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Multiple Literacies in the 21st Century

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Abstract

A phonological impairment is a disturbance in children’s speech sound production that occurs independently of physical or cognitive impairment. Phonological impairment may arise from inadequate mental representations of speech sounds and/or difficulty accessing representations. Affected children may struggle to acquire phonological awareness and/or experience persistent academic deficits. Questions remain as to identifying the factors that lead to risk for reading and spelling difficulties in this population. Prior research confirmed that in the general population a concurrent, additive “double-deficit” underlies reading disability—(1) undeveloped phonological awareness and (2) deficient rapid naming of visual symbols. The present study found that deficits in phonological awareness and rapid naming converged in 23 children with phonological impairment and a significant percentage of variance in reading and spelling performance was accounted for by the aggregated factor of phonological awareness and rapid naming performance. A “double deficit” coexisted in this sample of children with phonological impairment.

A phonological impairment is a disturbance in the speech sound production system that results in systematic speech errors (Bird, Bishop, & Freeman, 1995; Shriberg & Kwiatkowski, 1994). This speech-language deficit occurs in children in preschool and the primary grades and is independent of children having any physical, developmental, or cognitive impairment.
The purpose of this research was to investigate whether phonological impairment coexisted with deficits in phonological awareness and/or verbal working memory in a sample of children in grades one to three. Further, we explored the co-occurrence of deficits in phonological awareness and verbal working memory in children with phonological impairment to observe any combined impact on reading and spelling skills.

Phonological impairment is systematic in that it may result in children producing words with particular types of errors. Phonologists describe a complex array of numerous errors, but there are three main error types which commonly occur and which can be easily recognized. One type of error involves changing the syllable structure of words, for example, the closed syllable “soup” is produced as an open syllable “sou” because the final consonant is deleted. A second error pattern changes how and where speech sounds are produced in the mouth. Although the child’s intention is to say “car” her production is “tar,” not because she is hearing and accessing a /t/ sound but because her representation of the /k/ sound is the sound we most closely associate with /t/. The /t/ sound is produced at the front of the mouth but the /k/ sound is produced at the back so this change in place of production results in a speech error. Children may produce complex patterns of sound changes and substitutions, for instance every b, f, v, th, s, z, sh, zh, ch, or j comes out sounding like a p, b, t, d, k, or g, either with one sound predictably and consistently substituted by another sound or as unpredictable errors within a realm of possible substitutions. As part of this pattern of sound changes, children may reduce consonant clusters so that “stove” becomes “tove.” In a third pattern of phonological impairment, children change certain sounds predictably or idiosyncratically in the context of certain words. Often this occurs because children are using one simple sound for two more complicated sounds, so that “grandpa” becomes “fampa.” Children with phonological impairment may speak with many different manifestations of any or all of the numerous possible error patterns. A constellation of several types of errors occurring simultaneously can render the speech of some children with phonological impairment difficult to understand.

Phonological impairment may arise due to children’s inadequate mental representations of speech sounds (Bird et al., 1995) and/or due to difficulty accessing their internal representations of speech sounds (Catts, 1989). Phonological impairment affects from 7.5% (Shriberg & Kwiatkowski, 1994) to 10% (National Institute on Deafness and Other Communication Disorders [NIDCD], 2000) of children ages 3 to 11. Of affected children, 80% require speech-language therapy to facilitate remediation and 50% to 70% experience academic difficulties that may persist through grade 12 (NIDCD, 2000; see also Bishop & Adams, 1990; Lewis, Freebairn, & Taylor, 2000; Torgesen, Wagner, & Rashotte, 1994).

The progression from phonological impairment to difficulties with reading and spelling may be due to inadequate development of the internal phonological representations that are needed to facilitate speech sound production and to map sounds to letters in order to read and spell (Catts & Kalami, 1999; Frith, Wimmer, & Landerl, 1998; Manis, Seidenberg, & Dot, 1995; Olofsson & Niedersoe, 1999; Share, 1999; Webster & Plante, 1992). Children develop both conscious and unconscious representations of phonemes (Webster & Plante). Children with phonological impairment may have trouble consciously classifying and analyzing speech sounds (Bird et al., 1995) and/or may unconsciously store imprecise phonological representations of words in memory (Lewis, Freebairn, & Taylor, 2002). Both sorts of inaccuracies may lead to errors in decoding (Shankweiler & Liberman, 1992) and/or spelling (Clarke-Klein & Hodson, 1995). Notably, however, speech sound errors do not map directly onto spelling errors (Stackhouse & Wells, 2001).

**Phonological Impairment and Phonological Awareness**

Bird et al. (1995) and Bishop and Adams (1990) indicated that adequate internal representations of speech sounds contribute to phonological awareness, which is the metalinguistic ability to reflect upon and manipulate speech sounds independently from the linguistic meanings that sounds convey (Rasinski & Padak, 2001). Phonological awareness is critical for learning to read and spell (Torgesen, 1999). Some children with phonological impairment lack the internal phonological representations that are necessary for developing phonological awareness (Catts, 1989; Torgesen, 1999). Webster and Plante (1995) hypothesized that phonological awareness bootstraps onto the child’s phonological system with instabilities in the phonological system constraining phonological awareness. Strong and accurate internal phonological representations provoke the association of phoneme to grapheme, allowing reading and spelling to develop (Frith et al., 1998). Accurate word pronunciation stimulates and supports awareness of spelling patterns (Ehri et al., 2001; Rasinski & Padak, 2001). Children with reading disabilities may not perceive distinctions between phonemes as accurately as typical readers (Torgesen, 1999).

To summarize the connection between phonological impairment and phonological awareness, accurate word pronunciation stimulates and supports awareness of decoding and spelling patterns. Therefore, the presence of phonological impairment may hamper acquisition of important literacy milestones—first, the accurate manipulation of speech sounds that phonological awareness entails, and, later, grasping that speech sounds in words are represented by certain patterns of letters and applying phonologically based decoding and spelling skills (Bail & Blachman, 1991; Lewis et al., 2002; Rasinski & Padak, 2001; Templeton & Morris, 1999).
Phonological Impairment and Rapid Naming of Visual Symbols

Apart from phonological awareness, there is a second possible connection between phonological impairment and reading and spelling difficulties. Lovett, Lacrenza, Borden, Frijters, Steinbach, and DePolma (2002) confirmed undeveloped phonological awareness as one of two core processing deficits underlying reading disability, with the other core deficit being rapid naming deficiency. Researchers have thus formulated a "double-deficit" hypothesis which contends that some children exhibit a concurrent, additive deficit in phonological awareness and in rapid naming of visual symbols (Wolf et al., 2002). The purpose of rapid naming of items that have been encountered in the environment, including letters and visual symbols, is that it demonstrates verbal working memory. Some children with phonological impairment have deficits in verbal working memory, in either encoding, retrieval, or both processes (Catts, 1989; Shriberg & Kwiatkowski, 1994; Webster, Plante, & Cowvillion, 1997).

Rapid naming is generally assessed by asking children to name colors, letters, or numbers (Wagner, Torgesen, & Rashotte, 1999). Lovett, Steinbach, and Frijters (2000), Schatschneider, Carlson, Francis, Foorman, and Fletcher (2002), and Wolf et al. (2002) variously contributed the view that these rapid-naming tasks are not equivalent demands. Rapid naming of letters reveals additional separate cognitive-linguistic processes that are critical for learning to read (Wolf & Bowers, 1999). Children who have trouble rapidly naming orthographic symbols are evidencing deficiencies related to phonological representations (i.e., names or labels) and/or orthographic representations (e.g., letter forms). While names of real world objects can be linked to real-life experiences and stored as episodic memory (Tulving, 1972), there are few environmental associations that can be linked to letter names. Visual symbols enter memory as icons (Klatzky, 1980) which are then arbitrarily named and stored as semantic memory—as retention of general, impersonal facts or names (Tulving, 1972). Each time a letter stimulus is encountered it must be matched to letter templates or prototypes stored in iconic memory and then matched to its name stored in semantic memory. Inefficient or slow naming suggests (a) inadequate iconic storage of orthographic representations, (b) inadequate semantic memory for letter names, and/or (c) deficient connections between letter names and orthographic symbols (Wolf & Bowers, 1999).

There is ample evidence that deficits in rapid naming of visual symbols coexist with reading difficulties (Bowers & Wolf, 1993; Lovett et al., 2000; Wolf, 1991). In one study good readers named visual symbols faster and more accurately than poor readers (Stanovich, 2000). Roodenrys and Stokes (2001), and Stothard, Snowling, Bishop, Chipchase, and Kaplan (1998) reported that children with reading impairments performed poorly on rapid-naming tasks. Some children with phonological impairment lack speed and accuracy in retrieving names for visual stimuli (Children of the Code, 2004; Wolf, et al., 2000).

It might be thought that children who are having difficulty learning letter symbols might be taught to read using fluent, whole-word reading strategies (Gordon Pershey & Gilbert, 2002) or by memorizing "sight words," that is attaining rapid, context-free identification of words frequently encountered. However, children who cannot rapidly name letters are at considerable risk for having difficulty developing rapid automatic reading of "sight words" (Bishop & Adams, 1990; Kamhi, 2000; Manis et al., 1999; Stanovich, 2000; Wolf et al., 2002). Sight-word reading by children with rapid-naming deficits would require multiple exposures to stimuli and possibly the application of other learning strategies in order for memorization and rapid access to be attained (Lovett et al., 2000).

In summary, the connection between phonological impairment and rapid naming of visual symbols is that rapid naming reveals the verbal working memory abilities that allow for short-term storage and manipulation of phonological information. Verbal working memory span must be sufficient for retaining internal representations of speech sounds in "on-screen" memory long enough to perform phonological manipulations.

While a deficit in either phonological awareness or rapid naming will interfere with learning to read and spell, coexistence of both deficits is cumulatively injurious to learning to read and spell (Lovett et al., 2000). A phonological awareness deficit compromises meaningful letter-to-sound decoding, while a rapid-naming deficit hampers rapid identification of letters and of words as whole units, such that even familiar words may not be recognized consistently and read fluently (Lovett et al., 2000).

We conducted the present study because it appears that there is scant published research on the coexistence of deficits in phonological awareness and rapid naming in children with phonological impairment. Moreover, there is a lack of documentation of the impact of coexisting deficits in phonological awareness and rapid naming on reading and spelling abilities in children with phonological impairment.

The purpose of this research was to investigate whether phonological impairment coexisted with deficits in phonological awareness and/or verbal working memory in a sample of children. We explored the convergence of the "double deficit" in phonological awareness and rapid naming in children with phonological impairment to observe any combined impact on reading and spelling skills.
Description of the Study

Our research questions involved six comparisons of group performance. First, we asked whether children with phonological impairment would perform more poorly than typically developing peers on six sets of measures. We measured physiologically based functions associated with speech—suprasegmental quality of speech, meaning variations in voice intonation, voice pitch, and rate of speech (set 1) and oral motor control (meaning the ability to produce rapid, coordinated movements of the lips and tongue) (set 2). We presented a variety of cognitive-linguistic tasks that tax verbal working memory and administered rapid naming testing (set 3). We also tested phonological awareness (set 4) and achievement in reading (set 5) and spelling (set 6).

Second, six additional research questions explored measures of association among variables. We asked whether the presence of phonological impairment could be associated with lesser performance in these same areas: (a) suprasegmental quality of speech, (b) oral motor control, (c) verbal working memory (specifically including rapid naming), (d) phonological awareness, (e) reading, and (f) spelling. Third, we questioned whether phonological awareness and/or rapid naming abilities could be shown to have an impact upon the reading and/or spelling performance of children with phonological impairment. In this way we explored whether a “double deficit” in phonological awareness and rapid naming coexisted in this sample of children with phonological impairment.

Methodology

Participants were 23 English-speaking children previously diagnosed with phonological impairment and receiving speech-language therapy (Group 1) and 23 unimpaired peers (Group 2). No children in Group 2 had ever been diagnosed with a speech-language problem or received speech-language therapy. In each group there were 12 children in 1st grade, 8 in 2nd grade, and 3 in 3rd grade matched for race, gender, age (range 6.4 - 9.1), free lunch status, and IQ (average range). The children were from 10 elementary schools in one Midwest county where the median household income was $60,000 (U.S. Census Bureau, 2000). All passed pure tone air conduction hearing screening at 20 dB HL for 500, 1000, 2000, and 4000 Hz and were judged to have functional hearing. Groups 1 and 2 performed significantly differently on a test of speech sound production. Specifically, a measure of Percentage of Consonants Correct (PGC) obtained by applying results of the Goldman-Fristoe Test of Articulation-2 (GFTA-2; Goldman & Fristoe, 2000) to a procedure adapted from Shriberg, Kwiatkowski, Best, Hengst, and Terselic-Weber (1986) revealed that the children in Group 1 had significantly poorer speech sound production than children in Group 2 [ANOVA] \( F(1, 44) = 55.16, p < .001 \). Children in Group 1 produced significantly fewer consonants correctly. The groups were judged to be dissimilar and dichotomous on the variable of speech sound production.

Procedures involved administration of standardized tests and observational measures in randomized order over three individual testing sessions per child. Each testing session lasted roughly one hour. Randomized order of participation was utilized, meaning that Group 1 and Group 2 children were tested concurrently. One group was not tested before the other group. Testing took place over approximately four months. Individual students left class and were tested in unused rooms in their school buildings. The second author served as tester.

To assess suprasegmental quality of speech, we subjectively analyzed a conversational sample for adequate quality (pitch, intonational contours, and rate of speech) and scored a “0” for adequate, “1” for quality that deviated 10% or less of the time, or “2” for quality that deviated greater than 10% of the time, as stipulated by guidelines proposed by Zelvis (1986). To assess oral motor skill, we scored a “1” for adequate rate, strength, and precision of oral movement and “2” for slowed rate, strength, and precision of oral movement, according to a scale developed by Zelvis (1986). We selected the Zelvis screening tool for this study because it is the approved instrumentation at our university’s speech and hearing clinic.

We tested verbal working memory via the Clinical Evaluation of Language Fundamentals-3 Screening Test (CELF-3; Semel, Wig, & Secord, 1996) subtests for word forms (holding a stimulus sentence in mind and filling in a blank), following directions, and sentence repetition, as well as via the Comprehensive Test of Phonological Processes (CTOPP) (Wagner, Torgesen, & Rashotte, 1999) non-word repetition test. We administered the CTOPP rapid naming subtests of visually presented colors, objects, numbers, and letters and computed a composite score. For phonological awareness we computed a CTOPP composite score for subtests of elision of sounds from words, blending sounds to form words, and matching initial and final sounds in words. We also administered the reading and spelling subtests from the Kaufman Test of Educational Achievement (K-TEA) (Kaufman & Kaufman, 1985). We computed mean scores for each group on all measures.

Results

The children with phonological impairment performed significantly poorer than unimpaired peers on most measures, with Group 1 mean scores often below normative means for the standardized subtests. Given an alpha level of .05, differences between groups were significant for suprasegmental
quality (ANOVA) $F(1, 44) = 7.48, p = .009$), oral motor control (ANOVA) $F(1, 44) = 6.11, p = .0170$), two of four cognitive-linguistic tasks that tax verbal working memory (CELF-3 sentence repetition (ANOVA) $F(1, 44) = 5.55, p = .023$), CTOPP phonological awareness (ANOVA) $F(1, 44) = 10.39, p = .002$), CTOPP rapid naming (ANOVA) $F(1, 44) = 4.72, p = .035$), CTOPP rapid naming (ANOVA) $F(1, 44) = 28.04, p < .0001$), K-TEA reading (ANOVA) $F(1, 44) = 31.72, p < .0001$), and K-TEA spelling (ANOVA) $F(1, 44) = 9.84, p = .003$).

A Multivariate Analysis of Variance (MANOVA) compared groups based on all variables combined—suprasegmental quality and oral motor control, verbal working memory, rapid naming, phonological awareness, reading, and spelling. The difference between groups was significant (MANOVA) $F(1, 44) = 14.25, p < .0001$). Importantly, a MANOVA that compared the groups based on two variables combined, reading and spelling, showed that the difference between groups is significant (MANOVA) $F(1, 44) = 15.58, p = .0001$) for these critical academic areas.

Figure 1 confirms that all participants with phonological impairment attained lower phonological awareness and rapid naming composite scores than typically developing peers. The Figure 1 frequency polygon depicts the intersection of bivariate data, i.e., the performance on the phonological awareness composite and the rapid naming tasks for the two data sets, Group 1 and Group 2. The differences between the groups of children are illustrated.

**Figure 1. Intersection of Phonological Awareness and Rapid Naming Scores**

Measures of association among variables were ascertained for the children with phonological impairment. Pearson Product Moment correlations associated children’s scores on PCC with all other variables. We found a significant correlation between poor production of consonants and poorer scores on oral motor control ($r = -.597, p = .0003$), CELF-3 cognitive-linguistic tasks that tax verbal working memory (word forms, $r = .517, p = .012$; direction following, $r = .612, p = .002$; sentence repetition, $r = .464, p = .026$), and CTOPP rapid naming ($r = .405, p = .004$). Correlations showed that phonological impairment was associated with diminished performance in oral motor control, verbal working memory, and rapid naming, but not with lower scores on phonological awareness, reading, or spelling.

Because correlational data did not fully describe whether phonological impairment was associated with deficits in phonological awareness, reading, and/or spelling, Stepwise Regression Analyses were run to determine whether performance on the phonological awareness test could account for variance in reading and spelling test scores. Performance on CTOPP phonological awareness tasks accounted for 41% of the variance in K-TEA reading scores ($p < .001$) and 64% of the variance in K-TEA spelling scores ($p = .008$) for children with phonological impairment.

Sixty-nine percent of the variance in K-TEA reading scores obtained by children with phonological impairment could be accounted for by performance on CTOPP phonological awareness and CTOPP rapid naming scores as a combined independent variable ($p < .0001$) [coefficient analysis: phonological awareness at $p < .0001$; rapid naming at $p = .004$; this indicates adequate stringency for each predictor variable].

To explore the presence of a “double deficit” in this sample, a Stepwise Regression revealed that 66% of the variance in K-TEA reading and spelling scores as a combined dependent variable could be accounted for by performance on CTOPP phonological awareness and CTOPP rapid naming scores as a combined independent variable ($p < .0001$) [coefficient analysis: phonological awareness at $p < .0001$; rapid naming at $p = .009$; this indicates adequate stringency for each predictor variable]. A significant percentage of variance in the reading and spelling performance of children with phonological impairment could be accounted for by the aggregated factor of performance on phonological awareness and rapid naming tasks. A “double deficit” coexisted in this sample of children with phonological impairment.

**Discussion**

The present study contributes to the research on the “double deficit” that causes affected children to struggle with reading and spelling. Specifically, the findings of this study provide information on the coexistence of deficits in...
phonological awareness and rapid naming in the subpopulation of struggling readers who are children with phonological impairment. While the affects of phonological impairment on literacy acquisition are still uncertain, the differences found between children with phonological impairment and matched unimpaired children were significant for all measures except two verbal working memory tasks (not rapid naming). Children with phonological impairment performed below the normative mean on tests of rapid naming, phonological awareness, reading, and spelling. Phonological impairment correlated with poorer performance on cognitive-linguistic tasks that tax verbal working memory and on rapid naming. In this sample, the children's speech sound production errors could be regarded as having presaged the noteworthy language and memory issues that may impact literacy acquisition.

Conclusions

Phonological impairment is evident in children in the preschool years, before literacy emerges. Speech disturbances which render a child difficult to understand should not be dismissed as developmental motor skill. Results of the present study suggest that speech-language pathologists and educators should monitor young children with phonological impairment who are at risk for literacy difficulties. Children with phonological impairment should undergo team assessment by speech-language pathologists and reading specialists to reveal concurrent deficits in phonological awareness, rapid naming, reading, and spelling. Traditional speech-language assessments and interventions for preschool and primary grade children with phonological impairment have focused primarily upon the characteristics of the child's speech output. Individualized interventions usually take place outside the classroom and with little teacher involvement. Collaboration between speech-language pathologists and preschool and primary-grade teachers might be expanded so that speech-language pathologists supplement individual therapy with intervention within the context of classroom academic demands. Interventions can be tailored to address classroom language and literacy difficulties (for reports of intervention efficacy, see Hesketh, Adams, Nightingale, & Hall, 2000; Nathan, Stackhouse, Goulardis, & Snowling, 2004; Ravchew, Nowak, & Cloutier, 2004; Stackhouse, Wells, Pascoe, & Rees, 2002). All team members would stimulate phonological awareness and rapid naming of letters and visual symbols. Additionally, collaborations would allow teachers to understand children's short-term and long-term speech-language therapy targets and reinforce target behaviors during classroom interactions. These interventions are in accordance with the mandates of the No Child Left Behind Act of 2001 (2002) to reduce academic failure and help children perform on reading achievement testing.

It is important to note that not all children with phonological impairment will manifest difficulties in phonological awareness, rapid naming, reading, and spelling. Future research may distinguish subtypes of phonological impairment, as in phonological impairment with phonological awareness deficit, phonological impairment with verbal memory deficit, phonological impairment with both phonological awareness and verbal memory deficits, or phonological impairment without other deficits.

References


