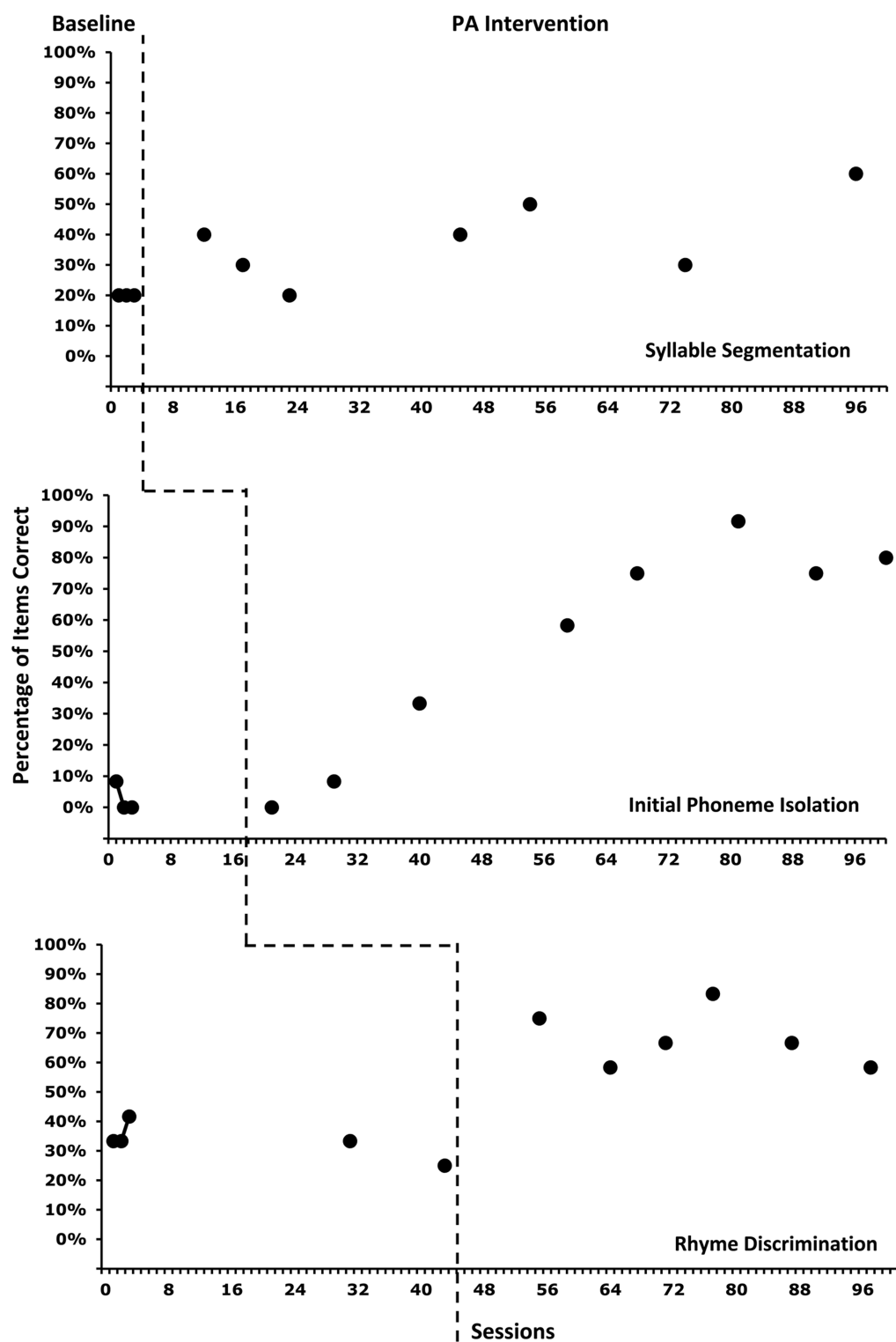
*Initial phoneme isolation.* Prior to instruction, Owen was unable to isolate initial phonemes. He showed a slow but steady improvement with instruction, reaching mastery on the fifth instructional probe. His mean baseline performance was 3%. His intervention mean was 50%, and his mean across the last three data points was 83%. The PND was 71%. Owen's ability to isolate initial phonemes appeared, at least to begin with, to depend upon his knowledge of phonemes. On the second, third, and fourth probes, Owen only isolated initial phonemes in words beginning with taught phonemes and none beginning with untaught phonemes. On the fifth probe Owen isolated seven of eight taught and two of four untaught phonemes and by the sixth probe he isolated eight of eight taught and three of three untaught indicating that he did begin to generalize the skill of isolating initial phonemes from taught to untaught phonemes, but later than that of the other children in the study. On the PAT-2 subtest, he improved from 0 to 5.

*Rhyme recognition.* Prior to instruction, Owen consistently performed at chance levels. With instruction, his performance rapidly improved but did not reach mastery criterion until the fourth instructional probe, and then his performance fell below criterion again. His mean baseline performance was 33%. His intervention mean was 68%, and he had a mean of 69% across his last three data points. PND was 100%. Although performance was unstable for instructional probes, performance on generalization tests showed considerable improvement. At pretest, Owen scored 0 on both tests. His posttest scores were 8 and 6 on the rhyme discrimination subtest and rhyme recognition test, respectively.

Visual inspection of Owen's graph (Figure 5) revealed that (a) while showing improvement with instruction, he did not show mastery for syllable segmentation; (b) there was a functional relationship between instruction and performance for initial phoneme isolation; and (c) although Owen showed mastery on one intervention probe for rhyme recognition, criterion was not maintained. Owen's pretest and posttest score on the PAT-2 phoneme blending subtest was 0. Of the five participants, Owen showed the least amount of growth in phonological awareness. He



**Figure 4** Acquisition of phonological awareness skills by Sawyer, a bilateral hearing aid user, age 4 years and 9 months at study onset with an ESP Score of 4, and who used both spoken language and signs to communicate.



**Figure 5** Acquisition of phonological awareness skills by Owen, a unilateral CI user, age 5 years and 1 month at study onset with an ESP Score of 3, and who used signs and some spoken language to communicate.

also had the weakest speech perception and expressive vocabulary abilities (see Table 1).

### Summary of Five Participants

For syllable segmentation, the four students' mean performance during baseline was 23% (range 10–34%) with a performance increase to 66% (range 39%–86%) during intervention with a last three data point group mean of 74%. Rebecca reached criteria for segmentation during baseline and therefore her scores are not included above. Overall, for initial phoneme isolation, the mean performance for the five students during baseline was 8% (range 0–33%). Group performance increased in initial phoneme isolation to a mean of 68% (range 50–79%) with a mean of 95% across the last three data points. During rhyme discrimination baseline, Derek reached mastery criterion. The mean performance for the remaining four students was 43% (range 33–65%) for baseline. The group increased in performance of rhyme discrimination to a mean of 73% (range 68–79%) and a mean of 83% across the last three data points.

### Discussion

NELP (2008) established hearing preschoolers can be taught phonological awareness, and such instruction results in improved reading abilities in elementary school. Furthermore, evidence exists that school-age DHH children who have functional hearing possess phonological awareness skills (Johnson & Goswami, 2010; Spencer & Tomblin, 2009). However, with the exception of 1 six-week case study (Smith & Wang, 2010), we have scant evidence that DHH preschool children with functional hearing can develop phonological awareness. The purpose of this study was to examine the effects of explicit instruction on the phonological skills of young DHH children with the ability to understand spoken language. Explicit phonological awareness instruction was embedded in a balanced emergent literacy intervention, *Foundations for Literacy*. We found, with a few exceptions, that instruction was effective in teaching DHH preschoolers the three target phonological awareness skills.

First, we asked, can DHH preschoolers with functional hearing learn to segment spoken words into syllables? Four of the five children were able to segment

words consistently with one to four syllables by the end of the study. For these children, syllable segmentation seemed a relatively easy skill to acquire. One child, Rebecca, met mastery during baseline and two others, Derek and Sawyer, began acquisition during baseline. Baseline assessments included modeling and explicit instruction during the three practice items. For these two children, three sessions with the modeling and practice items appeared to be enough to begin learning the skill.

In contrast, for Owen, syllable segmentation was the hardest skill. The research teacher reported that Owen had difficulty producing multisyllabic words. Because children were expected to say the word while tapping the syllables, speech production is likely an important skill for phonologically segmenting words into syllables. The features of syllable segmentation instruction found in *Foundations* that supported the children's learning were (a) explanation that words have word parts or syllables, and (3) modeling accompanied by visual/kinesthetic representation of each syllable as it is produced through either tapping or clapping. These components were also part of the syllable segmentation assessment, which may explain the skill acquisition during baseline.

The next question posed was, can these children learn to recognize words that rhyme? Derek was able to recognize words that rhymed during baseline, and there was evidence that Harrison's ability to do so was emerging. For Sawyer, Owen, and Rebecca a functional relation between rhyme instruction and rhyme recognition was apparent. Sawyer quickly obtained the skill upon instruction; however, Owen had difficulty maintaining complete mastery of this skill, and maintenance for Rebecca was uncertain as mastery was obtained so late in the study. Because both Rebecca and Owen performed better on the PAT-2 rhyme discrimination posttest than they did on the rhyme recognition posttest, their relatively poor performance may have been attributable to two features of the probes. The rhyme recognition probes utilized pictures, which may have been confusing because the goal was an auditory association and not a visual one. Trials also had three choices that required holding items in short-term memory prior to answering. Practice of a similar task during the intervention had only two choices.



For the four children who had not mastered rhyming prior to the study, rhyme instruction utilizing *Foundations* was effective. It included (a) preteaching the concepts of 'alike' and 'same'; (b) saying a target and then a nonrhyming word as a contrast, and then the target again, then the rhyming word, then saying the rhyming pair again with emphasis; (c) modeling of a pair of rhyming words at the beginning of rhyme activities; and (d) providing practice with rhyme recognition, rhyme discrimination, and rhyme families.

Our third research question was can these children learn to isolate the beginning phoneme in words, and if so, do they use their alphabet knowledge when isolating beginning phonemes? All five students reached the mastery level and maintained it once it was achieved. A clear functional relation between instruction and initial sound isolation was demonstrated. In examining whether the children were dependent upon their alphabetic knowledge in isolating initial phonemes, we found that four of the children were not. Derek, Sawyer, Harrison, and Rebecca were able to isolate initial phonemes in words beginning with both taught and untaught phonemes rather quickly. However, Owen's ability to isolate initial phonemes depended on grapheme-phoneme correspondence instruction, as he was able to isolate words only beginning with taught phonemes for the majority of the study. Because he had less speech perception than the other children and difficulty with speech production, it was likely that he initially needed the practice of hearing and saying phonemes in isolation in order to isolate them at the beginning of words.

The results of this study showed that the instructional method utilized in *Foundations* is highly effective in teaching initial sound isolation to the participants. This method combines (a) preteaching of the concepts of "word," "sound," and "beginning"; (b) explicit instruction, initially utilizing only words beginning with phonemes that have been taught during grapheme-phoneme correspondence instruction; (c) utilizing a closed set of graphemes initially to provide visual support for phoneme isolation; and (d) gradually shifting to more general skill development with instruction and practice that included auditory-only presentation of words and words that did not start with taught phonemes.

We examined if individual differences in language, functional hearing, or chronological age affected learning of these skills and the rate of acquisition of these skills. In this study, Derek, Sawyer, Harrison, and Rebecca had consistent word recognition of spoken language (i.e., ESP score of 4) and were binaurally amplified. Owen had less speech perception (i.e. ESP score of 3) and was unilaterally amplified. As stated earlier, Owen was the only child who did not master consistent segmentation of words into syllables. Additionally, he was the only child whose ability to isolate initial phonemes was dependent upon his knowledge of phonemes (i.e., taught vs. untaught). In this study, auditory perception of spoken language appeared to have an influence on phonological awareness development. As this conclusion rests on one child, it is evident that further research is needed. Owen had fewer expressive language skills (i.e., age equivalent of 2.4 on the EOWPVT in which signed and/or spoken answers were accepted) than the other children, which cannot be ruled out as a contributing factor to his performance.

Visual inspection of the graphs showed that the time required for skill acquisition varied greatly by both child and skill. While the children varied along a number of variables (i.e., communication mode, language, and chronological age) that might be expected to affect phonological awareness, these did not appear to relate to individual differences in learning. The use of sign language did not interfere with the development of spoken phonological awareness for deaf children with functional hearing as two of the children used sign language. Age and language also appeared not to have an influence on being able to acquire phonological awareness skills. Derek, the youngest child, was able to detect rhymes at the onset of the study and learned to segment syllables and isolate initial sounds much more quickly than the other children.

We found that phonological awareness took weeks and sometimes months to develop. This is in contrast to the speed with which other DHH children learned grapheme-phoneme correspondences (e.g., see single-subject results reported in Beal-Alvarez et al., 2011; Bergeron et al., 2009). This extended period of learning is not surprising as phonological awareness requires skill development that emerges over time (e.g., learning to determine initial sound must be applied to

multiple words), unlike knowledge acquisition that is often learned more quickly (e.g., learning that the letter b says /b/).

We must note that phonological awareness instruction in this study differed from typical techniques of reading instruction for hearing children. It also differed from previous studies involving DHH children in which instruction utilized curricula developed for hearing children with adaptations provided via Visual Phonics or Cued Speech (Colin et al., 2007; Guardino et al., 2011; Narr, 2008; Smith & Wang, 2010; Trezek et al., 2007). We designed *Foundations* to incorporate instructional techniques that are fundamental to teaching DHH children by providing teachers with strategies that specifically target varying degrees of language and functional hearing.

### Limitations and Future Research

Our study shows that young DHH children can learn phonological awareness skills with explicit instruction. We cannot state that other instructional techniques to teach the same skills would not be equally beneficial. Due to the integrative nature of the intervention, with instruction of phonological awareness linked to instruction of grapheme–phoneme correspondences, we also cannot state that the instructional strategies utilized in this study will work outside the context of *Foundations*.

Another limitation to this study was the lack of an assessment of social validity, which is typically included in single-case research. Input from parents or classroom teachers would have provided an objective viewpoint. Another potential limitation is that the primary developer of *Foundations* and first author of this paper developed the assessments used to measure growth, and supervised the research teachers. We attempted to control for this by having independent assessors test the children with standardized tests at the beginning and end of the school year. However, these assessments were not double-scored for reliability, which is an additional limitation. The results of these measurements did support those of our single-case results. The beginning of instruction of a new skill prior to the mastery of the previous skill may also be seen as a limitation; however, research with hearing children has shown that phonological awareness skills need not be mastered prior to the introduction of a more complex skill (Anthony et al., 2003).

The small sample of this study and the restriction to only DHH children with functional hearing limits the generalization of the results to all DHH children. Future research should focus on how to adapt instruction and learning objectives for children with little or no functional hearing. For example, the ability to segment syllables may require the support of a multisyllabic word in print and therefore must wait until the child is reading. However, the understanding that words have syllables may be introduced at the preschool level as a pattern perception activity. Furthermore, research should address how DHH children who are developing phonological skills are using them in decoding words and the reading process.

### Conclusions

Due to the advances in technology, a large number of DHH children can perceive spoken language (i.e., have functional hearing; Easterbrooks et al., 2008). Phonological awareness and alphabet knowledge are foundational to mapping spoken language onto the printed word. Many DHH children with functional hearing are not developing age-appropriate phonological awareness (Ambrose et al., 2012; Easterbrooks, et al., 2008; Spencer & Tomblin, 2009; Webb & Lederberg, 2012). Our study suggests that such phonological awareness development is possible even for those with delayed language and at very young ages. Though phonological awareness has not typically been a part of the reading instruction of DHH children (LaSasso & Mobley, 1997), teachers should know that such development is possible, at least for children with functional hearing. Based on this study, explicit instruction in early phonological awareness skills may provide DHH children with functional hearing the ability to manipulate the sounds in spoken language, which along with alphabetic knowledge is the foundation for learning to decode words and read with a level of functional proficiency.

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## Conflicts of Interest

No conflicts of interest were reported.

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