Research Article

The Relationship Between Speech, Language, and Phonological Awareness in Preschool-Age Children With Developmental Disabilities

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Purpose: A number of intrinsic factors, including expressive speech skills, have been suggested to place children with developmental disabilities at risk for limited development of reading skills. This study examines the relationship between these factors, speech ability, and children's phonological awareness skills.

Method: A nonexperimental study design was used to examine the relationship between intrinsic skills of speech, language, print, and letter-sound knowledge to phonological awareness in 42 children with developmental disabilities between the ages of 48 and 69 months. Hierarchical multiple regression was done to determine if speech ability accounted for a unique amount of variance in phonological awareness skill beyond what would be expected by developmental skills inclusive of receptive language and print and letter-sound knowledge.

Results: A range of skill in all areas of direct assessment was found. Children with limited speech were found to have emerging skills in print knowledge, letter-sound knowledge, and phonological awareness. Speech ability did not predict a significant amount of variance in phonological awareness beyond what would be expected by developmental skills of receptive language and print and letter-sound knowledge.

Conclusion: Children with limited speech ability were found to have receptive language and letter-sound knowledge that supported the development of phonological awareness skills. This study provides implications for practitioners and researchers concerning the factors related to early reading development in children with limited speech ability and developmental disabilities.

It is estimated that more than 3.5 million Americans or 1.3% of the population evidence a disability that impacts their ability to use speech as a primary means of communication (Beukelman & Mirenda, 2013). Augmentative and alternative communication (AAC) systems are often used by individuals with impairments in speech. The introduction of these systems, particularly speech-generating devices (SGDs), during early intervention has made a positive impact on children's language and vocabulary development (Ronski et al., 2010; Ronski, Sevcik, Barton-Hulsey, & Whitmore, 2015). The importance of literacy skills for individuals with limited speech who require AAC systems

cannot be underestimated (Light, McNaughton, Weyer, & Karg, 2008). Individuals who can read and write have access to a means other than speech for communication to convey ideas, thoughts, and opinions. A number of intrinsic factors, including developmental skill, receptive language, and expressive speech and language skills, have been suggested as factors that place children with developmental disabilities at a greater risk for limited development of reading skills. Currently, little is understood about how children who are born with developmental disabilities and have limitations in speech learn to read. This study fills a gap in the literature by determining what factors are most strongly associated with component reading skills of phonological awareness (PA) in preschool-age children between 4 and 5 years of age with developmental disabilities. An understanding of the relationship between children's developmental, language, and speech ability to PA will aid practitioners and researchers alike in targeting intervention and teacher education for preschool-age children with developmental disabilities.

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Editor-in-Chief: Krista Wilkinson

Editor: Cynthia Cress

Received May 17, 2017

Revision received September 5, 2017

Accepted October 17, 2017

https://doi.org/10.1044/2017_AJSLP-17-0066

Disclosure: The authors have declared that no competing interests existed at the time of publication.

The National Reading Panel examined the status of research-based knowledge on the effectiveness of various reading approaches for teaching typically developing children to read (U.S. Department of Health and Human Services, National Institute of Child Health and Human Development, 2000) and found that instruction in phonics and PA was highly effective. In their report, the National Reading Panel suggested that future research should include populations of children with disabilities. The Institute for Education Sciences (IES) National Center for Special Education Research conducted a review of centers receiving funding for reading research in at-risk populations (Connor, Alberto, Compton, & O'Connor, 2014). This IES review found that, although the amount of time required to achieve basic literacy skills was substantially longer for children with intellectual and developmental disabilities (IDD) compared to their typically developing peers, relationships between PA and reading achievement found in students with IDD were similar to those found in their typically developing peers. When examining the literature for research on instruction in PA, specifically for children with developmental disabilities and severe speech impairments, Barker, Saunders, and Brady (2012) found only eight studies, with a total of 26 children, that attempted to teach PA and individual word reading to children with severe speech impairments. In order for adequate reading intervention strategies to be implemented, we must understand the factors at play for children with IDD who have limited speech when learning to read. With recent advances in the use of experimental methods to assess PA in children with limited speech (Barker, Bridges, & Saunders, 2014; Gillam, Fargo, Foley, & Olszewski, 2011; Preston & Edwards, 2010), there is a need for systematic exploration of the PA skills of these children at the early stages of reading development. Understanding the impact of speech and language on the development of PA is critically needed so we can encourage reading development in children with IDD in preschool.

PA

Development of Phonological Awareness

PA refers to an explicit and conscious awareness of the sound structure of a language and the ability to manipulate segments of phonemes (McArdle & Chhabra, 2004; Perfetti, 1985; Stanovich, 1986). Ehri (2004) suggested the development of PA begins with an awareness of words that rhyme, then an awareness that words are composed of component sounds and sound segments (e.g., onsets, rimes) that are blended together to form a word. Finally, children are able to manipulate sound segments of words as evidenced by their ability to perform phoneme deletion tasks (e.g., say smile without the /s/). In order to perform PA tasks at the level of the individual phoneme however, children must understand that sound blends within a word are further composed of individual phonemes. For example, the word trip may be divided into an onset syllable /tr/ and rime syllable /ɪp/ or into individual phonemes of /t/ /r/ /ɪ/ /p/ (Treiman & Zukowski, 1991). Children between the ages

of 4 and 5 more readily break words first into their component onset and rime syllables rather than into smaller individual phonemic units. Children 7 years of age, on average, are able to break words into individual phonemic units (Treiman & Zukowski, 1991).

Perfetti (1985) suggested that linguistic knowledge may be a more accurate characterization of what children bring to the development of reading. This linguistic knowledge is commonly assessed using PA tasks to understand the relationships between linguistic knowledge and reading development. This relationship between children's knowledge of the sound structure of his or her language and learning to read may be reciprocal such that as children apply phonological knowledge to printed words, they use these printed words to further understand and refine their phonological knowledge. For example, in a longitudinal study by Perfetti, Beck, and Hughes (1981), two kinds of phonemic knowledge were emphasized: phoneme synthesis (e.g., knowing that /k/ /æ/ /t/ = cat) and phoneme analysis (e.g., knowing that cat without /k/ = at). Perfetti and colleagues found that children were able to perform phoneme synthesis tasks prior to reading printed words; however, the ability to perform phoneme analysis tasks followed progress in word reading. According to Perfetti et al. (1981), children's access to the use of letters to code phonological representations refined children's phonological knowledge. Children learn to use orthographic patterns as visual representations of speech sounds and begin to then more readily parse the sounds in words. It is unclear if there is a similar developmental progression in children with developmental disabilities.

The Role of Speech

The knowledge children have about the sound structure of their language is believed to play a critical function in bridging the development of children's speech processes to reading processes (Frost et al., 2009). As Liberman, Shankweiler, and Liberman (1989) discussed, letters do not actually represent the sounds within a word but, instead, represent the underlying phonology. When three component sounds of a word are blended, the actual sound that is produced is different from its component parts represented by the letters on the page. Children typically first learn individual letter-sound relationships. This relationship deepens as children learn that combinations of letters represent certain sounds that may be different than their component parts first learned by mapping individual letters to sounds (e.g., sh is pronounced /ʃ/ and not /s/ /h/). Results from functional neuroimaging of children between 6 and 10 years of age suggested that as reading develops in children, the brain engages areas to process written language that were originally focused on processing phonological information in speech (Frost et al., 2009).

Children With Speech Sound Disorders

The relationship between expressive speech ability and PA has been explored in a number of studies involving preschool-age children with speech sound disorders

thought to be at risk for delayed reading development (Anthony et al., 2011; McNamara, vanLankveld, van Vervaeke, & Gutknecht, 2010; Preston & Edwards, 2010). In a study by Preston and Edwards (2010), children with speech sound disorders who had speech errors that are truly deviant in nature were found to have a more poorly specified phonological representational system that impacted PA skill differently than in children who were delayed in their development relative to chronological age or children who used speech sound distortions (e.g., children who use lateralized /s/). This research investigating relationships between speech sound disorders and PA skill in preschool-age children has provided an important framework to further explore hypotheses related to speech production and PA so that we may better understand differences in children's phonological representational systems that are critical to later reading development. Limited research has been conducted to determine the correlates of speech ability to PA in children who have significant limitations in speech (e.g., dysarthria, apraxia of speech) such that they are unable to produce functional speech.

Phonological Awareness in Children With Limited Speech

Opportunity for participation in activities of PA is often limited for children with developmental disabilities who have difficulty in producing speech. A small number of studies to date have explored the relationship between expressive speech ability and PA in preschool-age children who have limited to no motor speech ability, with a greater number of studies involving individuals who are school-age or adults. (Bishop & Robson, 1989; Card & Dodd, 2006; Foley & Pollatsek, 1999; Gillon, 2005; Iacono & Cupples, 2004; Sutherland & Gillon, 2007; Vandervelden & Siegel, 1999, 2001). Given that individuals with limited speech ability are a heterogeneous group, the study of the impact of speech ability on PA is inherently complex. The current literature involving individuals with limited speech yields few generalizable results but is composed of key studies that raise important questions for further exploration.

Historically, the most readily available way to infer phonological abilities has been to use nonword spelling tasks. In individuals with cerebral palsy who were anarthric or dysarthric, severity of speech impairment did not affect participants' ability to accurately spell nonwords (Bishop & Robson, 1989). More comprehensive measures of PA, such as word and nonword blending, phoneme counting, and phoneme analysis, were reported by Iacono and Cupples (2004) in adults with limited speech ability. Positive associations between phonemic awareness and word reading in 34 adults with limited speech ability were found. In these studies of adults with cerebral palsy and roughly average intellectual ability, speech ability did not appear to play a critical role in their development of PA and ultimate application to print when assessed via nonword spelling tasks.

There is little research aimed at understanding the development of PA in children with very limited speech ability (Card & Dodd, 2006; Gillon, 2005; Peeters, Verhoeven, de Moor, & van Balkom, 2009; Peeters, Verhoeven, van

Balkom, & de Moor, 2008; Vandervelden & Siegel, 1999). Furthermore, studies inclusive of children with mild to moderate intellectual impairment are extremely limited. Studies to date have focused broadly on considerations of PA instruction and the links to reading ability or the development of adapted PA assessment tools for children with limited speech (Barker et al., 2012; Johnston, Davenport, Kanarowski, Rhodehouse, & McDonnell, 2009; Machalicek et al., 2010). In a study to investigate the importance of speech ability in the development of PA, five children with cerebral palsy who could speak and six children with cerebral palsy who could not speak between the ages of 6 and 12 were assessed for rhyming ability, phoneme and syllable segmentation, and phoneme identification and manipulation ability (Card & Dodd, 2006). Children who could speak performed better on tasks of phoneme manipulation (elision) and visual rhyme identification tasks, but not on any of the other tasks of PA requiring them to identify the number of syllables or phonemes in a word; identify syllables in the beginning, middle, or end of a word; identify spoken rhyming words; and read nonwords using an adapted response. This study suggested that the ability to speak may be important for some aspects of PA, but the ability to produce speech is not necessary for the development of all aspects of PA. Therefore, the development of phonological representations may not be entirely dependent on speech ability (Card & Dodd, 2006). Alternately, elision is one of the most advanced phonological skills (Ehri, 2004; Treiman & Zukowski, 1991) and only develops after children begin to read and can readily segment words using a visual representational system similar to that in print (Perfetti, 1985). The participants in the Card and Dodd (2006) study were not fluent readers; therefore, their hypothesis concerning the extent to which articulation is engaged to solve elision tasks remains a question.

In a longitudinal study of children between 5 and 6 years of age with cerebral palsy, Peeters et al. (2009) found a strong effect of speech production skill at baseline on PA 1 year later. Speech production was found to play an important role in the development of PA such that children who had better articulation skills were more aware of the sound structure of their language. Vandervelden and Siegel (1999) investigated phonological processing in children and adolescents with cerebral palsy and a range of speech ability and found no significant differences between participants with cerebral palsy and no speech impairment and participants with cerebral palsy and speech impairment. Further research with preschool-age children using a range of PA tasks that involve children who have a range of speech ability and etiology other than cerebral palsy is warranted to better understand the implications of limited speech ability on the development of PA.

Impact of IDD on PA

In children and adults with IDD who are able to speak, PA has been found to have a positive, predictive relationship to reading ability as in children without disabilities (Barker et al., 2014; Bradford, Shippen, Alberto, Houchins, & Flores, 2006; Cupples & Iacono, 2000; Hedrick, Katims, &

Carr, 1999; Saunders & DeFulio, 2007; Wise, Sevcik, Romski, & Morris, 2010). Foundations of PA for individuals with IDD are described by Peeters et al. (2008) as skills such as nonverbal reasoning, speech ability, auditory perception, auditory short-term memory, and vocabulary; however, it is not clear that development in each of these areas is necessary for the acquisition of PA. When using the Wechsler Intelligence Scale for Children–Third Edition (WISC-III; Wechsler, 1991) to measure intelligence (IQ), Conners, Atwell, Rosenquist, and Sligh (2001) found intelligence was not consistently related to the strength of decoding skills for 65 children with IDD. Children who were stronger decoders of print were significantly better than weaker decoders of print in language ability, PA, and phonological memory but did not necessarily have higher IQ scores. Because of historical limitations in assessment tools for the evaluation of PA and other reading skills (e.g., letter knowledge, letter–sound knowledge) in children with limited speech, no extant research has examined the factors involved in the development of early literacy skills in preschool-age children with IDD and speech impairment.

Assessment Tasks for Phonological Awareness

Ehri (2004) described the need to consistently define what is meant by PA across reading research. As evident in the studies reviewed thus far, this need becomes particularly important when we discuss individuals with IDD who may have a range of ability, including a range of speech, language comprehension, and vocabulary skills. The measurement tools we use and how we define the skills they assess are of critical importance to make conclusions about the developmental processes at play in reading development.

A number of tasks have been used in the literature to date to assess PA. Depending on the particular component of PA assessed, these tasks lie along a developmental continuum. Rhyming tasks use ending rime sounds to ask the child to identify words that rhyme or sound the same. Onset–rime manipulation tasks ask the child to isolate, identify, segment, or blend syllables of a word that appear at the beginning (onset) or end (rime). Tasks that assess PA at the level of the individual phoneme include phoneme isolation tasks, where the child is asked to identify the first or last sound of a word. Phoneme blending tasks require the child to put component phonemes together to make a whole word. Inherently, each of these tasks requires productive speech output and place retrieval demands on a child's extant vocabulary knowledge.

Phonological Assessment for Children With Limited Speech

Currently, few assessment tools exist to evaluate phonological skills in children with limitations in speech. Many of these tools are experimental, are part of an instructional curriculum (Browder, Ahlgrim-Dezell, & Wood, 2015; Light & McNaughton, 2009), or only assess one level or type of PA skill (Barker et al., 2014; Gillam et al., 2011; Vandervelden & Siegel, 2001; Williams, 2014). Preston and Edwards (2010)

developed an experimental PA assessment that did not require a spoken response in order to assess PA in children with speech sound disorders. Phonological skills that were assessed included rhyme matching, onset segmentation, onset matching, onset–rime blending, and blending of individual phonemes to make a word. With recent advances in experimental tools to assess PA in children with limited speech ability, more research is warranted using these tools with children with IDD as early as preschool. This study extends the use of the experimental task developed by Preston and Edwards (2010) to preschool-age children with developmental disabilities who have a range of speech ability.

Current Study

This study describes relationships between receptive language, speech ability, early literacy skills, and PA in preschool-age children between 48 and 69 months of age with developmental disabilities. Three specific research questions are asked in order to make conclusions regarding intrinsic factors related to the development of PA:

1. What are the profiles of PA, print and letter–sound knowledge, developmental skill, receptive vocabulary, and speech ability in preschool-age children with developmental disabilities?
2. What is the relationship between PA, print and letter–sound knowledge, developmental skill, receptive vocabulary, and speech ability in preschool-age children with developmental disabilities?
3. When controlling for developmental skill and print and letter–sound knowledge, does speech ability account for a significant amount of variance in PA in preschool-age children with developmental disabilities?

Method

A nonexperimental study design was used to examine the relationship between a range of variables to PA in children with developmental disabilities between the ages of 48 and 69 months. All participants completed a series of assessments that measured skills including speech, language, orthographic knowledge, and PA. Relationships between these intrinsic skills to PA were examined across the entire group of participants. Control over the order of administration of measures was counterbalanced using a Latin square design. The age range of 4–5 years was chosen because this is the age when typically developing children are able to complete tasks of PA and begin PA instruction in preschool. Because a central question in this study was to determine the role of intrinsic factors including speech ability and developmental skill on PA skills, these abilities were allowed to vary across participants recruited for the study.

Participants

Forty-two children between the ages of 48 and 69 months ($M = 56$ months, $SD = 6.36$ months) with

developmental disabilities and a range of speech ability were recruited. Participants who met state criteria and district eligibility for enrollment in preschool special education services under the Individuals With Disabilities Education Act Part B and received a score of at least 2 *SDs* below average on one or more of the subtests of the Mullen Scales of Early Learning (MSEL; Mullen, 1995) were included. All four subtests of the MSEL (Fine Motor, Visual Reception, Receptive Language, and Expressive Language) were used to evaluate and ensure that children included in the study were children with a developmental delay in areas other than motor speech ability, receptive language, or expressive language alone. Approval was granted from a local metro Atlanta area school district to recruit participants, along with approval from nine private preschool programs for children with developmental disabilities and metro Atlanta area clinics and recreational programs for children with developmental disabilities.

Three of the 42 children were a set of triplets, and two other participants of the total 42 children were siblings. Twenty-one of the children were African American (50%), one child was Asian, two were multiracial, 17 were White (40%), and one identified as other race. Thirty children were male (71%), and 12 were female. Seventeen children (40%) had a diagnosis of autism spectrum disorder, seven (16%) were diagnosed with global developmental delay, six (14%) had Down syndrome, and six (14%) had specific diagnoses of fragile X syndrome, Phelan-McDermid syndrome, Smith-Magenis syndrome, Angelman syndrome, tuberous sclerosis complex, and histiocytosis. Three children's parents reported unknown etiology, and three children's parent (parent of the triplets) did not return the demographic survey to report diagnosis. Because one parent of triplets did not return the demographic survey and another parent had two children in the study, demographic information from 38 parents was collected. The average age of each child's consenting parent was 38.40 years of age (*SD* = 9.15, range 21.53–72.94). One parent was male, and 37 parents were female. Thirty-five of the 38 parents reported their education level. Ten parents had at least a high school education, four parents had at least associate degrees, 11 parents had at least a bachelor's degree, seven had master's degrees, and three had doctoral degrees.

Recruitment targeted children with a range of speech ability from limited impairment in expressive speech to

significant impairment in expressive speech ability. Table 1 describes children's speech characteristics as measured by the Kaufman Speech Praxis Test for Children (KSPT; Kaufman, 1995), an assessment used to measure oral motor skill (Part 1), motor speech production (Parts 2 and 3), and speech intelligibility (Part 4).

Speech intelligibility, as measured by the KSPT Part 4 for children, ranged from 0 (*complete unintelligibility*) to 7 (*complete intelligibility*), with a mean of 3.57 (*SD* = 2.62; decodable). Eighteen children had a range of mild to severe verbal apraxia, seven had speech sound (articulation) disorders, eight children had dysarthria of speech with a range from mild to severe (six children had flaccid dysarthria and two had mixed flaccid/spastic dysarthria), and nine had no speech disorder. Seventeen children used speech in sentences; eight children used short phrases; seven children used single words for communication; eight children primarily communicated using either gestures, vocalizations, or physical touch/manipulation; and two children used an SGD AAC system as a primary means of communication.

Participants had a range of language ability and evidenced intentional communication in at least one modality of speech, gesture, sign, or use of visual-graphic symbols on an AAC system. All participants had upper extremity motor skills necessary for direct selection of pictures on an easel or computer touch screen. Children were excluded if they met school district eligibility under the categories of deafblind, deaf/hard of hearing, emotional and behavioral disorder, and visual impairment or used English as a second language.

Setting

Parental consent for participation in the study was obtained by distributing consent forms to 12 special education pre-Kindergarten classrooms across nine elementary schools. A total of 24 children from the nine different elementary schools returned consent forms to allow his or her participation in the study. These 24 children were seen for direct assessment in their local preschool in a separate room nearby their classroom free of distraction. Nine of the 42 children were recruited for participation from three private preschool programs in the metro Atlanta area serving children with developmental disabilities. These nine children were seen for direct assessment in their preschool in a

Table 1. Mean raw, standard scores, range, and confidence intervals on the Kaufman Speech Praxis Test.

Measure	Raw <i>M (SD)</i>	Range	95% CI	Standard score ^a <i>M (SD)</i>	Range	95% CI
Kaufman Part 1	8.00 (3.90)	0–11	±1.18	82.17 (35.47)	2–111	±10.73
Kaufman Part 2	44.40 (24.51)	0–63	±7.41	66.43 (49.50)	1–113	±14.97
Kaufman Part 3	38.07 (30.41)	0–80	±9.20	87.62 (30.67)	45–129	±9.28
Kaufman Part 4	3.57 (2.62)	0–7	±0.79	94.60 (18.75)	61–121	±5.67

Note. CI = confidence interval; Kaufman = Kaufman Speech Praxis Test for Children (Kaufman, 1995).

^aMean standard scores are reported from the normative sample of children with speech impairments in the Kaufman Speech Praxis Test for Children.

separate room nearby their classroom. The remaining nine of 42 children were recruited from metro Atlanta area clinics and recreational programs for children with IDD. Seven children were seen at the recreational center where they were recruited, and two children traveled to Georgia State University where they were seen in a research laboratory setting.

Assent was obtained from the child by continuously monitoring his or her willingness to participate throughout the entire assessment process. A single examiner, the first author, conducted all direct assessment with children in the study. At least two assessment sessions, and sometimes a third, were conducted with each child. Assessment sessions ranged from 30 min to 1.5 hr each depending on the child's ability to sustain a meaningful level of engagement with the task as judged by the examiner. Breaks were incorporated as necessary for each child to remain attentive. In the event a child was not able to attend long enough to complete all of the measures planned for each session, a third visit was scheduled to complete the remaining tasks. All assessment sessions were completed in no longer than 2 weeks.

Assessment Measures

A series of standardized and experimental measures were used. Table 2 summarizes each measure that was used, the skills it assessed, and estimated time of administration. A speech-language pathologist administered and scored all assessments. A graduate speech-language pathology student trained in the assessment tools used scored 20% of the assessments to check for reliability of raw and standard score calculations done by the examiner. An agreement score of 0.98 was found by dividing the number of agreements by the number of agreements plus disagreements for the scoring of all direct assessments.

Speech Assessment

The KSPT (Kaufman, 1995) was used to assess oral motor skills and speech ability. Administration time took between 5 and 15 min. The KSPT allows for precise identification and description of children's motor speech proficiency using imitative responses across four subtests. Subtest 1 elicits information about the child's ability to imitate oral motor movements, such as opening their mouth, moving their tongue left to right, and puckering their lips. Subtest 2 elicits imitation of a range of speech sounds beginning with a series of pure vowel sounds in isolation (e.g., /i/ as in "hit"), progressing to vowel-to-vowel movement (e.g., /ai/ as in "high"), consonant production in isolation (e.g., /m/) and continues to elicit an increasingly more difficult series of vowel (V)-to-consonant (C) movement imitation tasks (e.g., imitation of CVCV words such as "mama," CV1CV2 words such as "bubble") that culminate in the ability to imitate words that have C1V1C2V2 structure (e.g., the word "happy"). Subtest 3 elicits imitation of complex consonant productions such as consonant blends (e.g., /s/ blends such as "swing," /r/ blends such as "frog") and complex polysyllabic words that involve CVCVCV sequencing such as "banana," "invitation," and the rapid and accurate production of the nonsense word /patəkə/. Subtest 4 allows the rater to score the child's spontaneous speech on a scale of 0–7 as completely unintelligible, decodable, or completely intelligible. Children were initially administered only Parts 1, 3, and 4. If a child was unable to complete Part 3, then Part 2 was administered. A raw composite score to describe motor speech ability was derived for each child by adding raw scores of Parts 2 and 3 for the KSPT. Raw scores for speech intelligibility were determined by Part 4. Mean standard scores used descriptively in this study were derived from the normative data of children with speech impairments on the KSPT. Raw scores were used in all data analyses.

Table 2. Assessment measures.

Measure	Skill(s) assessed	Time (min)	Standardized assessment	Experimental measure
<i>Initial visit</i>				
Kaufman Speech Praxis Test (Kaufman, 1995)	Speech ability	5–15	X	
Mullen Scales of Early Learning (Mullen, 1995)	Developmental skills of receptive and expressive language, visual reception, and fine motor skills	40–60	X	
Peabody Picture Vocabulary Test–Fourth Edition (Dunn & Dunn, 2007)	Receptive vocabulary	10–15	X	
Nonspeech phonological awareness assessment tasks (Preston & Edwards, 2010)	Rhyme matching, onset segmentation, onset matching, onset–rhyme blending, and blending of individual phonemes	20–30		X
Phonological Awareness Literacy Screening–PreK (Invernizzi, Sullivan, Meier, & Swank, 2004)	Conventions of print within the context of a book	10	X	
Section IV: Print and Word Awareness				
Phonological and Print Awareness Scale (Williams, 2014)	Uppercase and lowercase letter identification, letter–sound identification	10	X	
Subtest II: Print Knowledge				
Subtest V: Sound-Symbol Identification				

Although the KSPT does not determine dysarthria in children, the KSPT elicited oral motor movements and speech from the child that could be observed for characteristics of dysarthria. A supplemental checklist of symptoms of dysarthria adapted from Yorkston, Beukelman, Strand, and Hakel (2010) was used to identify children who have dysarthria. A child was determined to have dysarthria if he or she was observed to have at least one characteristic of dysarthria in two or more of the areas listed in the checklist (jaw, lips, tongue, velopharyngeal function, or respiration and phonation). The adapted checklist used in this study can be found in the Appendix.

Vocabulary, Language, and Developmental Skill

The Peabody Picture Vocabulary Test–Fourth Edition (Dunn & Dunn, 2007) was used to assess single-word receptive vocabulary. The MSEL was used to assess language and developmental skills across four scales: Visual Reception, Fine Motor, Expressive Language, and Receptive Language. The average time to complete the assessment for all children was between 40 and 60 min. The MSEL provides normalized *T* scores ($M = 50$, $SD = 10$), percentile rankings, and age-equivalent scores for each of the four scales, along with an overall early learning composite ($M = 100$, $SD = 15$). With the exception of the Expressive Language subscale, the MSEL relies very little on a spoken response to assess Receptive Language, Visual Reception, and Fine Motor skills, making it appropriate to use with the children in this study. A raw composite score of developmental skill was derived by adding the raw scores of the subtests of Visual Reception, Fine Motor, and Receptive Language to use in data analyses.

Conventions of Print and Print Knowledge

The Phonological Awareness Literacy Screening–PreK (PALS–PreK; Invernizzi, Sullivan, Meier, & Swank, 2004) was used to assess early literacy skills related to conventions of book reading. Only Section IV: Print and Word Awareness of the Phonological Awareness Literacy Screening–PreK was administered. This subtest uses a rhyming book, *Hey Diddle Diddle*, to assess knowledge of literacy broadly. Children were asked to find the title of the book, point to separate words, match words, show their understanding of the directionality of print, identify letters in a sentence, and point to words spoken by the examiner. The maximum raw score for this subtest is 10, with average raw scores for children in pre-kindergarten (PreK) between 7 and 9.

The Phonological and Print Awareness Scale (PPA; Williams, 2014) was used to measure early literacy skills of letter knowledge and letter–sound identification. A multiple-choice format is used for each subtest so that a spoken response is not required. The examiner read the instructions to the child, and the child pointed to his or her answer. Subtest II: Print Knowledge and Subtest V: Sound–Symbol Identification were used. Subtest II assessed print knowledge by evaluating the child’s ability to identify uppercase and lowercase letters. Subtest V evaluated the child’s

ability to identify phonemes (sounds) that matched corresponding letters in the initial and final position of words.

Phonological Awareness

PA was assessed using experimental assessment methods as described by Preston and Edwards (2010). Experimental measures from Preston and Edwards (2010) were presented to participants using a touch-screen tablet device. Four pictures were presented on the touch screen for the child to choose from. A standard recording was presented to the child for each item within each subtest to identify the target word or phoneme(s) they were to choose or blend to identify its picture referent. Each color picture was named prior to the child’s selection of the correct answer to ensure he or she had the opportunity to pair the word representing each picture with its name. Five practice items were presented prior to the subtests of rhyming, onset segmentation, and onset matching. At least two practice items were presented prior to the subtests of onset–rime blending and blending phonemes. A child received 1 point for each test item answered correctly thereafter. Phonological skills that were assessed included 16 items of rhyme matching (e.g., “Which one rhymes with Dan?”) 10 items of onset segmentation (e.g., “Which one begins like Tom?”), 10 items of onset matching (e.g., “Which one begins with /p/?”), six items of onset–rime blending (e.g., “Which one is a picture of /f - ɪ f/?”), and six items of blending of individual phonemes (e.g., “Which one is a picture of /f - ɪ - f/?”). Raw scores were calculated for each subtest. An overall composite score was calculated by adding scores across each subtest.

Results

Descriptive Profiles

Children were divided into four groups based on their performance on the KSPT and dysarthria assessment (verbal apraxia, articulation disorders, dysarthria of speech, or no speech disorder). Participants were divided into these groups for descriptive purposes in order to show the variability in performance within each group on developmental, language, and reading measures used in the study reported in Tables 3 and 4. Mean raw and standard scores, standard deviations, and distributions for all direct assessment measures of receptive and expressive language, visual reception, fine motor skills, and receptive vocabulary for the 42 children are reported in Table 3. Mean raw scores, standard deviations, and distributions for all direct assessment measures of early reading skills including print and word awareness, letter and letter–sound knowledge, and PA are reported in Table 4. Children within each speech diagnostic category evidenced a range of skill in all areas of direct assessment.

PA scores were evaluated to determine if a combination of raw scores from subtests of the PA experimental assessment task (Preston & Edwards, 2010) could be used to represent a composite score for PA. Table 5

Table 3. Children's performance on measures of developmental, language, and vocabulary skill by speech diagnosis.

Group	<i>n</i>	CA in months <i>M</i> (<i>SD</i>)	PPVT-IV	Mullen Scales of Early Learning				
			<i>M</i> (<i>SD</i>) (range)	Visual Reception <i>M</i> (<i>SD</i>) (range)	Fine Motor <i>M</i> (<i>SD</i>) (range)	Receptive Language <i>M</i> (<i>SD</i>) (range)	Expressive Language <i>M</i> (<i>SD</i>) (range)	Early Learning Composite <i>M</i> (<i>SD</i>) (range)
Apraxia of speech	18	57.53 (6.69)	59.00 (23.07) (20–109)	24.83 (8.99) (< 20–53)	23.61 (10.05) (< 20–53)	20.94 (5.49) (< 20–37)	20.83 (5.17) (< 20–36)	53.56 (9.69) (48–81)
Articulation disorder	7	55.29 (6.45)	85.71 (12.55) (72–106)	47.29 (13.87) (33–74)	30.29 (8.60) (20–41)	29.29 (10.11) (< 20–47)	30.00 (7.26) (< 20–38)	70.71 (13.40) (58–97)
Dysarthria	8	56.25 (7.54)	72.75 (16.56) (45–95)	32.50 (18.34) (< 20–59)	23.37 (7.96) (< 20–39)	26.62 (12.69) (< 20–49)	25.50 (9.19) (< 20–39)	61.50 (16.70) (48–88)
No speech impairment	9	57.22 (5.50)	94.11 (13.91) (82–128)	39.78 (13.42) (20–61)	36.44 (17.99) (20–67)	42.33 (15.82) (21–67)	36.22 (11.18) (20–57)	79.44 (20.13) (49–105)

Note. Mullen Scales of Early Learning (Mullen, 1995) subscales are based on a mean of 50 and a standard deviation of 10; Early Learning Composite is based on a mean of 100 and a standard deviation of 15. Peabody Picture Vocabulary Test–Fourth Edition (Dunn & Dunn, 2007) scores are based on a mean of 100 and a standard deviation of 15. CA = chronological age in months; PPVT-IV = Peabody Picture Vocabulary Test–Fourth Edition.

Table 4. Children's performance on measures of early reading skills of print and word awareness, letter and sound-symbol awareness, and phonological awareness by speech diagnosis.

Group	n	CA M (SD)	PALS-PreK	PPA		Phonological Awareness					Total score (max = 48)
			Print and word awareness (max = 10)	Print knowledge (max = 17)	Sound-symbol awareness (max = 11)	Rhyme matching (max = 16)	Onset segmentation (max = 10)	Onset matching (max = 10)	Onset-rime blending (max = 6)	Phoneme blending (max = 6)	
			Raw M (SD) (range)	Raw M (SD) (range)	Raw M (SD) (range)	Raw M (SD) (range)	Raw M (SD) (range)	Raw M (SD) (range)	Raw M (SD) (range)	Raw M (SD) (range)	
Apraxia of speech	18	57.28 (6.62)	3.07 (2.74) (0-8)	6.61 (4.96) (0-13)	2.50 (2.81) (0-9)	3.67 (2.70) (0-9)	1.56 (1.34) (0-4)	1.72 (0.87) (0-5)	1.44 (1.65) (0-4)	1.44 (1.42) (0-4)	9.83 (7.41) (0-19)
Articulation disorder	7	55.29 (6.45)	5.71 (2.43) (3-9)	11.00 (3.42) (5-16)	4.00 (3.46) (1-11)	5.43 (2.57) (2-10)	4.57 (2.64) (2-10)	4.14 (2.12) (2-7)	2.86 (0.90) (1-4)	2.57 (1.51) (0-4)	19.57 (6.68) (12-32)
Dysarthria	8	56.25 (7.54)	3.75 (2.77) (0-7)	6.88 (3.98) (3-12)	2.63 (2.45) (0-8)	3.50 (3.21) (0-9)	1.75 (1.28) (0-3)	1.50 (1.51) (0-4)	1.50 (1.69) (0-4)	1.62 (1.19) (0-4)	9.88 (6.38) (1-21)
No speech impairment	9	57.22 (5.50)	6.22 (2.05) (3-9)	11.44 (3.50) (3-15)	4.56 (3.47) (0-10)	6.00 (4.53) (1-15)	2.67 (2.96) (0-9)	4.67 (3.54) (0-10)	2.22 (1.30) (1-4)	2.11 (1.90) (0-6)	17.67 (10.83) (5-40)

Note. CA = chronological age in months; PALS-PreK = Phonological Awareness Literacy Screening-PreK (Invernizzi et al., 2004); PPA = Print and Phonological Awareness Scale (Williams, 2014); max = maximum raw score.

Table 5. Summary of Pearson correlations, means, standard deviations, and 95% confidence intervals for scores on the experimental nonspeech phonological awareness assessment tasks.

Measure	1	2	3	4	5	6
1. Rhyming	—					
2. Onset segmentation	.54**	—				
3. Onset matching	.48**	.72**	—			
4. Onset–rime blending	.65**	.51**	.50**	—		
5. Blending phonemes	.24	.53**	.51**	.32*	—	
6. Composite score	.81**	.85**	.83**	.75**	.60*	—
<i>M</i>	4.43	2.33	2.71	1.86	1.81	13.14
<i>SD</i>	3.30	2.22	2.62	1.54	1.52	8.81
95% CI	±1.00	±0.67	±0.79	±0.47	±0.46	±2.66

Note. CI = confidence interval.

* $p < .05$. ** $p < .01$.

presents a summary of correlations for each subtest of PA. Medium to large significant correlations were found between all subtests of PA, except for the correlation between the subtests Blending Individual Phonemes and Rhyming.

A principal components analysis was run to determine if all subtest items were suitable for combining into one composite score of PA. The overall Kaiser–Meyer–Olkin measure was .782, and Bartlett’s test of sphericity was statistically significant ($p = .000$), indicating that the data were likely factorizable. The principal components analysis revealed one component with an eigenvalue greater than 1 and explained 60.49% of the total variance. Visual inspection of the scree plot confirmed one component should be retained. All subtests loaded on one component at .649 or above. Chronbach’s alpha for the five subtests was .809. A composite raw score for PA was derived by adding all subtest scores of PA and was used in further data analyses.

Relationships Between PA, Early Literacy Knowledge, Developmental Skills, and Speech

A Pearson partial correlation analysis was conducted to examine the relationship between PA; children’s developmental skill as assessed by the MSEL subtests of Visual Reception, Fine Motor, and Receptive Language; children’s speech ability; early reading measures of print and word awareness; letter knowledge; letter–sound knowledge; and receptive vocabulary. Table 6 presents a summary of correlations between raw scores for each measure with means, standard deviations, and 95% confidence intervals. Medium to large significant correlations were found between PA and all other measures, except letter–sound knowledge.

Speech Ability and Phonological Awareness

To determine if speech ability accounted for a unique amount of variance in PA skill beyond what would be

expected by developmental skill and print and letter–sound knowledge, a hierarchical linear regression was done. All variables met the assumptions required for hierarchical regression analysis using the Baron and Kenny (1986) method. With an alpha level of .05 and sample size of 42, the power to detect a large effect is 0.83. Participant age and developmental skill was entered in Step 1, print and letter–sound knowledge was entered in Step 2, and speech ability was entered in Step 3 to determine if speech ability accounted for a significant amount of variance in PA skill beyond what would be expected by print and letter–sound knowledge.

Raw scores were used in the regression equation for all variables. A composite raw score for developmental skill was derived by adding raw scores across the Visual Reception, Fine Motor, and Receptive Language subtests of the MSEL. Because of the Expressive Language subscale being highly correlated ($r = .90$) with speech ability, the Expressive Language subtest of the MSEL was not included in the regression equation. A raw score for print and letter–sound knowledge was derived by combining raw scores for the two subtests of Print Knowledge and Sound-Symbol Awareness of the PPA. A raw score for speech ability was derived by adding the raw scores from Subtests 2 and 3 of the KSPT.

There was independence of residuals as assessed by a Durbin–Watson statistic of 2.333. There was homoscedasticity as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values. A linear relationship was present between all variables. Figure 1 shows the scatter plot matrices with 95% confidence intervals for the variables of PA, developmental skill, print and letter–sound knowledge, and speech ability used in the regression equation. A main question of interest, the relationship between speech ability and PA, is depicted in Figure 1. Children with the lowest speech ability evidenced a range of PA skills, many with raw scores above 10, whereas children with the greatest speech ability also evidenced a range of PA skills. Table 7 reports the bivariate correlations for variables used in the regression equation.

A hierarchical multiple regression was run to determine if speech ability accounted for a unique amount of variance in PA skill beyond what would be expected by developmental skill and letter and letter–sound knowledge. See Table 8 for full details on each regression model. The full model of age, developmental skill, letter and letter–sound knowledge, and speech ability to predict PA (Model 3) was statistically significant, $R^2 = .431$, $F(4, 37) = 7.005$, $p = .000$, adjusted $R^2 = .369$. The addition of age and developmental skill to the prediction of PA (Model 1) led to a statistically significant ΔR^2 of .263, $F(2, 39) = 6.946$, $p = .003$. The addition of print and letter–sound knowledge to the prediction of PA (Model 2) also led to a statistically significant ΔR^2 of .163, $F(3, 38) = 9.377$, $p = .002$. In the final model, however, the addition of speech ability to the prediction of PA (Model 3) did not lead to a statistically significant ΔR^2 of .006, $F(4, 37) = 7.005$, $p = .552$. Speech ability did not explain a significant amount of variance in PA

Table 6. Summary of Pearson correlations between phonological awareness, developmental skills, print and word awareness, letter knowledge, letter–sound knowledge, receptive vocabulary, and speech ability.

Measure	1	2	3	4	5	6	7	8	9	10
1. PA composite	—									
2. Visual reception	.451**	—								
3. Fine motor	.499**	.776***	—							
4. Receptive language	.458**	.842***	.735***	—						
5. Expressive language	.660***	.816***	.782***	.866***	—					
6. Speech ability	.457**	.821***	.729***	.822***	.908***	—				
7. PALS-PreK	.548***	.743***	.695***	.716***	.828***	.805***	—			
8. Print knowledge	.531***	.664***	.629***	.606***	.671***	.602***	.557***	—		
9. Letter–sound knowledge	.595***	.369*	.417**	.341*	.451**	.299	.443**	.569***	—	
10. PPVT-IV	.617***	.766***	.747***	.857***	.858***	.775***	.791***	.675***	.547***	—
<i>M</i>	13.14	38.43	33.60	31.24	28.52	82.48	4.12	8.43	3.21	45.67
<i>SD</i>	8.81	9.21	8.19	8.81	9.90	53.07	2.91	4.70	3.03	26.71
95% CI	±2.66	±2.79	±2.48	±2.66	±2.99	±16.05	±0.88	±1.42	±0.92	±8.80

Note. PA = phonological awareness; Speech ability = Kaufman Speech Praxis Test for Children Part 2 and Part 3 raw composite (Kaufman, 1995); PALS-PreK = Phonological Awareness Literacy Screening–PreK (Invernizzi et al., 2004); PPVT-IV = Peabody Picture Vocabulary Test–Fourth Edition (Dunn & Dunn, 2007); CI = confidence interval.

* $p < .05$. ** $p < .01$. *** $p < .001$.

beyond what would be expected by age, development skill, and print and letter–sound knowledge.

Discussion

This study contributes to our understanding of the relationship between key intrinsic factors that are related

to the development of PA in children with developmental disabilities during preschool. Of particular interest in this study is the contribution of speech ability to PA skill. This study extends prior research with school-age children, adolescents, and adults in systematically evaluating the relationship between speech ability and early reading skills inclusive of PA in children between the ages of 4 and 5

Figure 1. Scatter plot matrices with 95% confidence intervals for the relationship between phonological awareness, developmental skill, print and letter–sound knowledge, and speech ability.

Table 7. Pearson correlations of measures of phonological awareness, orthographic knowledge, speech ability, and developmental skill.

Measure	1	2	3	4	5
1. PA composite	—				
2. Age	.275*	—			
3. Developmental skill	.506**	.391**	—		
4. Print and letter–sound knowledge	.624**	.164	.645**	—	
5. Speech ability	.457*	.275*	.856**	.542**	—

Note. $N = 42$. PA = phonological awareness; Developmental skill = raw composite score of Visual Reception, Fine Motor, and Receptive Language subtests of the Mullen Scales of Early Learning (Mullen, 1995); Speech ability = Kaufman Speech Praxis Test (Kaufman, 1995) raw score of Parts 2 and 3.

* $p < .05$. ** $p < .001$.

with developmental disabilities. Findings from this study support the work of Card and Dodd (2006) and Vandervelden and Siegel (1999), suggesting that speech ability does not play a significant role in PA skill when controlling for developmental skills inclusive of receptive language. Children's print knowledge and letter–sound knowledge were instead found to be significant predictors of PA for these children. Children with developmental disabilities in this study may be following similar patterns in the development of linguistic knowledge for reading that Perfetti and colleagues (1981) described. Children's letter and letter–sound knowledge accounted for a significant amount of variance in PA skill beyond what would be expected by their extant developmental skills, including receptive language. Children's knowledge of print to code phonological representations may have enhanced their phonological knowledge as Perfetti et al. (1981) suggested. Speech ability did not contribute to a significant amount of the variance in PA skill observed in children in this study.

The first and second aims in this study described the profiles and reported the relationship between intrinsic factors of early reading, speech, and language ability in preschool-age children with developmental disabilities. These

intrinsic components were speech ability, developmental skill (inclusive of receptive language), receptive vocabulary, PA, print knowledge, and letter–sound knowledge. Children were found to have a range of ability across all areas directly assessed, with strong, positive correlations found between many components, including receptive language and early reading skills. Speech ability and letter–sound knowledge, however, were found to have a small, non-significant correlation. There was a more limited range of performance on the letter–sound awareness task than on tasks of other early reading measures. Although there were some children who had high letter–sound awareness regardless of speech ability, there was a limited range of performance on this assessment. These findings are consistent with those of Card and Dodd (2006) and Vandervelden and Siegel (1999) suggesting that limitations in speech did not determine limitations in the performance on tasks of PA and tasks of nonword reading; however, the limited range of performance on these tasks for participants in this study warrants discussion. The Letter–Sound Awareness subtest of the PPA had inherent language processing demands that may have limited the performance of children in this study who largely had significant delays in receptive language

Table 8. Hierarchical multiple regression predicting phonological awareness from age, developmental skill, print and letter–sound knowledge, and speech ability.

Variable	Model 1			Model 2			Model 3		
	<i>B</i>	<i>SE</i>	β	<i>B</i>	<i>SE</i>	β	<i>B</i>	<i>SE</i>	β
Constant	–11.609	10.919		–10.223	9.774		–8.194	10.419	
Age	.126	.207	.091	.202	.187	.146	.217	.190	.157
Developmental skill	.171*	.054	.470	.038	.063	.106	–.009	.102	–.026
Print and letter–sound knowledge				.680*	.207	.532	.685*	.209	.536
Speech ability							.024	.040	.145
R^2	0.263			0.425			0.431		
F	6.946*			9.377*			7.005*		
ΔR^2	0.263			0.163			0.006		
ΔF	6.946*			10.762*			0.361		

Note. Developmental skill = raw composite score of Visual Reception, Fine Motor, and Receptive Language subtests of the Mullen Scales of Early Learning (Mullen, 1995); Speech ability = Kaufman Speech Praxis Test (Kaufman, 1995) raw score of Parts 2 and 3.

* $p < .001$.

development. Children were asked to find either the letter that made the first sound in a word or the letter that made the last sound in a word. Some children learned very quickly after completing the practice items what was being asked of them; however, others had difficulty in understanding the directions of the task. Future research should explore the use of assessment tools that reduce the language demands of tasks that assess component reading skills.

Examining the scatter plots of children's performance on measures of speech in relation to PA, developmental skill, and letter knowledge in Figure 1 is helpful in interpreting differences noticed in the pattern of linear relationships between these variables. Children with the lowest speech ability evidenced a range of PA skills, and so did children with the greatest speech ability. In addition, findings from this study support the pattern of development of PA described by Treiman and Zukowski (1991). Overall, children with developmental disabilities and limited speech ability had greater skills in rhyming and segmenting onset syllables of words and greater difficulty in blending individual phonemes in words noted in Table 4. This pattern of phonological skill is found in typically developing children between 4 and 5 years of age, with skill in blending individual phonemes emerging later in development as children develop greater letter-sound and grapheme-phoneme knowledge. Children with the greatest letter-sound knowledge in this study also had the greatest PA skills.

The third and final question in this study was to determine if speech ability accounted for a significant amount of variance in PA beyond developmental skill inclusive of receptive language and print and letter-sound knowledge. In the final regression model, print and letter-sound knowledge remained a significant predictor of PA skill, even beyond what would be expected by developmental skill alone. Children's speech ability did not add any unique variance to the model beyond what would be expected by children's developmental skill or print and letter-sound knowledge. These findings are again consistent with those of Card and Dodd (2006) and Vandervelden and Siegel (1999) that suggest that speech ability in children and adolescents with cerebral palsy did not determine their PA skills. Children in this study had developmental skills, receptive language, and print knowledge independent of their speech ability that supported development of PA skill. This study extends our knowledge of the factors at play in the development of PA for children with limited speech ability. The intrinsic factors of receptive language, print, and letter-sound knowledge are important in the development of PA, just as they are in typically developing children (Ehri, 2004; Perfetti et al., 1981; Treiman & Zukowski, 1991). Although vocabulary knowledge was not part of the regression equation because of its strong relationship with receptive language, vocabulary knowledge had an even higher correlation with PA than print and letter-sound knowledge. Children in this study with developmental disabilities who have strengths in print and letter-sound knowledge and vocabulary may have greater overall linguistic knowledge, thus impacting their PA skill.

Clinical Implications

The results of this study support the findings of Perfetti (1985) and Perfetti et al. (1981) that suggested reciprocal relationships between knowledge of print, vocabulary, and PA. These results suggest that the ability to speak may not be an important component in the linguistic knowledge necessary for PA and later reading development. Therefore, speech ability should not be a factor in determining access to reading instruction for children with developmental disabilities. Although this study cannot confirm the directionality of the relationship between PA and print and letter-sound knowledge, the introduction of early reading skills to children regardless of speech ability, including instruction in letter and letter-sound knowledge, may enhance PA skills that are foundational for the development of reading. For children who have limited speech ability and require the use of an SGD for expressive communication, significant adaptations in reading instruction are necessary; however, little is known about strategies that are successfully employed using an SGD. Future research should explore the use of SGDs to adapt instruction in PA and other early reading skills of letter-sound knowledge during preschool so that children with limited speech may have access to reading instruction.

Limitations

Measurement

A number of limitations of this study have been addressed throughout the discussion regarding specific measures described. Measures of PA, print knowledge, letter-sound knowledge, and speech ability produced both floor and ceiling effects for children in this study. The measurement tools used to assess children in this study may be less sensitive in measuring the particularly low skill level of many children who participated. For example, some children had very low raw scores on the test of letter-sound knowledge. This assessment used only a limited number of individual letters and their sounds and assessed this knowledge using linguistically complex instructions. Children in this study often had difficulty in understanding the task. However, when children were asked to imitate consonant speech sounds on the KSPT, children often said the letter name of the sound that was made by the examiner (e.g., child said "C" when asked to imitate the /k/ sound) but could not perform the task of letter-sound matching when directly assessed using the PPA. In order to validly assess early component reading skills of children with IDD with limitations in receptive and expressive language, assessment tools that are sensitive to measuring the true abilities of children are needed. The assessment tools used in this study to assess reading and speech ability were not designed to be used with children with IDD and receptive language delays. Further research is warranted exploring the measurement properties of these tools and how they function with children with IDD and receptive and expressive language delays.

PA assessment. An additional and important limitation is in the method of PA assessment used in this study. This study assessed PA using an experimental task developed by Preston and Edwards (2010) to measure PA without requiring a spoken response. Similar patterns of performance were found by children in this study as were found in Preston and Edwards (2010), with greater scores on subtests of rhyme awareness and lower scores on final subtests assessing blending phonemes. It should be noted, however, that vocabulary knowledge may have played an important role in children's response to this assessment task. Because the assessment did not require a spoken response, it relied on children to pick from one of four pictures presented on a computer touch screen. Children were provided the name of each picture prior to answering; however, there were inherent demands of language processing and vocabulary knowledge during the task, specifically for the final items of blending. Barker et al. (2012) suggested that future research should refine ways to assess PA using tasks that are less dependent on vocabulary knowledge.

Future Research Directions

This study provides a description of the relationship between a number of intrinsic factors related to PA in preschool-age children with developmental disabilities. Future research should continue to refine our understanding of the relationships between these variables by using assessment tools that allow for inclusion of children with limited speech ability and may use AAC systems as a primary means of communication. An assessment tool central to the findings in this study was an experimental tool to measure PA that did not require a spoken response. There is a great need for the validity and development of such assessment tools that can be used with preschool-age children with limited speech ability. The development of assessment tools that do not require speech production are a necessary first step that will allow for measurement of reading intervention outcomes for students with limited speech ability. With a greater understanding of the component factors involved in the development of early reading skills, we can create strategies to instruct children with a range of speech ability in these fundamental reading skills. With greater reading skills, children with IDD and limited speech may have greater access to AAC supports and the academic curriculum to promote growth and development to their fullest potential.

Acknowledgments

This research was supported in part by an American Speech-Language-Hearing Association New Century Scholars Doctoral Scholarship, which was awarded to Andrea Barton-Hulsey; a Dissertation Grant from the University Research Services and Administration, Georgia State University, which was also awarded to Andrea Barton-Hulsey; and the Research on the Challenges to Acquiring Language and Literacy Initiative at Georgia State University. Preparation of this article was supported by the Eunice Kennedy Shriver National Institute of Child Health & Human

Development of the National Institutes of Health (T32HD007489 and U54 HD090256).

This article is based on data collected for a dissertation by Andrea Barton-Hulsey as part of the requirements for the PhD degree in Developmental Psychology at Georgia State University. The authors would like to thank the families, teachers, and children who made this research possible.

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Appendix (p. 1 of 2)**Dysarthria Checklist**

Jaw

- ☐ Atrophy
- ☐ Reduced contraction
- ☐ Structural restrictions
- ☐ Adventitious Movement (circle one)
  - Chorea Dystonia Fasciculations Hemiballismus
  - Myoclonus Spasms Tics Tremors
- ☐ Other: _____

Lips

- ☐ Atrophy
- ☐ Adventitious Movement (circle one)
  - Chorea Dystonia Fasciculations Hemiballismus
  - Myoclonus Spasms Tics Tremors
- ☐ Resting asymmetry
- ☐ Inability to plose (/p/)
- ☐ Inability to vary tension
- ☐ Imprecise labial consonants
- ☐ Other: _____

Tongue

- ☐ Atrophy
- ☐ Adventitious Movement (circle one)
  - Chorea Dystonia Fasciculations Hemiballismus
  - Myoclonus Spasms Tics Tremors
- ☐ Resting asymmetry
- ☐ Inability to vary muscular tension
- ☐ Inability to plose (/t/)
- ☐ Imprecise consonant production
- ☐ Inability to differentiate vowels
- ☐ Other: _____

Participant ID# _____

Velopharyngeal Function

- ☐ Nasal emission
- ☐ Hypernasality
- ☐ Resting Asymmetry
- ☐ Inability to sustain (/pop pop pop/)
- ☐ Adventitious Movement (circle one)
  - Chorea Dystonia Fasciculations Hemiballismus
  - Myoclonus Spasms Tics Tremors
- ☐ Other: _____

Respiration and Phonation

- ☐ Abnormal loudness (reduced/excessive)
- ☐ Loudness variation
- ☐ Shortness of breath
- ☐ Abnormal quality (breathy/hoarse/harsh/strained-strangled)
- ☐ Phonatory breaks
- ☐ Instability (mild/moderate/severe)
- ☐ Stridor (inspiratory/expiratory)
- ☐ Wet phonation
- ☐ Abnormal voluntary cough (weak/absent)
- ☐ Other: _____

Scoring

0 = Not observed

1 = observed

Total Observed Characteristics: _____

At least 1 characteristic in 2 or more categories =
Dysarthria

Dysarthria (circle one): YES NO

Rate the overall severity of symptoms observed? (circle one)

Mild Moderate Severe

The following page may be used to further characterize the
type of dysarthria based on characteristics observed.

Appendix (p. 2 of 2)

Dysarthria Checklist

Mark the type of dysarthria that best represents the cluster of characteristics observed:

_____ **Spastic Dysarthria**

harsh or strained-strangled voice
hypernasality
myoclonus/spasms of jaw
imprecise consonant production

_____ **Flaccid Dysarthria**

hypernasality
nasal emission
breathy respiration
imprecise consonant production
inability to differentiate vowels
fasciculation of tongue
atrophy of tongue
inability to sustain /pop pop pop/

_____ **Mixed Spastic/Flaccid**

Hoarse or strained-strangled voice
Imprecise consonant productions
Inability to differentiate vowels
Hypernasality
Nasal emission

_____ **Ataxic Dysarthria**

Imprecise consonant production AND abnormal loudness
OR
Phonatory breaks (altered syllabic stress, prolonged intervals between syllables and words)

_____ **Hyperkinetic Dysarthria (Dystonia)**

Dystonia
Phonatory breaks
Loudness variation
Distortion of vowels

_____ **Hyperkinetic Dysarthria (Choreoathetosis)**

Abnormal exhalatory gusts of breath (instability in respiration)
Abnormal loudness
Chorea (tongue) resulting in disintegration of articulation

_____ **No characteristics of dysarthria observed**

Note. Adapted from Management of Motor Speech Disorders in Children and Adults, Third Edition (p. 3), by K. M. Yorkston, D. R. Beukelman, E. A. Strand, and M. Hakel, 2010, Austin, TX: PRO-ED. Copyright © 2010 by PRO-ED, Inc. Reprinted with permission. No further duplication allowed.