Defining Reading Disabilities: Multiple Deficits Behind One Problem

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The ability and lack of ability to read have been well-researched for over a century. Early research done by the French neurologist Dejerine in 1896, helped pave the way for further research in the area of reading disabilities (Wolf, 1999). Dejerine first spoke of alexia, or the inability to read, which seemingly resulted from brain lesions in the temporal lobe. Since then, psychologists and educational professionals have researched dyslexia as well as the broad category of reading disabilities to find possible causes. Many theories and possible causes have surfaced as a result of this research.

Most notably, research has identified four specific areas of deficit in relation to reading difficulties. These areas are phonological awareness, rapid automatic naming, visual-orthography, and the newly emerging "double deficit" hypothesis.

The first part of this paper focuses on defining key terms in the area of reading disabilities. The second section focuses on current research available in support of or against the influence of these deficits on reading disabilities. Finally, the third section will use the information presented in current research as a guide for interventions to be used in the classroom curriculum.

Defining the Deficits: Causes of Reading Disabilities

While the four areas of deficits are easily identified, they are sometimes difficult to define. Each area involves multiple factors, all which relates to reading and/or reading difficulties. Below is a summary of each area and the factors needed to effectively define them.

Phonological Awareness

For the past 20 years, phonological awareness has been considered the most influential factor in predicting reading difficulties in students (Badian, 2005). Thus, much of the available research on reading disabilities has focused on phonological awareness deficits and how to alleviate them.

Phonological awareness or PA, is defined as "the ability to understand and use the sound system of our language" (Altor, 2002, p.48). Unlike phonics, PA is an oral language skill and requires the ability to orally segment syllables as well as small units of sounds known as phonemes. Phonological awareness is a precursor to understanding the relationship between sounds and symbols (the alphabetic principle). In order to successfully read, students must be able to segment sounds as well as blend them together to make words. PA typically begins with teaching children to identify rhymes, separate syllables, and separate onset and rimes. Eventually, students are expected to segment and blend sounds as well as add and delete sounds. All of these skills are necessary to effectively read.

Rapid Automatic Naming

Rapid Automatic Naming (RAN) has also become a highly researched area in reading disabilities. Maryann Wolf and Patricia Bowers first presented research on RAN in 1993. Their work was highly influenced by Denckla and Rudel's 1976 research which hinted at the importance of recall and automaticity in reading (Wolf & Bowers, 1993). RAN refers to the naming speed necessary in letter and word automaticity as well as retrieval speed. Research had, until recently, grouped RAN as a skill under the umbrella of phonological awareness (Savage & Frederickson, 2006). However, in their 1993 study, Wolf and Bowers used two separate longitudinal studies to demonstrate that "the two deficits [phonological and RAN] have independent, additive effects" (p. 5). The authors maintained that even with great phonological awareness skills, slow naming and retrieval speed will hinder effective readers.

Their research on RAN has led to another deficit area, the "double-deficit theory" (Wolf and Bowers, 1993), which is discussed further below.

Double-Deficit Theory

The double-deficit theory is not a theory based on a new deficit area but instead, a culmination of two deficits. The double deficit theory was developed and presented in 1993 by Bowers and Wolf. This

theory explains that students with phonological awareness deficits and RAN deficits are poorer readers than those students with only one deficit (Wolf, 1999). Bowers and Wolf (1993) discuss four subtypes of reading deficits. The first subtype is students that are good non-word decoders (ie., nonsense words such as "zark") and demonstrate good fluency in regular word reading. These would be the "typically developing" students. The next two subtypes are "single deficit" students. These students will either be poor non-word decoders while demonstrating good fluency in regular word reading (phonological awareness deficit) or good non-word decoders while demonstrating poor fluency in regular word reading (RAN deficit). Finally, the authors maintain that the double-deficit students are students who demonstrate poor non-word decoding skills as well as poor regular word reading thus creating a "double-deficit". Bowers and Wolf maintain that these students with the double deficit are poorer readers than those with only one area of deficit.

Visual-Orthographic Difficulties

The fourth deficit is actually one of the oldest deficits recognized in reading disabilities. Badian (2005) defines visual-orthographic skills as "the ability to recognize whether letters or numerals are correctly oriented" (p. 28). Visual-orthographic deficits were noted in early studies on dyslexia from 1895 and 1896 (Badian, 2005). However, Badian (2005) maintains that after Vellutino's book on Dyslexia released in 1979, linguistic deficits became the focus cause of the reading disorder . Historically, orthographic difficulties are often one of the most recognizable signs of Dyslexia. Despite lack of support for this deficit, several studies cited by Badian in her article "Does a Visual-orthographic deficit contribute to reading disabilities?" support that "low level visual tasks.. have been shown to correlate with reading" (p.30). These tasks include visual discrimination between letters and numbers or non-alphanumeric symbols as well as the ability to discriminate between letters within the alphabet. Other tasks may include word recognition and subtle changes in letters. These affect not only the ability to read but also the ability to comprehend.

Research on Reading Difficulties

` While there is a seemingly unlimited amount of research available on phonological awareness during the last 20 years, the current research trends are focused on the relationship between PA and RAN. This section will summarize research available on phonological awareness alone as well as visual-orthography deficits alone. The bulk of this section is dedicated to research on the double-deficit hypothesis. In these studies, students with RAN deficits only are studied but the data are used to support the hypothesis that students with PA and RAN deficits are weaker readers. No current studies were found that isolated RAN deficits.

Research on Phonological Awareness

Many articles have discussed the effects of phonological awareness alone as a cause of reading difficulties. Most current research focuses on interventions used to increase PA and in turn increase reading skills rather than how much PA alone affects reading ability. In 2002, Abbott et al. presented a longitudinal study on the affects of PA on reading skills. The authors identified two Kindergarten teachers that felt their program lacked in teaching phonemic awareness, a subset of phonological awareness. Using the Dynamic Indicators Basic Early Literacy Skills (DIBELS) reading test, 27 students were identified as needing phonemic awareness training (Abbott et al., 2002). All students received 2 30 minute sessions a week of phonemic awareness instruction. The students who scored the lowest on the DIBELS assessment received an additional four times a week of small group instruction while the average students received this instruction only 2 times a week. High performing students received only one time a week. The program focused on onset fluency and letter identification rather than phonemic segmentation. As a result of the intervention, all students, including low performing students, made great gains in onset fluency and letter identification. The researchers continued to provide intervention in to the students' first grade years. By mid-year of first grade, the low performing students made gains of up to

90% in phoneme segmentation, the 1st grade focus skill (Abbott et al., 2002). However, none of the low performing students passed the DIBELS benchmark.

In 2006, Savage and Frederickson sought to further validate the effects of phonological awareness on reading as well as examine other factors. "Beyond Phonology: What else is needed to describe the problems of average and below-average readers and spellers?" looks at phonology as a predictor of reading difficulties as well as of the predictive value of handedness, rapid naming, and memory. The authors tested 67 children with the mean age of 10 years and 7 months (Savage & Frederickson, 2006). The students were recruited by a newspaper ad asking for children with "dyslexia". Not all of these children were enrolled in special education despite being poor readers. To test phonological awareness, the authors used a rhyming test in addition to a non-word reading test, both from the Phonological Assessment Battery (Savage & Frederickson, 2006). Students who scored standard scores below 85 on the phonological awareness tests were grouped as having phonological deficits. As expected, "preliminary analyses confirmed that the average and below-average reader groups differed significantly on [the] phonological processing variable" (Savage & Frederickson, 2006, p. 407). The authors also found that with reading, phonological awareness was a stronger predictor of skill rather than handedness, working memory, and RAN. This will be discussed further in the next section.

Another study by Reading and Van Duren (2007) compared the scores of 1st grade students who received PA training in Kindergarten to those who had not. At the beginning of first grade, DIBELS was administered. Students who received training in Kindergarten scored much better on the phoneme segmentation subtest than those who did not receive PA training. Both sets of students received PA training in 1st grade. In the end of their 1st grade year, the students were again assessed with DIBELS. By the end of the year, students that had not received PA training the year before had improved tremendously. Only 10 students who had previously not received PA training continued to need additional support (Reading & Van Duren, 2007, p. 277). This number decreased from 23 students needing

additional training at the beginning of the year. As Reading and Van Duren (2007, p.282) stated "the results of this study suggest that 1) learning PA skills at the beginning of 1st grade is early enough to support later reading development; 2) learning these skills can occur in a short amount of time". Thus, PA skills are important in teaching reading skills and results can be seen in a short time.

Research on Rapid Automatic Naming and the Double Deficit

Several studies have been performed to research Bowers and Wolf's (1993) idea of the "double-deficit". As stated, Bowers and Wolf first presented the hypothesis in 1993, based on two individual longitudinal studies. In the first study, 38 children were split into 4 groups based on "tests of reading accuracy, comprehension, and fluency, symbol naming speed, phonemic awareness and vocabulary knowledge" (Bowers & Wolf, 2007). The authors found that "effects of phonemic decoding and lexical speed are additive for the skill in question" (Bowers & Wolf, 1993, p.4). These single deficit students, whether PA deficit or a RAN deficit, had similar performances on word identification and reading comprehension. These students were able to compensate for their deficit. However, students with double-deficits performed poorer in all areas, including reading comprehension. This finding lead the authors to believe that each deficit, PA and RAN, had an additive effect to the reading disability. Study 2 performed by the authors had similar results. While initially the double deficit group did not vary tremendously from the single deficit RAN group in 1st grade, the double deficit students skills worsened by 4th grade. The "double deficit group [became] progressively more impaired than all other subgroups" (Bowers & Wolf, 1993, pg. 4). The results of these studies led the authors to define the double-deficit hypothesis and conclude that RAN is independent of phonological awareness though both correlate with reading disabilities.

In 2000, Manis, Doi, and Bhadha presented a study following up on Bowers and Wolf's work on the double-deficit. The study included 85 1st graders, 68 of these students were followed into 2nd grade. These students were given standardized reading tests (WISC-II subtest), serial naming speed tests, tests of phonological skill, non-word reading tests and tests of orthographic skill. The authors found that students with reading difficulties had problems with RAN as well as problems in PA. However, each of these problems were independent of each other. Some students with RAN difficulties did not have PA problems while some students with PA deficits did not have RAN deficits. There were a group of students that demonstrated difficulty in both areas. The authors in this study did not test the effect the double deficit had on reading but rather noted that the presence of either deficit or both was common in students with reading disabilities. "As such, a deficit in speed of processing warrants consideration in explanatory models of reading disabilities" (Manis et al., 200, p. 520).

In 2002, Schatschneider et al.'s study again tested the double deficit theory. The authors tested 947 students using a battery of tests on phonological awareness, the Rapid Automatized Naming test, and the letter-word identification and passage comprehension subtests of the Woodcock-Johnson Psycho-educational Test Battery revised (Schatschneider et al., 2002). The study found a positive correlation between naming speed (RAN) and phonological awareness. Schatschneider et al. states that "children with phonological awareness deficits are less likely to have severe impairments in phonological awareness than children with deficits in both phonological awareness and naming speed" (2002, p. 252). This study supports the double deficit hypothesis as well as claims that phonological awareness is more closely correlated with success in decoding (especially non-words) while RAN is more likely to influence success in fluency. Together, as in Bowers and Wolf's 1993 study, children are less likely to be successful in the entire reading process.

However, not all studies completed on the double deficit theory have supported its claim. In 2001, Ackerman et al. published their refutation of the theory, "The Double-Deficit Theory of Reading

Disability Does Not Fit All". In their study, the authors tested 56 elementary students with reading disabilities and 45 typically developing elementary students. The elementary students scored lower in all areas of phonology as well as rapid naming of letters and numbers, as expected by the authors (Ackerman et al., 2001). In testing the double-deficit theory, the authors probed further into the group of students with reading disabilities. Unlike Bowers and Wolf 's (1993) theory, the authors found no variation in ability between those with deficits in individual areas such as phonological awareness or rapid naming and those with the double-deficits. If the double-deficit theory was true, those students with deficits in both phonological awareness and rapid naming would have markedly lower reading abilities than those with only single deficits.

In 2002, Hammill, Mathers, Allens, and Roberts completed another study on factors predicting reading ability. The authors tested 200 first grade students from general education classes and resource programs. The students were tested using 16 measures that evaluated individual skills such as rapid automatic naming, listening comprehension, and semantics. Hammill et al.'s study supports Wolf and Bowers claim that rapid naming is a poor predictor of spoken language thus, making it a factor separate from phonological awareness. In contrast, further evaluation of the data collection did not support the use of the double-deficit theory in predicting poor word readers. The authors placed students into two groups: those that scored in the 25th percentile and below in phonological awareness tasks and those who scored in the 25th percentile and below in the rapid naming tasks (Hammill et al., 2002). This was cross-referenced with those who scored in the 25th percentile and below in word recognition. The authors found that these data didn't support the criterion for accurate screening. While it did help the authors differentiate between good and bad readers, it also produced false-positives. The double-deficit theory over-identified children with word recognition problems by 44% (Hammill et al., 2002).

As demonstrated by these studies, there is not full agreement about the double-deficit hypothesis in the professional community. Despite variations in the studies, it has been shown that rapid automatic

naming is a separate entity from phonological awareness. This claim alone cannot support or refute the idea that students with deficits in both areas have more significant reading disabilities. Instead, it can recommend that students be screened as soon as possible and interventions be relevant to the deficits the students are demonstrating.

Research on Visual-Orthographic Deficits

As stated, there is a relative lack of current research in the area of visual-orthographic deficits. In 2002, Terepocki, Kruk, and Willows completed a study on "The Incidence and Nature of Letter Orientation Errors in Reading ". The authors tested 10 children with reading disabilities and 10 children without reading disability in several tasks involving visual discrimination. The students were required to identify correct orientation of letters on a computer as well as complete written tasks. They concluded that "children with reading disability confused the orientation of stimuli more frequently than average readers in reception and production tasks that required either short or long-term memory" (Terepocki, et al., 2001, p. 228). The authors, however, could not conclude that reversals were the sole cause for reading disabilities in these students. Other factors, such as phonological awareness, needed to be taken into consideration. Students with poor phonological awareness skills may rely more on their visual skills. However, if there is a visual-processing problem, this will increase their reading difficulty in relation to letter recognition. The questions remaining from this study support the further need for research in this area.

Badian (2005) performed a study assessing the effect of visual-orthographic deficits on reading ability. As Badian notes that, and as demonstrated in the earlier review of research, it is apparent that phonological awareness and rapid automatic naming play a large role in reading ability. Badian (2005) tested 207 children for phonological awareness, naming speed, visual-orthographic skills (cross out backward numbers), intellectual ability, verbal short term memory, and reading measures. With these results, Badian divided the students into two groups: visual-orthographic deficit group and non visual-

orthrographic group. Badian found that "the visual-orthographic measure accounted for significant independent variance in each reading measure, and for more variance in reading comprehension than phonological awareness or naming speed" (2005, p. 44-45). Badian also found that students with visual-orthographic deficits were poorer readers than those without. Reading comprehension was extremely compromised by the ability to determine the correct orientation of letters.

Implications for Education

As demonstrated by the research presented, naming speed, phonological awareness, and visual orthographic deficits all may have negative effects on reading. Each of these deficits has been found to be independent of each other. However, more than one deficit can occur at a time creating poorer readers than those with any one deficit alone. Current educational law demands that teachers maintain practices that are research-based and data-driven. However, even with continued research in other deficits that affect reading ability, the focus continues primarily to be on phonological awareness.

It is apparent that phonological awareness is an important feature of any reading program. To be successful, students need to be able to segment words and blend sounds. However, as these studies reveal, for some students, PA training may not be enough. When PA training does not alleviate all reading difficulties, students should be tested further to find other deficits. As Miller and Felton (2001, p.132) state in their case study of a 14 year old student reading on a second grade level "students with more severe deficits must be identified early, and appropriate intervention must begin immediately".

The question arises that with evidence supporting the effects all three deficits have on reading, should testing for early reading skills should include tests of RAN, PA, and visual-orthography? Some current early literacy tests already help identify orthographic and rapid naming deficits. Rapid naming of letters in a predetermined time may show orthographic problems if students mix up letters such as b and

d, n, u, h, m, and r. Testing students that fail timed portions with non-timed tests can help identify possible RAN deficits that can be further tested using specific rapid naming tests. These subtests are included in popular early reading tests such as DIBELS, PALS, and EARS. The ability for students to be tested early can decrease the number of students, like the young man in Miller and Felton's 2001 study, who are reading more than 2 levels below grade level in middle school or higher.

As the research shows, however, there is some question as to whether RAN and the double-deficit hypothesis can be a true predictor of reading difficulties. In Hammill et al.'s article, the double-deficit hypothesis caused a significant amount of false positives in relation to reading disabilities. Therefore, answering the posed question, perhaps the why isn't as important as the actual identification of students with reading disabilities. Educators should continue using tests with due caution that measure multiple skills, including phonological awareness, visual-orthography, and RAN and use these results accordingly. Classroom interventions should still focus on all areas of reading, as all of these skills are necessary to be an effective reader. Until further research is done, we can assume that all of these children can benefit from the same basic interventions and modifications can be made on an individual basis.

Discussion

While it is apparent that many steps are being taken in education toward alleviating reading difficulties, further research needs to be completed before any definite answers are provided. While the double-deficit theory becomes more popularized in work regarding reading disabilities, there is still many more questions that need to be answered. Do students with this double-deficit really become poorer readers than those with only single deficits? If so, what interventions can we use for these students? Since this theory is rather new, long term studies need to be provided that show the effects of double-deficits on readers as compared to those with only a single deficit and then demonstrate general interventions being used with single deficit students are not enough for double-deficit students. If the double-deficit theory is in fact a larger problem than research can currently define, then reading programs in place will need to be

examined for comprehensiveness. Proposed programs will also need to be tested in comparison to current reading programs which tend to focus on solely phonological awareness.

More research also needs to be done on visual-orthographic difficulties and its relationship to reading. A correlation has been demonstrated in current studies but more long term studies need to be completed so that more interventions can be designed for these specific students.

In addition, the studies reviewed in this paper focused on elementary aged students. More research would need to be completed with older students to see if there is a relationship between naming speed and age. Researchers suggested a link between processing speed and working memory and the age of the student yet no real studies have been done to find a true link.

Finally, several researchers questioned the effect of phonological short term memory and IQ on reading ability. Further research would need to be completed in order to determine the effect if any, these factors may have on reading ability. Possibly related to these factors, research should continue for those students that may be "treatment resistors". While visual-orthographic deficits, RAN, and PA deficits are clearly being addressed, there will still be some students that do not improve with these interventions. For these students, further testing would need to be completed, perhaps in short term memory or working memory, to find ways in which to reach them. As educators, we must seek answers to change "treatment resistors" into effective readers.

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