CORRECTION OF PHONOLOGICAL DEFICITS IN STUDENTS WITH DYSLEXIA THROUGH THE USE OF A PHONEMIC ALPHABET, THE INITIAL TEACHING ALPHABET (I.T.A.)

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Abstract

Dyslexia is a neurobiological disorder rooted in the phonological processing system which impairs the ability to analyze spoken language by word, syllable, and sound boundaries. It is estimated that the incidence of dyslexia in transparent languages like Italian and German is half the incidence found in the United States due to the complexity of English orthography. The 44 sounds of English can be written in more than 1,100 ways using the 26 letters of the English alphabet. Young children who cannot segment and blend syllables and sounds are at risk of reading failure. While their normally-developing peers in kindergarten are writing words the way they sound, e.g., “sed” for “said,” children with phonological deficits fail to “crack the sound-symbol code” that leads to reading success.

A previous brain mapping study by the second author revealed that remediation of dyslexia using the initial teaching alphabet (i.t.a)., a phonemic alphabet which represents each of the 44 sounds of spoken English with a unique symbol, resulted in normalization of brain function during reading. However, it was not clear whether the reading or writing component of the study contributed to the normalization outcome. This study investigated the use of i.t.a. for remediation of phonological deficits using a researcher-developed writing process called “Slash and Dash.” Eight upper elementary Special Education students learned to segment spoken words by making a slash for each syllable heard in a multisyllabic word. Next, they made a dash for each sound within each syllable. They then used the i.t.a. symbol-picture chart to identify each sound in the dictated word. Last, they typed the word into an electronic dictionary, the Franklin Speaking Speller, to find the correct spelling.

This process was repeated daily for 30 sessions, using words from the students’ content classes.

Pre-tests and post-tests of phonological processing skills crucial to acquisition of reading included:

1 the Auditory Analysis Test-Revised (AAT-R), which assesses the ability to analyze spoken language by asking students to delete syllables and sounds from spoken words; and

2 three spelling tests with misspellings scored for Good Phonetic Equivalents, i.e., representation of each sound phonetically in dictated words. The spelling tests used included the Wide Range Achievement Test (42 words), the Words Their Way spelling test (42 words), and a researcher-developed spelling list consisting of polysyllabic words from the 6th grade reading curriculum.

Results of the pre- and post-tests in this single-subject study were analyzed through graphical presentation of each student’s pre- and post-test scores and also by statistical analysis of group results. Paired-sample t-tests indicated significant progress on each measure.

WRAT-4 pretest average of 14% Good Phonetic Equivalents rose to 47% on post-test (p.=.0002). On the 6th grade word list, students went from an average of 3% Good Phonetic Equivalents to 21% (p. =.0006). The results of both analyses indicated highly significant differences.

The most striking result of this study was the students’ gain on the Auditory Analysis Test-Revised (AAT-R). Although this investigation did not directly work on the skills tested on the AAT-R, students went from a pretest average standard score of 81 to 103 on post-test (p.=.02). This suggested normalization of their underlying neurophysiological deficits in phonological processing, supporting the finding of normalization of brain function using electrophysiological brain mapping procedures in previous studies.

Keywords: Dyslexia, phonological processing, reading disability, spelling disability.

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1 INTRODUCTION

While there is a general consensus worldwide that dyslexia is a neurobiological disorder rooted in the phonological processing brain system associated with translation of speech sounds to print [1], the expression or severity of the resulting reading and written language disorder appears to be mediated by the particular orthographic characteristics of the language. That is, languages such as German, Finnish, and Spanish that have a transparent sound-symbol relationship are reported to have smaller incidences of reading failure than orthographically-dense languages such as French, English, and Hebrew. [2].

The neurobiological origin of dyslexia as a disorder of the phonological processing system was documented by brain imaging studies of dyslexic subtypes during reading aloud tasks [3] [4]. Identifying children with reading failure as either dysphonetic (lack of phonological skills needed for acquisition of decoding) or dysorthographic (over-emphasis on phonological processing resulting in lack of automatization of word recognition), Flynn and colleagues [3] [4] found that both subtypes of dyslexic readers differed from their normally-developing peers (Fig. 1).

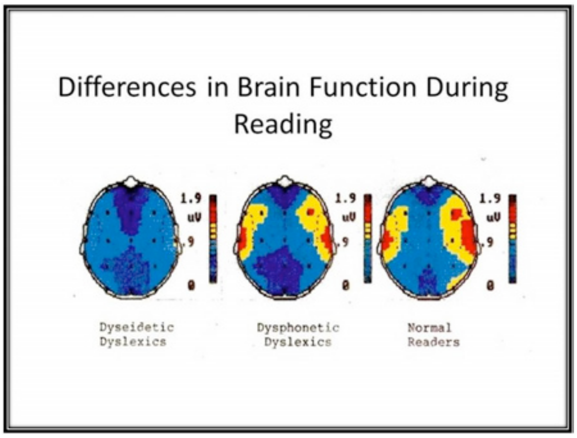

Figure 1. Brain map of dyslexic subtypes compared to normal readers during reading aloud task.

Intervention protocols that emphasized the use of a transparent alphabet adaptation of the regular English alphabet, the initial teaching alphabet (i.t.a.), and repeated guided oral re-reading of instructional-level text resulted in remediation of dyslexia in children identified with phonological deficits (dysphonetic readers). Re-imaging of a small group of these children upon acquisition of expected reading levels revealed normalization of brain function during reading aloud (Fig. 2). Both remediated dyslexics and normal readers differed from a new group of dysphonetic readers who were just starting the intervention project. Recently, this normalization of brain process following successful remediation of adolescent dyslexics has been reported by Shaywitz and colleagues [5].

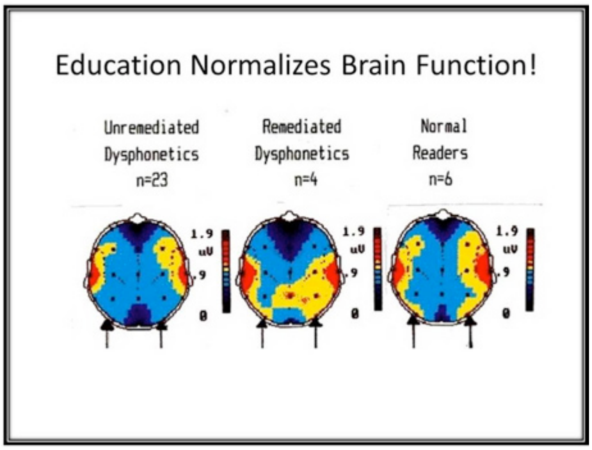

Figure 2. Brain map of remediated dysphonetic readers compared to normal readers and unremediated dysphonetic peers

Flynn and colleagues [3] [4] drew two important conclusions from their brain imaging studies. First, dyslexia can be remediated through a focus on writing spoken words exactly how they sound using the initial teaching alphabet (i.t.a.) for children whose deficit was a lack of the phonological awareness skills needed to encode and decode words [6]. Second, it appeared that successful remediation of reading disability resulted in normalization of brain function [4]. However, the exact mechanism by which this protocol resulted in normalization of brain processing was not clear, since the intervention protocol also featured the use of tutor-guided oral re-reading to improve accuracy and fluency. Therefore, the present study was undertaken to isolate the use of i.t.a. for analysis of spoken language and transcription to sound spelling in order to determine what role i.t.a. plays in improving phonological processing in children with dysphonetic dyslexia.

The importance of studying whether phonological awareness can be improved through the use of the protocol implemented in this study is exemplified in Fig. 3, which depicts how all aspects of reading failure can be traced back to phonological deficits beginning in the preschool years.

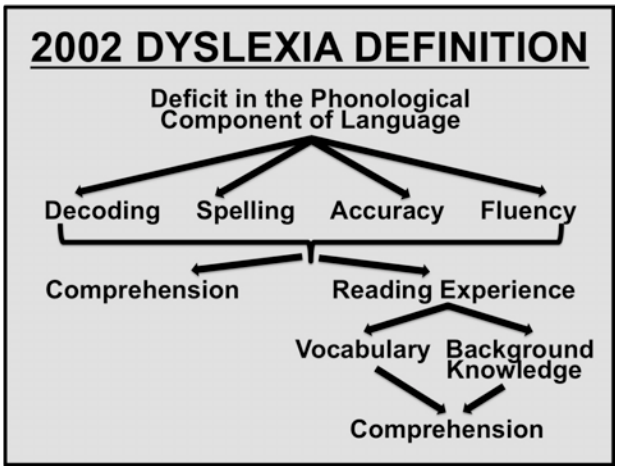

Figure 3. How Deficits in Phonological Awareness Impact all Aspects of Reading

2 METHODOLOGY

2.1 Sample

As part of a master's degree in Literacy Education and in collaboration with the second author of this paper, the first author employed a single-subject design involving a sample of eight 4th-6th grade students in her Learning Disabilities class. A phonological analysis strategy, Slash and Dash [7], featured i.t.a. for analysis of multisyllabic words from a 6th grade reading curriculum. None of the words used in this investigation had been correctly spelled or read by the subjects before initiation of the research protocol. The intervention lasted for 30 school days and involved phonological encoding of four polysyllabic words each day, using a strategy for moving from analysis of spoken words through sound spelling using i.t.a. and culminating in retrieval of correct spellings through Slash and Dash, a procedure developed by the second author [7].

Flynn [8] demonstrated the process of Slash and Dash in a video recording with an eighth grade student. Students with dysphonetic dyslexia spend a considerable amount of time in the spelling by sound stage, using i.t.a. to write every word, including those that they recognize and can spell orthographically, in order to make their phonological system fully operational.

2.2 Procedure

This investigation featured the Slash and Dash process developed to remediate phonological deficits in dyslexic readers. Each day, four multisyllabic words were dictated using the following steps:

1. A multisyllabic word, e.g., "opportunity," was presented orally by the investigator.
2. Students marked a slash, spaced across the page, for each syllable heard.
3. Each syllable was analyzed and a dash entered for each sound in the syllable.
4. Students used the i.t.a. chart (Fig. 4) to write the symbol representing each sound.

5 Using a speaking electronic dictionary, students typed in the phonetic spelling of the word. When an i.t.a. symbol not present in the regular alphabet was indicated, the students typed in the nearest English equivalent letter or letters.

6 The speaking dictionary typically returned multiple versions of the target word, so identification of the correct one was verified by listening to the recorded pronunciation.

7 The orthographically-correct rendition of the word was written above the phonetic (i.t.a.) representation to help the student internalize both how the word looked (orthographic) and how it sounded (i.t.a.).

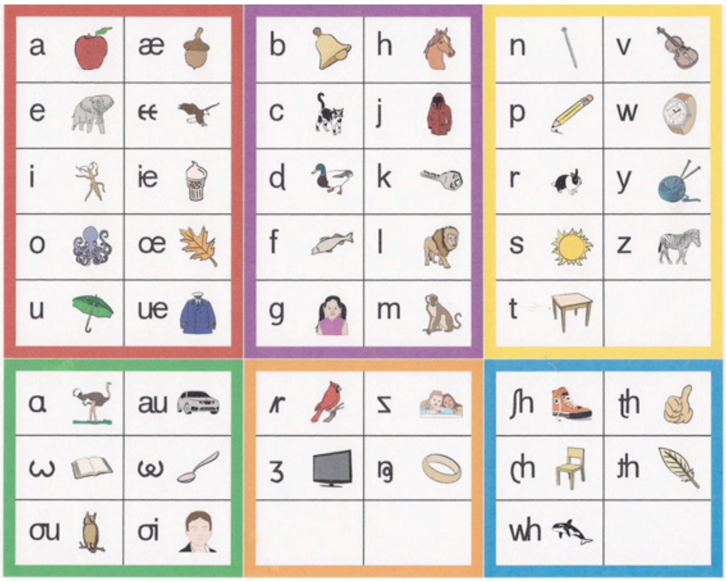

Figure 4. The initial teaching alphabet (i.t.a.) chart

Fig. 5 represents a completed word study card featuring both the orthographic representation of the word (correct spelling) and the phonetic rendition (i.t.a.). These cards were used for spelling, reading, and vocabulary development, with definitions and sample sentences written on the back.

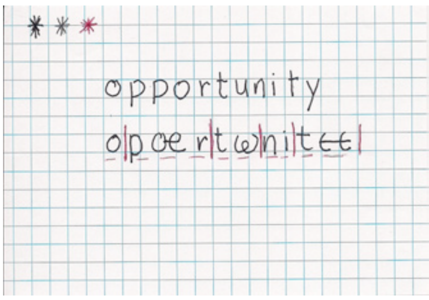

Figure 5. Completed Slash and Dash word card

2.3 Instrumentation

2.3.1 Assessment of Phonological Awareness: AAT-R

To investigate whether this intervention had an effect on underlying phonological skills, the Auditory Analysis Test-Revised [9] was used at the beginning and conclusion of the project. This oral assessment, originally developed by Rosner [10], was revised by Flynn [9] to reflect a developmental continuum of difficulty. The test requires students to delete a syllable or sound from a spoken word and indicate what new word was formed. For example, "take away /s/ from *stale.* What's left?" Significant research across three decades validates the use of phonological tasks like this for identification of children with phonological deficits [11].

2.3.2 Assessment of Phonological Awareness Transfer to Spelling: WRAT-4

The second question of this study was whether a relatively brief period of exposure to Slash and Dash would result in remediation of dysphonetic spelling, as measured by an increase in Good Phonetic Equivalents (GFEs) for misspelled words. Good Phonetic Equivalents are misspellings where every sound in dictated words is represented. Without the ability to write unknown spoken words phonetically, dysphonetic dyslexics are unable to take advantage of electronic spelling aids to find the correct spelling of unknown words. The *Wide Range Achievement Test-4* Spelling subtest [12] is typically used to establish age-level comparisons of spelling ability. Because this test requires a ceiling of 10 misspelled words in a row before discontinuation, it provides a rich source for analysis of misspellings. More than 40 year ago Boder [13] noted the inability of dysphonetic dyslexics to produce Good Phonetic Equivalents (GFEs) as a sign of phonological impairment, a finding that was supported by the research of Flynn and colleagues [3] [4] [6]. Therefore, the percentage of Good Phonetic Equivalents for misspellings on the WRAT spelling test was used as pre and post-tests of the ability to write words the way they sound. An example of a Good Phonetic Equivalent would be *sicologee* for *psychology.* A misspelling that is not a Good Phonetic Equivalent (GFE) would be *instoot* for *institute.*

2.3.3 Assessment of Spelling by Sound Transfer to Curriculum: 6th Grade Content Dictation

Dictation of ten multisyllabic words chosen by the researcher from the school-adopted 6th-grade reading curriculum was also used to assess the ability to write Good Phonetic Equivalents for unknown words. None of the students in this sample were able to read or write the chosen words correctly before the intervention began.

3 RESULTS

The results of this investigation are reported both graphically (pre and post-test performance on each assessment for each of the eight students) and statistically (paired-sample t-test comparisons or pre and post-test scores on the measurement variables of this study).

3.1 Ability to Write Good Phonetic Equivalents: WRAT-4 Spelling Test

Ten misspelled words from the WRAT-4 Spelling subtest were analysed to determine whether every sound in the dictated word was represented. Percentages of pre and post-test Good Phonetic Equivalents (GFEs) for each of the eight students are represented graphically in Fig. 6, providing evidence that the Slash and Dash phonological awareness intervention resulted in increased ability to write words the way they sound. All students increased by at least two words in their ability to write a phonetic equivalent of the WRAT-4 dictated words, which ranged from two to five syllables in length. It should be noted that while students used i.t.a. during the intervention, they were required to use traditional orthography (the regular English alphabet) for pre and post-test dictations.

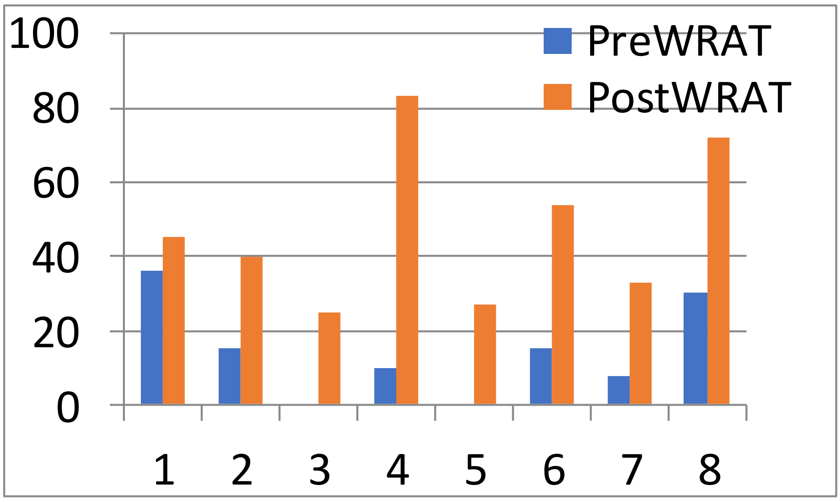

Figure 6. Percent of misspellings GFE for each student

Student pre and post-test scores for misspelled words represented as GFEs on the WRAT-4 were also analysed using a paired-sample t-test to determine whether students as a group had made statistically-significant gains in their ability to analyse spoken words and write them phonetically. Results indicated that the average gain of 33 percentage points across the 30 sessions of this study was statistically significant (Table 1).

Table 1. *Paired-sample t-test for GFEs on WRAT-4*

GOOD PHONETIC EQUIVALENTS- WRAT			
	Mean	Std.Deviation	Sig.
Pre-WRAT	14	13	0.002
Post-WRAT	47	21	

3.2 Ability to Write Good Phonetic Equivalents: Multisyllabic Words

Students' ability to transfer gains in phonological awareness to multisyllabic curriculum content words, tested by dictation of 10 multisyllabic words from the 6th grade reading curriculum, is depicted in Fig. 7. Note that while only one student was able to write any Good Phonetic Equivalents (GFEs) for the 10 dictated words on pre-test, all were able to do so on post-test.

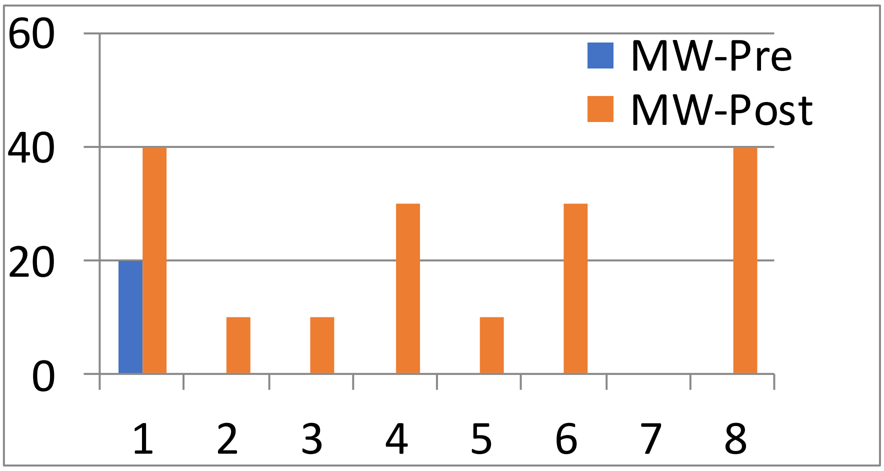

Figure 7. Percent of Multisyllabic Words Written as Good Phonetic Equivalents

The paired-sample t-test results for the 6th grade word dictation test (Table 2) revealed a significant increase in the ability to phonologically analyze multisyllabic words and to represent them as Good Phonetic Equivalents (GFEs).

Table 2. *Paired-sample t-test for GFEs on 6th Grade Multisyllabic Words Test*

Multisyllabic Words List of 10 Words Scored for GFEs			
	Mean	Std.Deviatation	Sig.
Pre-MW	3	7	
Post-MW	21	16	0.006

3.3 Phonological Awareness: Auditory Analysis Test-Revised (AAT-R)

The Auditory Analysis Test-Revised was used to investigate whether Slash and Dash using i.t.a. improved underlying ability to analyse spoken words For this analysis, standard scores (mean=100, s.d.=15) were used to plot pre and post-test performance of the eight students. Inspection of the graphical results in Fig. 7 indicate that while only one student approached age-level performance on pre-test (SS=100) all but two reached or exceeded average performance on post-test.

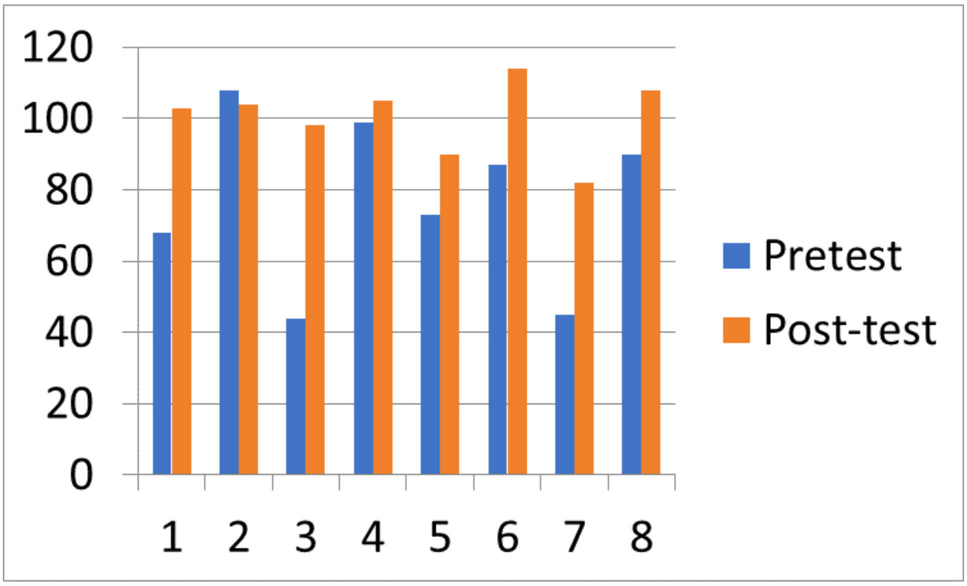

Figure 7. Auditory Analysis Test-Revised (AAT-R) Study Results

Results of the paired-sample t-test for AAT-R standard scores (Table 3) supported the graphical representation. Students had, on average, gained 21 standard score points from pre to post-test. The narrower standard deviation on post-test (7.6 points) compared to pre-test spread of 21.5 points reinforced the finding that training in analysis of spoken words and using i.t.a. to write them phonetically had significantly improved all students' phonological processing abilities. In fact, six of the eight students posted standard scores within the average range for phonological awareness compared to proficient readers.

Table 3. *Paired-sample t-test of Phonological Processing: AAT-R*

Auditory Analysis Test-Revised Standard Scores			
	Mean	Std.Deviation	Sig.
Pre-AATR	81	21.5	
Post- AATR	103	7.6	0.02

4 CONCLUSIONS

While previous intervention and brain imaging studies supported the use of the initial teaching alphabet (i.t.a.) for remediation of dyslexia, the present investigation leads to greater explanatory power in explaining how i.t.a. works. Children whose reading failure occurred because of an inability to analyse spoken language, a crucial precursor for success in encoding and decoding, demonstrated statistically and educationally significant improvements in their ability to listen to spoken words and recreate the syllables and sounds of those words with a phonetic alphabet. This in turn allowed them to access the correct spelling of words by use of an electronic spelling aid. In this study, the Franklin Speaking Dictionary was used, but more recent interventions have used electronic dictionaries on cell phones and iPads with similar success.

This study also demonstrated that a relatively short period of time implementing the Slash and Dash protocol resulted in educationally-significant gains in spelling by sound, with concurrent success in using electronic dictionaries to access correct spelling. Because these electronic aids contain definitions of the target words, vocabulary is also enhanced. Teachers at all levels elementary through college can use this protocol to introduce and practice multisyllabic words that are important for understanding the content of their discipline.

Finally, it is important to note that this investigation resulted in improved performance on the underlying brain processes operant in understanding how spoken words can be analysed through segmenting, deleting, and blending. Given that phonological processing deficits are known to be the cause of cascading levels of reading failure, the fact that all students improved and that six of the eight students reached age-level performance on phonological awareness is an exciting breakthrough in understanding how to remediate underlying phonological deficits. It would be interesting in future research to pair pre and post-test brain imaging recordings of students performing the AAT-R with the spelling dictations of this study. Based on our previous brain imaging studies that featured reading aloud from text written at each student's frustration reading level, we would predict normalization of brain function in areas of the brain found to correlate with phonological analysis of spoken words following a similar intervention protocol.

ACKNOWLEDGEMENTS

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