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Building the Alphabetic Principle in Young Children Who Are Deaf or Hard of Hearing

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Acquisition of phoneme-grapheme correspondences, a key concept of the alphabetic principle, was examined in young children who are deaf or hard of hearing (DHH) using a semantic association strategy embedded in two interventions, the Children's Early Intervention and Foundations for Literacy. Single-subject design experiments using multiple baselines across content were used to examine the functional relationship between student outcomes and the intervention provided. Only students who were able to identify spoken words were included in the studies. Study One was conducted with 5 children 3.10–7.10 years of age in oral or signing programs. Study Two was conducted with 5 children 3.10–4.5 years of age in an oral program. All children acquired taught phoneme-grapheme correspondences. These findings provide much-needed evidence that children who are DHH and who have some speech perception abilities can learn critical phoneme-grapheme correspondences through explicit auditory skill instruction with language and visual support.

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Introduction

Children and youth who are deaf or hard of hearing (DHH) frequently fail to attain proficient reading skills by the time they reach high school, a trend that has been well documented over the past three decades (Holt, 1994; Traxler, 2000). At the same time, educators of children who are DHH have endeavored to find appropriate and effective instruction for literacy skill development with limited success. For children with typical hearing, an auditory-based skill, such as the alphabetic principle (the knowledge that letters represent *phonemes* in spoken language and are blended to make spoken words), is considered an essential component of literacy development (National Reading Panel, 2000). The purpose of the current study is to determine the effectiveness of an intervention focused on the building of phoneme-grapheme correspondences, which is the foundation of the alphabetic principle, when implemented with young children who are DHH.

Traditional reading instruction in the education of children who are DHH has focused on the development of language and vocabulary (Spencer, Tomblin, & Gantz, 1997) rather than on instruction of the alphabetic principle because of the children's lack of spoken word knowledge (Schirmer, 2001). For example, in a 1997 survey, more than 70% of teachers who work with children who are DHH stated that they used special basal readers and language experience approaches to teach reading (LaSasso & Mobely, 1997). Perfetti and Sandak (2000) posited that lack of phonological representation of words was a factor in the lower literacy levels among students with severe to profound hearing losses: "[there is a] fundamental discrepancy between their incomplete spoken language system and the demands of reading a speech-based system" (p. 47).

In the past 10 years, more sophisticated technology, including cochlear implants, has mitigated at least some of the documented barriers to the development of an auditory-based phonological foundation for reading in children who are DHH. Federally mandated Newborn Hearing Screening (1993) has also allowed children who are DHH access to this technology and early intervention services at a much earlier age. Cochlear implants provide substantial auditory information as well as improved speech perception abilities for children who do not benefit from conventional amplification (Cheng, Grant, & Niparko, 1999; Spencer & Oleson, 2008). For children with hearing aids, improved technology has resulted in amplification that more closely matches their hearing loss, which allows for an overall increase in the quality and comprehension of sound (Parker, 2002).

These changes have yielded a new generation of children who are DHH. Easterbrooks, Lederberg, Miller, Bergeron, and Connor (2008) found that more than 70% of children ages 3 to 7 years who attended either signing or oral self-contained DHH classrooms in a large metropolitan area and who had no additional disabilities were able to identify spoken words. Compared to previous

generations, a greater number of children who are DHH may now have the ability to read using processes similar to those used by children with typical hearing. In other words, many children who are DHH have a more complete representation of spoken language than previous generations.

Building the Alphabetic Principle

Alphabetic knowledge, the foundation of the alphabetic principle, is defined as the knowledge that "written graphemes correspond to the phonemes of spoken words" (Scarborough & Brady, 2002, p. 322). The earliest building block of this skill is learning phoneme-grapheme correspondences. Higher levels of this letter knowledge are associated with a child's ability to detect and manipulate phonemes (Stahl & Murray, 1994). The letter knowledge of children with typical hearing in preschool, kindergarten, and first grade is predictive of their growth in phonological awareness over a one- to two-year period (Burgess & Lonigan, 1998; National Early Literacy Panel Report, 2009). For children who are DHH with spoken language abilities, Easterbrooks and others (2008) found that alphabetic knowledge, as measured by the number of phoneme-grapheme correspondences children knew, strongly correlated with phonological awareness and early literacy skills concurrently and over time. Unfortunately, many children who are DHH still have weak alphabetic knowledge (Aram, Most, & Mayafit, 2006; Easterbrooks et al., 2008).

The National Reading Panel (2000) and the more recent National Early Literacy Panel (NELP, 2009) reported that for children with typical hearing, regardless of socioeconomic status, explicit instruction in building alphabetic knowledge strongly supports reading development, as it contributes to growth in decoding, comprehension, and spelling. For children who are DHH, Schirmer and McGough (2005) concluded that, at the time of publication, no studies specifically addressed building alphabetic knowledge. Since then, the limited research on interventions that include phoneme-grapheme correspondence instructions for young readers who are DHH suggests such instruction might have a significant effect on reading skills. Trezek and Malmgrem (2005) found that middle school students who are DHH were able to acquire phoneme-grapheme correspondences when instructed with SRA Corrective Reading where the phonemes are expressed using Visual Phonics (hand movements that represent articulation of phonemes; Waddy-Smith & Wilson, 2003). Other studies of elementary-aged students who are DHH have found that instruction in phoneme-grapheme correspondences improved their performance on phonological awareness, word identification, and non-word decoding in standardized assessments (Aghababian, Nazir, Lancon, & Tardy, 2001; Trezek & Wang, 2006; Trezek, Wang, Woods, Gampp, & Paul, 2007). The latter two studies used curriculum designed for children with typical hearing to teach phonics by making articulatory information "visible" through Visual Phonics. Visual Phonics is hypothesized to provide children who are DHH

with multisensory experiences that support the acquisition of the alphabetic principle (Morrison, Trezek, & Paul, 2008).

Purpose

The purpose of the current research was to assess the effectiveness of a semantic association strategy for teaching phoneme-grapheme correspondences in young children who are DHH. Research on children with typical hearing has found that instructional strategies that create meaningful associations between letters and sounds or names improve learning. Instructional strategies include picture mnemonics that create a meaningful association between a letter shape and a word that begins with the letter (e.g., drawing an *f* to resemble a flower; Ehri, Deffner, & Wilce, 1984), and providing a kinesthetic cue for producing the phoneme (e.g., LiPS picture cards; Lindamood & Lindamood, 2005). Similar to LiPS picture cards, Visual Phonics provide haptic and kinesthetic cues to the articulatory sequences of phoneme production (Morrison et al., 2008).

The semantic association instructional strategy was based on a strategy used to teach phoneme-grapheme correspondences in the Children's Early Intervention (CEI) program (Tade & Vitali, 1994), a curriculum developed for children with communication disorders. Phoneme-grapheme correspondences are taught through stories accompanied by a picture that builds an association between the phoneme and grapheme by embedding them in a meaningful context (e.g., the letter /m/ is associated with the phoneme *mmm* through a story in which a child eats ice cream and says *mmm-mmm, that's good*). While other approaches provide semantic cues to letters (e.g., picture mnemonics; Ehri et al., 1984), this approach provides semantic cues to remember the phonemes – a likely source of difficulty for young children who are DHH (Morrison et al., 2008). The semantic instructional strategy of teaching phoneme-grapheme correspondences can also incorporate other aspects important to early reading instruction, especially for children with language delays, such as vocabulary and comprehension of stories (Morrison et al., 2008; NELP, 2009). While the approach appeared successful in a local school program for children who are DHH, no published research (to our knowledge) has established its effectiveness.

We expanded on the original strategy in two ways: First, after the story was read, the children enacted the story (e.g., made ice cream sundaes). In addition to further cementing the semantic association by ensuring children understand and "feel" the story, these language experiences provided multiple opportunities for teachers and students to produce the isolated phoneme in a fun context. Second, small picture cards, called concept cards, were used as semantic cues to the phonemes (e.g., picture of an ice cream sundae for the phoneme /m/) in activities where children were asked to recall the phonemes. For example, these concept cards were used in activities where the children decoded or sounded out words.

Theoretical Basis

Paivio (1971) posited a Dual Coding Theory (DCT) of general cognition that in recent years has been applied to literacy (Sadoski & Paivio, 2004) and provides an "account of the relationships among decoding, comprehension, and response" (p. 1329). DCT proposes that experiences are coded as logogens (language codes) or imagens (nonverbal codes), and that all experiences can contain elements of both representational systems. Further, haptic representations (i.e., kinesthetic or tactile) contribute to the mental models we make of experiences. The semantic association strategy is consistent with this theory, although no single theory can explain all the complexities of the literacy acquisition process (Strain, Patterson, & Seidenberg, 2002). Concept cards provide the "glue" that binds a phoneme to a grapheme by focusing on a child's haptic representation of an experience. For example, the young child who experienced delicious enjoyment of an ice cream sundae while murmuring "*mmm*" may represent that haptic experience in his logogenic and imagenic system. The concept cards then provide an external representation of that haptic imagen (the deliciousness). This is then chained to, or provides a bridge between, grapheme and phoneme, activating a representation. "When enough input is received from any one source or a combination of sources, the representation is activated" (Sadoski & Paivio, 2004, p. 1333). In other words, the haptic and mental imagery of an experience embedded contextually in the concept card provides the meaningful link between grapheme and phoneme. The mental model the child develops will be a combination of phoneme, imagen, and grapheme. Some children will take longer than others to link graphemes to phonemes. Some will quickly grasp the link between grapheme and phoneme and will drop the imagen earlier than others. Still others will need the "glue" for a longer period before associations between graphemes and phonemes become automatic.

Research Design

Study One occurred during the first year of a 4-year research project that developed an early literacy curriculum for young children who are DHH with some spoken word identification skills (and therefore have representation of English phonemes). We assessed the effectiveness of the semantic association strategy using stories and pictures from the CEI embedded in a 35-minute-a-day intervention program. Study Two, implemented in the fall following Study One, assessed the effectiveness of this strategy embedded in a newly created, 60-minute-a-day early literacy curriculum called Foundations for Literacy (Lederberg, Miller, Easterbrooks, Bergeron, & Connor, 2009). This curriculum was designed to provide both code-based (alphabetic knowledge and phonological awareness skills) and meaning-based (vocabulary and comprehension) instruction (NELP, 2009) while specifically adapting to the needs

of prekindergarten children who are DHH by providing multimodality support (Morrison et al., 2008).

A multiple-baseline probe design across content (i.e., correspondences) was used in both studies to determine if a functional relationship existed between the intervention and the acquisition of phoneme-grapheme correspondences for individual children who are DHH. Multiple-baseline design is a preferred design to assess acquisition of learned behaviors that cannot be "unlearned" (Kazdin, 1982), such as when examining literacy interventions (Barger-Anderson, Domaracki, Kearney-Vakulick, & Kubina, 2004). Evaluations of effective instructional techniques with children who are DHH can be challenging because of small sample sizes and large variability, which makes control groups very difficult to obtain. By using a single-subject design, children are used as their own controls, and individual differences in instructional effectiveness can be analyzed. The effectiveness of instruction for children who vary in age, language, and hearing abilities is apparent from analyzing the results by individual children. In addition, single-subject designs can determine the efficiency of the intervention by measuring how many instructional sessions are necessary for acquisition to occur (Kazdin, 1982).

STUDY ONE

Method

Setting and Participants

We implemented the intervention in two schools. The first was a 42-student, auditory/oral program (78.5% received financial aid) within a larger, 401-student school in which 6% of students were African-American, 85% were Caucasian, 2% were Hispanic or Latino, 3% were Asian, and 4% were classified as Other (demographics from 2007–2008). The second school used Simultaneous Communication and American Sign Language (ASL) with its 193 students (referred to as the "signing program" in this paper). All the students were eligible for free or reduced-price meals, and 45% were African-American, 22% were Caucasian, 26% were Hispanic or Latino, 4% were Asian, and 3% were classified as Multiracial (demographics from 2006–2007).

All participants were selected based on the following criteria: (1) an unaided pure tone hearing (PTA) loss of 55 dB in the better ear, average or greater, (2) enrolled in a prekindergarten, kindergarten, or first grade classroom, (3) no additional disabilities of a significant nature, (4) no previous exposure to the CEI, (5) lack of knowledge of a majority of the targeted phoneme-grapheme correspondences, and (6) a score of 3 or 4 (i.e., at least some spoken word identification) on the Early Speech Perception Test (ESP) (Moog & Geers, 1990). (The ESP assesses pattern and spoken word discrimination through pictures or objects in a closed set format.

Table 1. Participant demographics

Participant	*Age*	*Gender*	*Unaided PTA*	*Listening Age*	*ESP Score*	*Standard Score WJAT-III Expressive Vocabulary*	*School Placement*
Adam	3.10	M	CI	6 months	4	92	Auditory-Oral/preschool
Kyle	4.2	M	CI	16 months	4	97	Auditory-Oral/preschool
Sid	5.6	M	CI	22 months	4	92	Sign/kindergarten
Arnold	6.8	M	68	42 months	4	79	Sign/1st grade
Jason	7.10	M	76	34 months	4	76	Sign/1st grade

Note. Age expressed in years.months; Listening age = chronological age minus age received first implant or amplification; PTA = pure tone hearing; ESP = Early Speech Perception Test; WJAT-III = Woodcock-Johnson®III NU Test of Achievement-Expressive Vocabulary subtest.

The results place children into one of four speech perception categories: 1 = no pattern perception, 2 = pattern perception, 3 = some word identification, and 4 = consistent word identification.) School personnel assisted in identifying children who met our criteria. Because the auditory/oral program uses the CEI in its kindergarten curriculum, only five 4-year-olds were eligible for the study. Of those, 3 children already knew many of the targeted phoneme-grapheme correspondences and were therefore excluded from the study. As shown in Table 1, the 2 children included in the study were young (3.10 and 4.1 years of age) and used cochlear implants. At the signing school, 40% of the prekindergarten, kindergarten, or first graders had an ESP score of 3 or 4 (6 children). Baseline probes showed that 2 of these children already had a majority of the targeted phoneme-grapheme correspondences, and 1 child was anxious about leaving his classroom and therefore could not be considered an assenting participant in the study. The remaining 3 children met all six criteria and participated in the study. These children were in kindergarten or first grade and included 2 children who had a severe hearing loss and wore hearing aids and 1 child who used a cochlear implant. While participating in this study, all students wore their personal amplification devices.

The intervention took place over a period of 8 or 9 weeks, 4 days per week for about 35 minutes each day, in a pullout model of instruction. Children were instructed in small groups (n = 2 or 3) by two research-teachers who were employed as members of the research team. A state-certified teacher of the deaf with 5 years of experience working with the CEI curriculum in an auditory/oral setting instructed the two-student group in the auditory/oral program. A state-certified teacher of the deaf with 17 years of experience working with students who were DHH instructed the three-student group at the signing program. This teacher was fluent in ASL and used a mix of ASL and sign-supported speech for instruction.

Experimental Design

A multiple baseline probe across content (phoneme-grapheme correspondences) was used to determine the effects of the intervention. Unlike many single-subject designs, instruction was implemented according to a prescribed scope and sequence, and was overall the same for all children regardless of prior knowledge or acquisition. This was because the goal of the study was to evaluate a curriculum the way it would be implemented in a typical school setting. This design was also used to determine effectiveness of the curriculum for individual students. Therefore, decision rules for criterion are based on individual performance and subsequent analysis is for the individual rather than for the instructional group.

Independent and Dependent Variables

The independent variable of this study was the semantic association strategy used to explicitly teach phoneme-grapheme correspondences embedded in the literacy intervention. The dependent variable assessed the acquisition of phoneme-grapheme correspondences through a spoken-production assessment. The expressive assessment consisted of a prompt, "What sound?" when shown a grapheme on either an index card or letter tile. Data were recorded as the number of correctly produced (spoken) correspondences when given three trials.

Procedures for Intervention

Baseline

Children were taken out of their regular classroom for 35 minutes over a period of 4 days during 1 week for baseline assessment. In addition to administering the baseline assessments, teachers read stories to and played with the children using activities that were unrelated to the intervention.

Intervention

The intervention used the pictures and stories from the CEI to teach phoneme-grapheme correspondences. The CEI was designed as a curriculum for children who have delays in speech, language, or reading, and emphasizes speech production and language development. The scope and sequence of the CEI curriculum introduces the sounds that are the easiest to produce first, based on the development of speech in children with typical hearing. Correspondences were taught in the following order: *m*, *long e*, *b*, *long o*, *t*, *s*, *p*, *long i*, and *f*. While some of these graphemes are associated with multiple phonemes (e.g., /e/), only one phoneme is introduced at a time.

Teachers introduced a new phoneme-grapheme correspondence approximately every fourth session (with the exception of *m* and *long e*, which were taught on the same day). The framework of the weekly lessons is described below, followed by an example from the first week's lessons. Only activities that are relevant to instruction of the phoneme-grapheme correspondences are described. The teacher's mouth was visible during introduction of each phoneme as well as during instruction.

Day 1: Story

The target phoneme-grapheme correspondence was introduced by reading the appropriate CEI story illustrated by a picture card (called large concept card).

Example of a lesson: Phoneme: /m/, Grapheme: Mm

Large concept card: A boy eating ice cream, with the letters **M** and **m** on the card.

Teacher: *This is George, and he loves ice cream sundaes. When George looks at an ice cream sundae, he opens his eyes wide and says a long /m-m-m/.* [Signals the children to make the sound /m/]. *George likes to write /m/.*

Children practiced saying *m* while the teacher pointed to the **m** on the large concept card.

Day 2: Language Activity

The CEI story was again read while referring to the large concept card. Then, to build a strong semantic association between the picture and the phoneme, teachers and children enacted this story. Of note, these activities were not part of the CEI curriculum and thus represent an enhancement. The language experience activity always involved multiple opportunities to produce the isolated phoneme in a meaningful context. The teacher corrected the children's production when necessary. The large concept card and related letters were displayed and referred to during the language experience to build associations. For example, the teacher and children made real ice cream sundaes and, while eating, the children practiced saying */mmm/* in response to teacher model and prompts.

Day 3: Review/Key Word Activity

The CEI story was read again, and children were prompted to say the phoneme when the teacher pointed to the letters on the large concept card. Following the CEI curriculum, children were introduced to decoding and blending by "reading" "key words" that were made up of the taught phonemes. For example, after instruction on *m* and *e*, the key word *me* was introduced.

Example of a lesson: Key word: *me*

Teacher: *What sound is this?* [Holds up magnetic letter m] *'Mmmm,' that's right. What sound is this?* [Holds up magnetic letter e] *'Eeee,' that's right! Good job. Now that we know two sounds, we can make a word. I'm going to put these two sounds together to make a word.* [Teacher slowly brings the letters together as she says the sounds] *'Mmmm-eeeee.' 'Mmmm-eeeee.' Say it with me: 'Mmmmm-eeeeee.' Now let's put the sounds together: 'mmmmmeeeee.' What word is that?* [Teacher answers] *'Me!' When I put 'mmmmeeee' together, it says 'me.'*

Day 4

Using the key words, children had opportunities to develop phonological awareness skills through activities that focused on initial sound identification, blending, and phoneme segmentation skills. Teachers used blocks or small concept cards (picture cards to provide a semantic cue to the story and language activity) to represent the phonemes.

Phoneme Books

Books from the CEI, called "Funday Books," were used to give students opportunities to practice the phoneme-grapheme correspondences and the key words with the written text. The books contained all large concept cards and key words previously taught. Each page provided several examples of the grapheme and printed word, and the teacher led students in reading practice.

Results of single-subject assessment were used to initiate additional practice on taught phoneme-grapheme correspondences for individual students on all days. In addition to the activities that were specific to the semantic association strategies, daily activities included phonological awareness activities, writing games (e.g., picking out letters to write one's name), learning the alphabet song, and vocabulary instruction.

Assessment Procedures

Original Baseline

During the baseline week, teachers assessed students on the six consonant sounds (*m*, *b*, *t*, *s*, *p*, and *f*) and three long vowel sounds (*long e*, *long o*, and *long i*) for four sessions (i.e., 4 days). Baseline consisted of three trials for each of nine phoneme-grapheme correspondences, for a total of 27 trials in random order. Students did not receive feedback during baseline or any other phase of the assessments.

Intervention Assessment

During days 2, 3, and 4 of an instructional week, assessment included only the targeted correspondences and any previously taught correspondences for

which students had not reached criterion. Criterion was defined as 100% correct on four consecutive assessments (i.e., day 2-4 of intervention week, and day 1 of the following week).

Probes

On day 1, prior to the start of a new lesson, the teacher administered a probe that consisted of three trials of all nine phoneme-grapheme correspondences, identical to the baseline assessment. This served as a baseline probe for those correspondences that had not yet been taught and a maintenance probe of previously taught correspondences. If a student dropped below 100% on any particular correspondence during maintenance, it was included in the intervention assessment until criterion was met again.

Treatment Fidelity

A member of the grant team (different from the research teachers) conducted treatment fidelity measures on all available videotapes (33% percent of 36 total sessions) from the auditory/oral program and all available videotapes (22% percent of 32 total sessions) from the signing program. The observer measured treatment fidelity using the checklist shown in Table 2.

Fidelity was measured by the percentage of critical elements for an activity that was observed, divided by the number of times the activity was observed. If the element was not in view on the videotape (e.g., "the large concept card was visible to the child"), it was not calculated toward the total. The average percentages for all elements were 75% or higher with a median of 100% (see Table 2).

Results

The dependent variable was graphed for all children. First, we inspected the graphs to determine which correspondences the children knew at baseline. To be conservative, knowledge of a correspondence was defined as a child producing the correct phoneme for at least two of the three trials in any given baseline assessment. Visual inspection of the data indicated that participants knew all of the long vowel phoneme-grapheme correspondences in the original baseline assessment. In addition, baseline probes showed that 3 students learned consonant correspondences, *f* (Adam), *s* (Jason), and *s* and *p* (Sid), between the original baseline and instruction on that correspondence. (Pseudonyms are used for all students.)

Further data analyses are reported only for the phoneme-grapheme correspondences students did not know (see Table 4 for listing of correspondences for each student). Figure 1 displays Adam's responses during baseline (to the left of the dotted line) and after intervention (to the right of the dotted line).

Table 2. Treatment fidelity

Group	*Auditory/oral program*	*Signing program*	*Averages*
Story			
Large concept card is visible to all children	100.00%	100.00%	100.00%
Teacher reads/tells a story that includes phoneme, letter name, and is represented by picture on large concept card	100.00%	100.00%	100.00%
Teacher produces phoneme while pointing to each letter on large concept card	100.00%	100.00%	100.00%
Teacher provides written model of target letter	50.00%	100.00%	75.00%
Teacher prompts student to imitate her after each production	100.00%	50.00%	75.00%
Children attempt to imitate teacher's production	100.00%	100.00%	100.00%
Percentage observed for story	91.67%	91.67%	91.67%
Language activity			
Teacher refers to large concept card at beginning of activity	100.00%	100.00%	100.00%
Large concept card is visible to children	80.00%	100.00%	90.00%
Children engage in activity represented in concept cards	100.00%	50.00%	75.00%
Teacher models target sound during activity	100.00%	100.00%	100.00%
Child attempts/produces target sound during activity	100.00%	100.00%	100.00%
Teacher provides corrective feedback if needed	100.00%	100.00%	100.00%
Percentage observed for language activity	96.67%	91.67%	94.17%
Review: grapheme-phoneme			
Teacher shows grapheme and models sound	80.00%	100.00%	90.00%
Teacher prompts students to imitate sound while pointing to letter	100.00%	100.00%	100.00%
Students produce sound	100.00%	100.00%	100.00%
Large concept card visible to children	100.00%	100.00%	100.00%
Percentage observed for grapheme-phoneme	95.00%	100.00%	97.50%
Phoneme books			
Child attempts/produces target sound as student or teacher points to each grapheme	100.00%	100.00%	100.00%
Child moves from page to page to practice grapheme-phoneme correspondences	50.00%	100.00%	75.00%
Percentage observed for phoneme books	75.00%	100.00%	87.50%

The double dotted lines indicate baseline probes that preceded instruction. To conserve space, we have included only the figure for Adam's data but describe figures for all children (figures are available on request). Visual inspection of these graphs indicated that changes in the dependent variable (i.e., number correct out of three trials) consistently occurred when the

independent variable was introduced for unknown correspondences. A functional relationship was established across all students between the instruction of unknown phoneme-grapheme correspondences using the semantic association strategy and its acquisition. Additionally, all students showed an ascending trend during the intervention phase and showed little variability during maintenance. All students reached criteria for unknown sounds within the allotted time before the end of the study. Three out of 5 students maintained 100% for the remainder of the study for all correspondences once criterion was reached. Of the other 2, 1 student, Adam, made one error for the *b* correspondence but returned to 100% for the next (and last) three sessions (see Figure 1). Arnold made one error for *b* correspondence then returned to 100% on the next probe. He also made an error for the *t* correspondence and continued to accurately produce it only two out of the three trials on probes until the end of the study.

Statistical analysis confirmed visual inspection results. Table 3 summarizes the compiled results of averages across participants and includes (1) baseline mean, (2) intervention mean, (3) mean difference, and (4) percentage of overlapping data between baseline and intervention. Effectiveness of the intervention was measured using percentage of overlapping data between baseline and intervention (as opposed to non-overlapping data used in behavior reduction research as described in Olive and Smith [2005]), and a low average percentage of overlapping data at 15% (range 2%–22%) for all 5 students across all unknown correspondences.

The efficiency of instruction was measured through latency, which is defined as the number of instructional sessions before reaching the first data point of criterion. The average latency was 4.49 sessions. Thus, on average, children needed a week of lessons to reach criterion. Table 4 describes latency data by correspondences and students. There were wide individual differences in average latency (range 1.8 to 7.2). Jason, the child who needed only minimal instruction, was the oldest student. In contrast, the youngest student, Adam, needed almost 2 weeks of instruction, on average, to reach criterion. Latency for the different correspondences also varied, but the lack of consistency across children for a given correspondence precludes any conclusion on their relative difficulty.

Discussion

The results suggest that an intervention with instruction using a semantic association strategy is an effective method to teach phoneme-grapheme correspondences to children who are DHH and who have spoken word identification skills. All children in the study reached criteria for all correspondences. Three children never made an error after reaching criterion. The other 2 made only minimal errors. Four of the 5 children needed the full week of lessons before they reached criterion. Not surprisingly, children's age seemed to

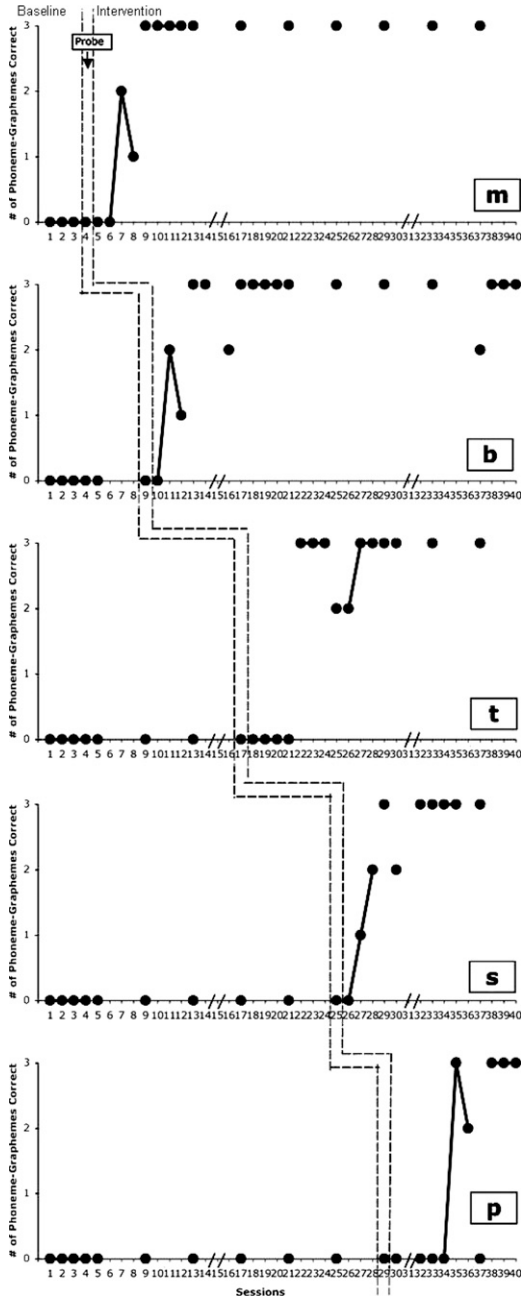

Figure 1. Graph showing acquisition of phoneme-grapheme correspondences for Adam, a 3.10-year-old boy from an auditory / oral program who uses speech to communicate and uses a cochlear implant.

Table 3. Percentage of overlapping data between baseline and intervention phases and mean number of correct responses in each phase for participants

	$M_{Baseline}$	$M_{Intervention}$	$M_{Difference}$	*POD*
Adam	0.29	2.43	2.14	20%
Kyle	0.00	2.25	2.25	10%
Sid	0.36	2.53	2.17	22%
Arnold	0.08	2.64	2.55	2%
Jason	0.28	2.90	2.62	20%
Averages	0.20	2.55	2.35	15%

Note. M = means; POD = percentage of overlapping data.

influence how quickly they learned the correspondences. Children who had speech perception skills in both oral and signing environments were able to learn the spoken phoneme-grapheme correspondences. Because of its success with the youngest children, this instructional strategy seems appropriate for inclusion in a literacy curriculum for young children who are DHH.

STUDY TWO

In the fall following Study One, researchers created and implemented a comprehensive and integrated prekindergarten literacy curriculum entitled Foundations for Literacy (Foundations) (Lederberg et al., 2009). Foundations was developed to include the five components of effective literacy instruction as defined by the National Reading Panel (2000): alphabetic knowledge (including phoneme-grapheme correspondences), phonological awareness, vocabulary, reading comprehension, and fluency, as well as evidence-based effective instructional strategies for early literacy instruction (NELP, 2009). Foundations also includes best practices for education of young children (e.g., active learning) (joint statement of the National Association for the Education of Young Children [NAEYC] and the National Association of

Table 4. Latency across students and unknown correspondences

Latency	*Adam*	*Kyle*	*Sid*	*Arnold*	*Jason*	*Averages by correspondence*
m	4	4	5	4	1	3.6
b	7	3	5	8	4	5.4
t	10	7	5	5	1	5.6
s	6	4	–	2	–	4
p	9	–	–	1	1	3.7
f	*not enough time to reach criterion*					
Averages by student	7.2	4.5	5	4	1.75	

Note. (-) indicates a known correspondence.

Early Childhood Specialists in State Departments of Education [NAEYC and NAECS/SDE, 2003]), and a multimodality approach to teaching reading (Morrison et al., 2008). Building on the results from the first study, this curriculum presented lessons to teach phoneme-grapheme correspondences through the use of a semantic association strategy that used stories and language experiences. While adopting the CEI story strategy, new stories and language experiences were created with illustrations that were more modern and culturally inclusive. In addition, further support for children with weak language skills was provided by including sequencing cards that illustrated the stories and by targeting key vocabulary words for instruction. Consistent with research on effective prekindergarten curriculum for children with typical hearing (NELP, 2009), Foundations included more extensive phonological awareness activities and a shared storybook reading component (reading comprehension). Fluency, while not measured in this 6-week study, developed from Study Two. The single-subject assessments emerged as practice for phoneme fluency that could be recorded and measured.

The goal of Study Two was to examine the effectiveness of a semantic association strategy embedded within Foundations for teaching phoneme-grapheme correspondences to young children who are DHH. A research-teacher taught five 3- to 4-year-olds using the curriculum for 1 hour a day, 4 days a week, for the entire school year. Study Two was a multiple baseline, across content study implemented for 6 weeks near the beginning of the school year. The design was similar to Study One, except that intervention assessments occurred less frequently to allow more time for instruction.

Method

Setting and Participants

The setting for this study was the auditory/oral program from the first study, and it used the same criteria for subject selection. Table 5 gives detailed demographic information about the participants. School personnel assisted in identifying children who met these criteria. Five prekindergarten students were eligible for the study, and all 5 children participated. Unlike the first study, no child was excluded because of phoneme-grapheme correspondence knowledge. While participating in this study, all students wore their personal amplification devices. The students received instruction in 1-hour sessions, 4 days per week from the research-teacher from Study One, who utilized a pullout model of instruction.

Experimental Design

A multiple baseline probe across content (phoneme-grapheme correspondences) was used to evaluate the effects of the intervention. Again, researchers

Table 5. Participant demographics

Participant	*Age*	*Gender*	*Unaided PTA*	*Listening Age*	*ESP Score*	*Standard Scores PPVT*	*School Placement*
Henry	3.11	M	CI	6 months	4	77	Auditory/ oral-preschool
Mary	4.5	F	CI	22 months	4	66	Auditory/ oral-kindergarten
Sally	4.4	F	CI	26 months	4	67	Auditory/ oral-preschool
Vikki	4.4	F	CI	24 months	4	68	Auditory/ oral-kindergarten
Wally	3.10	M	CI	4 months	4	97	Auditory/ oral-preschool

Note. Listening age = chronological age minus age received first implant or amplification; PTA = pure tone hearing; ESP = Early Speech Perception Test; PPVT-III = Peabody Picture Vocabulary Test-Third Edition.

were interested in evaluating the intervention in a naturalistic setting using a prescribed scope and sequence. Decision rules for criterion and analysis were again based on individual performance.

Independent and Dependent Variables

The independent and dependent variables for this study were the same as the first study. However, the intervention used the Foundations curriculum instead of our enhancement of the CEI. Three additional dependent variables were included as part of this study: (1) a pre-post, phoneme-grapheme correspondence assessment (with one opportunity to correctly produce a phoneme for a matched grapheme) that exclusively assessed the six target phoneme-grapheme correspondences in the study: *m*, *long e*, *b*, *long o*, *t*, and *n*. This assessment was administered immediately before and after the 6-week study; (2) An alphabetic knowledge test administered in the fall and spring. This test assessed production of all the consonant sound correspondences and the long and short vowel correspondences, as well as the *ch*, *th*, and *sh* clusters (see Easterbrooks et al., 2008, for a full description); and (3) A pre- and posttest on decodable words (Key Word Assessment) that assessed participants' reading/decoding skills. These tests included words that were spelled using the graphemes taught in the intervention. Some of the words were specifically taught as key words (e.g., *me*, *boat*); others were not (e.g., *toe*, *leaf*). The assessment included a production test with 17 taught words and 14 untaught words (students read the word on a

card), and an identification test of taught words (students were shown the key [decodable] word and had to select the correct referent from a set of three pictures).

Procedures

Baseline

Baseline procedures were the same as the first study.

Intervention

In each 1-hour session of Foundations for Literacy, about 15 minutes were allotted for each of the following: phoneme-grapheme correspondences, phonological awareness, and storybook reading. The remaining 15 minutes were used for review and reinforcement of skills, as well as vocabulary and fluency practice, including activities prerequisite to phonological awareness. Phoneme-grapheme correspondence instruction in Foundations maintained the use of the semantic association strategy through stories and language activities that provided opportunities for children to practice the sound in isolation. Correspondences were taught in the following order: *m*, *long e*, *b*, *long o*, *t*, and *n*.

The teacher introduced new phoneme-grapheme correspondences approximately every fourth session (with the exception of the first two correspondences, which were taught on the same day). The framework of a weekly lesson is described below, followed by examples of each day. Again, only the activities that are relevant to learning the phoneme-grapheme correspondences are described.

Day 1: Story

The target phoneme-grapheme correspondence was introduced with a large concept card and three or four picture cards in sequence (see Appendix A).

Example of a lesson: Phoneme: /t/, Graphemes: Tt

Large concept card: Miss Giggle listening to the clock, letters **T** and **t** on the card

Teacher: *Miss Giggle told Kate and Pete that she had a surprise. "The surprise is that the girl we met at the park will be coming after school everyday, too." Miss Giggle looked at her watch. "It is time for her to come," she said. Just then the doorbell rang. It was Sue and her mother. Sue had a present for Miss Giggle. Miss Giggle put the present to her ear. "I hear a sound: t, t, t, t," said Miss Giggle. She opened the present. It was a new clock. Miss Giggle decided to hang it on the wall. They all listened as it said "t, t, t, t."* [Signals to the children to make the sound /t/]. *Miss Giggle*

said, "That's the sound the letter t makes," and she wrote 't' on a card and stuck it on the box.

The children then practiced saying /t/ while the teacher pointed to the **t** on the card.

Day 2: Language Activity

The framework for the language activity in the Foundations curriculum was the same as the first study.

Example: The teacher surprised the students with presents. Inside the students' gift boxes were containers of Play-Doh. The teacher guided students to make clocks or watches out of Play-Doh and "listen" to them tick. The teacher prompted students to produce the /t/ sound (i.e., *What sound do you hear when you listen to the clock?*). The teacher corrected articulation, if needed.

Day 3: Language Activity Recall

Students participated in recall of the language activity that reinforced the phoneme-grapheme correspondence. The teacher used guided questions to help students recall activities from the previous day by creating three to five simple sentences describing the events of the activity. The students produced the phoneme in the recall activity and saw it written with the matching grapheme on the chart. The teacher then asked students to read the grapheme after it was written on the chart. A possible example of a language chart: [chart title] *We Made Clocks* [first sentence] *Miss Jessica gave us a present.* [second sentence] *We made clocks.* [third sentence] *Vikki made a watch.* [fourth sentence] *We listened. The clock said,* **t, t, t**.

Day 4: Review/Key Word Activity

The key word activity was similar to the first study except the students participated in another language activity prior to hearing the word blended. This language activity was related to the key word rather than the sound. The teacher focused on helping students gain a semantic understanding of the key word as well as provided several opportunities to practice the word.

Example: Key word: *boat*

The teacher played a searching game with the children in which they had to search for the paper boats in the "water" (blue tissue paper in a large tub) and say *boat* when they found a boat. Then the teacher assisted the students in sounding out and blending the phonemes in the word *boat* using small concept cards that served as a semantic cue for the phoneme (e.g., clock for t-t-t) (see Appendix A for illustration of the word *boat*). Eventually, graphemes instead of small concept cards were used for this activity.

Phoneme Book

Similar to the CEI practice books, students read their own Phoneme Books twice a week. These books included all large concept cards for every taught phoneme-grapheme correspondence as well as a page for all taught key (decodable) words. These books provided practice for independent "reading" of taught correspondences and key words (see Appendix A).

Assessment Procedures

Original Baseline

On the first day during the baseline phase, the teacher administered a pretest consisting of one instance of each grapheme that corresponded to the four consonant sounds, *m*, *b*, *t*, and *n*, and two long vowel sounds, *e* and *o*. The teacher then administered the baseline assessment for the single-subject studies for three sessions. Baseline assessment consisted of three trials for each of the six phoneme-grapheme correspondences for a total of 18 trials in random order. Students did not receive feedback during baseline or any other phase of the assessments.

Intervention Assessment

During days 2 and 4 of the intervention, assessment included only the targeted correspondences and any previously taught correspondences that had not reached criterion. Criterion was defined as 100% correct on four consecutive assessments (i.e., days 2 and 4 of one week and days 2 and 4 of the following week).

Probes

The teacher administered a probe twice during the intervention phase, which consisted of three trials of all six correspondences identical to the baseline assessment. This served as a baseline probe for those correspondences that had not yet been taught and a maintenance probe of previously taught correspondences. If a student dropped below 100% on any particular correspondence during maintenance, it was included in the intervention assessment until criterion was met again.

Treatment Fidelity

Treatment fidelity was conducted similarly to the first study, except that Language Activity Recall was added to the checklist. A member of the grant team (different from the research-teachers) conducted treatment fidelity measures on 37% percent of 24 instructional sessions. The observer measured treatment fidelity using a checklist shown in Table 6. Fidelity was measured by the

Table 6. Treatment fidelity

Group	*Group 1*	*Group 2*	*Averages*
Story			
Large concept card is visible to all children	100.00%	100.00%	100.00%
Teacher reads/tells a story that includes phoneme, letter name, and is represented by picture on large concept card	100.00%	100.00%	100.00%
Teacher produces phoneme while pointing to each letter on large concept card	100.00%	100.00%	100.00%
Teacher provides written model of target letter	100.00%	100.00%	100.00%
Teacher prompts student to imitate her after each production	100.00%	100.00%	100.00%
Children attempt to imitate teacher's production	100.00%	100.00%	100.00%
Percentage observed for story	100.00%	100.00%	100.00%
Language activity			
Teacher refers to large concept card at beginning of activity	*	*	*
Large concept card is visible to children	100.00%	100.00%	100.00%
Children engage in activity represented in concept cards	100.00%	100.00%	100.00%
Teacher models target sound during activity	100.00%	100.00%	100.00%
Child attempts/produces target sound during activity	100.00%	100.00%	100.00%
Teacher provides corrective feedback if needed	*	*	*
Percentage observed for language activity	100.00%	100.00%	100.00%
Language activity recall			
Teacher refers to large concept card	*	*	*
Teacher and students recall language activity	*	100.00%	100.00%
Teacher and students produce target sound	*	100.00%	100.00%
Percentage observed for language activity recall	*	100.00%	100.00%
Review: grapheme-phoneme			
Teacher shows grapheme and models sound	100.00%	100.00%	100.00%
Teacher prompts students to imitate sound while pointing to letter	100.00%	100.00%	100.00%
Students produce sound	100.00%	100.00%	100.00%
Large concept card visible to children	*	*	*
Percentage observed for grapheme-phoneme	100.00%	100.00%	100.00%
Phoneme books			
Child attempts/produces target sound as student or teacher points to each grapheme	100.00%	100.00%	100.00%
Child moves from page to page to practice grapheme-phoneme correspondences	100.00%	100.00%	100.00%
Percentage observed for phoneme books	100.00%	100.00%	100.00%

Note. (*) indicates element was not visible.

percentage of critical elements for an activity that was observed divided by the number of times the activity was observed. If the element was not in view on the videotape (e.g., "the large concept card was visible to the child"), it was not calculated toward the total. The average percentages for all elements were all 80% or higher, with a median of 100% (see Table 6).

Results

The dependent variable was graphed for all children. We inspected the graphs to determine which correspondences the children knew at the original baseline. Again, knowledge of a phoneme-grapheme correspondence was defined as a child producing the correct phoneme for at least two of the three trials in any given baseline assessment. Visual inspection showed that 4 out of 5 participants demonstrated knowledge of both long vowel phoneme-grapheme correspondences in original baseline or prior to instruction. Baseline probes revealed that all students except Vikki learned the *n* correspondence between the original baseline and instruction. Further data analyses are reported only for the unknown consonant correspondences (range three to four correspondences). The data, presented for Vikki in Figure 2, indicated that changes in the dependent variable occurred when the independent variable was introduced for unknown correspondences. A functional relationship was replicated across all students for the unknown correspondences using the semantic association strategy. All students reached and maintained criteria for unknown correspondences. All students showed an ascending trend during the intervention phase (figures of all students available on request).

Statistical analysis confirms replication results. Table 7 summarizes compiled results of averages across participants and includes (1) baseline mean, (2) intervention mean, (3) mean difference, and (4) percentage of overlapping data between baseline and intervention. Effectiveness of the intervention, as measured by percentage of overlapping data between baseline and intervention, averaged 11% across participants for unknown correspondences (range 7%–13%). The efficiency of the intervention, measured by average latency across students (multiplied times 2 since assessment was done every other day), was 5.8 sessions (range 4.7–8.0 sessions).

Table 8 describes latency data by correspondences and students. At the beginning of the study, average latencies suggest that students needed about 1 to 2 weeks of instruction before reaching the first data point of criterion for a correspondence. However, all students demonstrated increased efficiency, and the number of sessions before reaching the first point of criterion for correspondences decreased across time. Examining efficiency of specific correspondences also supports increased efficiency, where average latency for the first correspondence (*m*) was 8.4 sessions and then decreased to 2 sessions for the last two correspondences (*t*, *n*). Individual differences in latency did not seem to relate to any of the characteristics noted in Table 5.

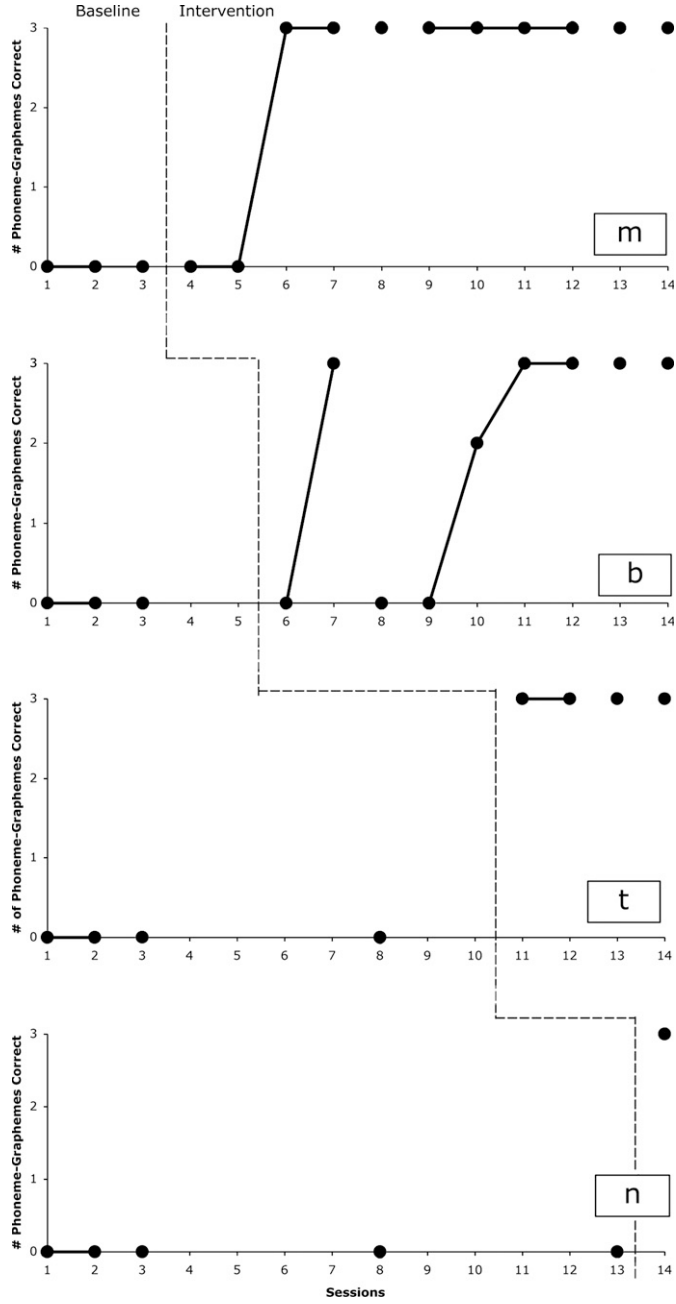

Figure 2. Acquisition of phoneme-grapheme correspondence for Vikki, a 4.4-year-old girl from an auditory/oral program who uses speech to communicate and uses bilateral cochlear implants.

Table 7. Percentage of overlapping data between baseline and intervention phases and mean number of correct responses in each phase for participants

	$M_{Baseline}$	$M_{Intervention}$	$M_{Difference}$	*POD*
Henry	0.17	2.50	2.33	12%
Mary	0.41	2.67	2.25	13%
Sally	0.61	2.80	2.19	13%
Vikki	0.27	2.62	2.36	10%
Wally	0.71	2.84	2.13	7%
Averages	0.43	2.69	2.25	11%

Note. POD = percentage of overlapping data.

The results of the pre- and posttests immediately before and after the intervention indicated that, prior to the intervention, these students had only limited alphabetic knowledge. Four out of 5 did not know any of the target letter names (which would have produced a correct score on the long vowel correspondences). Furthermore, none of the students knew any of the consonant correspondences. At the end of 6 weeks, all 5 students demonstrated knowledge of the six phoneme-grapheme correspondences.

As a component of the larger grant project's assessment battery, assessors tested the children on alphabetic knowledge and decoding at the end of the school year, after a year in the Foundations curriculum. Of those phoneme-grapheme correspondences tested, the results of these assessments indicated that students maintained the alphabetic knowledge they gained at the beginning of the year from this 6-week study. By the end of the year, children went from an average of four correspondences to 16 correspondences. More important, students were able to use those correspondences in a functional manner by decoding them in real words. Children from this study were able to decode 60% of words directly taught in the curriculum and 30% of the novel words.

Table 8. Latency across students and unknown correspondences

Latency	*Henry*	*Mary*	*Sally*	*Vikki*	*Wally*	*Averages by correspondence*
m	8	4	3	2	4	4.2 (8.4 sessions)
e	5	–	–	–	–	5 (10 sessions)
b	2	2	6	6	2	3.6 (7.2 sessions)
t	1	1	1	1	1	1 (2 sessions)
n	–	–	–	1	–	1 (2 sessions)
Averages by student	4.0 (8 sessions)	2.3 (4.7 sessions)	3.3 (6.6 sessions)	2.5 (5 sessions)	2.3 (4.7 sessions)	

Note. (-) indicates a known correspondence.

Discussion

The results of Study Two replicated the findings of Study One, showing that the semantic association strategy for building alphabetic knowledge is an effective and efficient method to teach phoneme-grapheme correspondences. All children reached criteria for all unknown correspondences. After reaching criterion, children maintained 100% accuracy and none made any errors. Children averaged a range from a little over 1 week to 2 weeks before reaching the first point of criterion and all children showed an increased efficiency in acquiring correspondences.

The research team decided to reduce the assessment schedule for this study by assessing every other day and probing every other week. However, this schedule proved to be a limitation in that some correspondences were not probed immediately prior to intervention (e.g., phoneme /t/). The assessment schedule from the first study, with probes immediately prior to intervention, provided better evidence for a functional relationship between the independent and dependent variables.

General Discussion

This type of research has several implications for populations of children who are DHH. These studies suggest that students who have at least some speech perception abilities can learn phoneme-grapheme correspondences using a semantic association strategy. These studies are the first research on instruction of phoneme-grapheme correspondences for children who are DHH at the prekindergarten age level. For this age group, the fun and engaging activities were most likely essential to the success of the strategy.

The strength of using a single-subject design for both studies was the ability to analyze assessment results by individuals. Children in Study One ranged from 3.10 to 7.10 years of age, and results suggested that age may have affected the rate of learning (i.e., older children had lower latency levels). However, latency was not related to age in Study Two, suggesting that this factor may not be important in learning among children in prekindergarten classrooms. The children in both studies varied in language levels, ranging from those with age-typical vocabulary to those with vocabulary scores more than 2 standard deviations below age-typical levels. Even with these varying factors, all children successfully learned targeted correspondences. Surprisingly, children's learning (as measured by latency) did not seem to be related to their widely differing vocabulary knowledge. The intervention may be appropriate for children of various abilities in prekindergarten classrooms. Of course, further replication with a wider variety of children is necessary before that conclusion can be drawn.

The semantic association strategy explicitly teaches phoneme-grapheme correspondences through stories that connect a semantic context to the phoneme.

Previous examples of alphabetic knowledge instruction programs, including instruction through alliteration (e.g., stressing the initial sound of a word or object), may require students to remember a potentially complex or unknown word or phrase as a reference for the correspondence. This method of instruction may present vocabulary or speech production challenges for children who are DHH. The semantic association of strategy instruction provides a reference that requires minimal language and an intuitive connection to an abstract idea. To further cement the connection between the meaning and the phoneme, the stories were enacted through multisensory language experiences. Here, teachers reinforced vocabulary and language related to understanding the meaning of stories, which was key to making a semantic connection. Finally, development of alphabetic knowledge is dependent on accurate phonological representations (Thomas & Senechal, 2004). During the language activities, multiple opportunities for students to practice the phoneme in isolation and subsequent opportunities for teacher correction when needed provided an engaging and age-appropriate setting in which to reinforce correct articulation. The emphasis of teachers modeling the phoneme in isolation may have improved children's speech-reading abilities for these phonemes, a skill that has been shown to be related to reading (Harris & Moreno, 2006). In addition, the multisensory experiences that focus on isolating phonemes from the speech stream may be particularly helpful for children with impoverished phonological representation (Morrison et al., 2008). The current studies suggest that the semantic association strategy may be an effective and efficient technique for children who are DHH.

Limitations

The current studies have several limitations. The independent variable included several instructional strategies, such as language activities and phonological awareness activities, which undoubtedly contributed to the successful acquisition of the phoneme-grapheme correspondences for the children in these studies. The single-subject design requires repeated measures in the form of daily or twice-weekly assessments. In our studies, these assessments may have had unintended benefits. In fact, additional practice from the assessments probably increased the fluency with which children knew the correspondences; for this reason, we incorporated similar assessments into instruction for the Foundations curriculum. However, because we cannot separate the individual strategies from the whole intervention, caution must be used when drawing conclusions about the success of using the semantic association strategy alone. Additionally, the researchers did not compare the semantic association strategy to other approaches teaching alphabetic knowledge. We do not know whether the semantic association strategy is more effective than, for instance, strategies that use a meaningful articulatory or kinesthetic connection to the phoneme (e.g., LiPS or Visual Phonics).

Future Research

Williams (2004) reviewed current literature on literacy for children who are DHH and outlined several areas of future research, including longitudinal studies that would "construct a detailed, theoretically-grounded representation of deaf children's emergent literacy development" (p. 362). While the importance of alphabetic knowledge for literacy development in children with typical hearing is well documented, longitudinal research is needed to establish the role of this knowledge for children who are DHH. Additionally, investigations that compare the semantic association strategy to other approaches that build phonological awareness in children who are DHH would help to identify other efficient and effective approaches. Information is also needed on how to build emergent literacy skills in children who are older than preschool/kindergarten age.

Future research may also explore how the strategies used in Foundations for Literacy could be modified for elementary-aged children whose classroom demands for literacy are qualitatively different than those of younger children. Finally, future research is needed to identify for which children auditory-based instruction to build alphabetic knowledge is appropriate, including children without speech perception abilities. Theoretically, although the children without speech perception abilities might learn to read through a different process than children who have phonological representations of spoken words, it may be that instruction using the semantic association strategy paired with Visual Phonics during preschool will build a foundation for instruction of reading programs, such as Reading Mastery (2008) in elementary school (see Trezek & Wang, 2006).

Conclusion

Alphabetic knowledge provides an early foundation for later literacy success. Research shows that explicit instruction in building early skills that enhance development of phonological awareness, such as phoneme-grapheme correspondences, in the general education population is an essential foundation for decoding written text (Snider, 1995). Research, such as the recent study by Spencer and Tomblin (2008), supports development of these skills in children who are DHH; however, Spencer and Tomblin found that elementary school children who are DHH with cochlear implants develop phonological awareness skills at a delayed rate. The children in the current study demonstrated that, despite their young ages and language delays, they could still acquire phoneme-grapheme correspondences. These results have strong positive implications for a future practice of targeting explicit phoneme-grapheme instruction with prekindergarten children who are DHH in order to prevent future delays in phonological awareness development.

While traditionally alphabetic knowledge is not taught until kindergarten, even for children with typical hearing, recent research suggests such instruction in prekindergarten can have long-term positive effects on later reading skills, including reading achievement and spelling (Kirk & Gillon, 2007; Korkman & Peltomaa, 1993). The current study suggests that children who are DHH, even those who have delays in language, are able to learn the foundation for the alphabetic principle during prekindergarten. Although the long-term consequences of early instruction on the alphabetic principle need to be explored, such a finding holds promise for improving literacy skills of children who are DHH.

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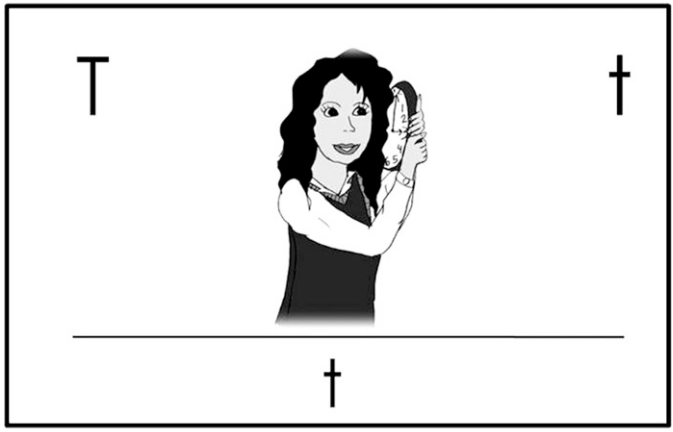
Appendix A

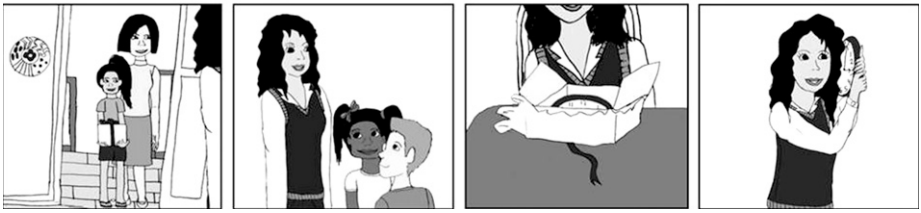
Story Card

/t/
Miss Giggle told Kate and Pete that she had a surprise. "Is it in the box?" asked Pete.
"No, it is not in the box," said Miss Giggle. "The surprise is that the girl, Sue, we met at the park will be coming after school everyday, too." Miss Giggle looked at her watch. "It is time for her to come," she said.
Just then the doorbell rang. It was Sue and her mother. Sue had a surprise for Miss Giggle. It was a present. She opened the present. It was a new clock.
"I hear a sound," said Miss Giggle. "t, t, t, t," She held the clock to her ear. "t t t t." Miss Giggle decided to hang it on the wall. They all listened as it said "t, t, t, t." That is the sound the letter "t" makes. Miss Giggle wrote 't' on a card and stuck it on the box.

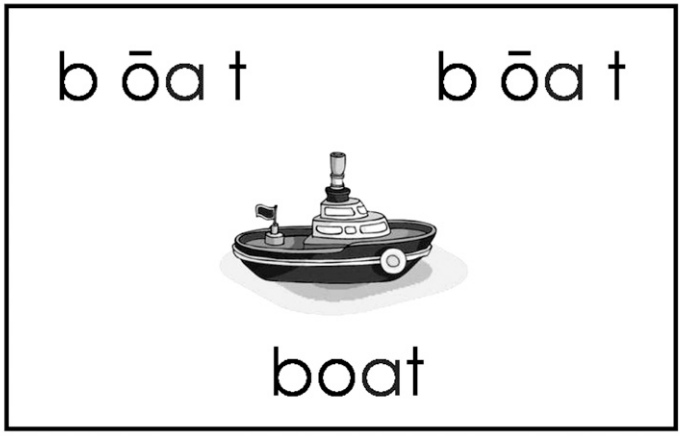
Large Concept Card



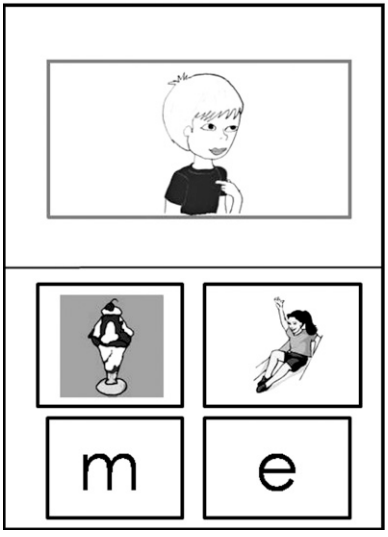
Sequencing Pictures



Phoneme Book Page



Blending Key Words



Small Concept Cards