THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF COMMUNICATION SCIENCES AND DISORDERS

DOUBLE DEFICIT HYPOTHESIS APPLIED TO POOR READERS WITH DIVERSE RISK FACTORS

VICTORIA MCGRATH
Spring 2011

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Communication Sciences and Disorders
with honors in Communication Sciences and Disorders

Reviewed and approved* by the following:

Dr. Carol Miller
Associate Professor
Thesis Supervisor and Honors Adviser

Dr. Maya Misra
Assistant Professor
Second Reader

* Signatures are on file in the Schreyer Honors College

Abstract

This study examined two age groups (ages 7;4-10;8 years and 11;0 -13;9 years) with 24 and 25 children in each group respectively. Each age group had both children who were at risk and those who were not at risk for reading and language disorders. The goal of this study was to compare younger vs. older children, and children at risk vs. those not at risk, using the Test of Word Reading Efficiency (TOWRE) (Torgesen et al., 1999), Comprehensive Test of Phonological Processing (CTOPP) (Wagner et al., 1999) and Clinical Evaluation of Language Fundamentals (CELF) (Semel et al., 2003) scores. First, we examined the Rapid Automatized Naming (RAN) raw scores from the CTOPP to determine whether the gap between the scores of at risk and not at risk participants increased or decreased with age. We predicted that the older cohort would have a larger gap between at risk and not at risk than the younger cohort. Second, we examined the relationship between processing speed, as measured by RAN, phonological decoding as measured by Phonemic Decoding Efficiency (PDE) subtest of the TOWRE and spoken language as measured by Core Language scores (CELF). We predicted that RAN and phonological decoding factors would be significantly correlated with language scores, by applying the double deficit hypothesis of dyslexia (Wolf & Bowers, 1999). RAN raw scores were found to differ by age group while RAN scaled scores differed by risk group. There was a substantially larger gap in children's RAN scaled scores when comparing the older cohort's at risk and not at risk groups. Together, risk group, PDE scaled score, and RAN scaled score significantly predicted Core Language score, but separately, only RAN scaled score was a marginally significant predictor.

TABLE OF CONTENTS

List of Tables and Figures

Introduction

Reading and Language Linked

Because reading is language based it is critical to understand how language and reading are interrelated. Although there are many similarities between the processes underlying both reading and processing the spoken word there are also many differences, and these similarities and differences help to explain why reading disability is viewed as a developmental language disorder (Catts & Kahmi, 2005).

There are many different views of reading but two well-known views are that of the broad view of reading and the simple view of reading. The broad view of reading emphasizes the higher level thinking process involved in reading and is usually associated with comprehending text information. The simple view of reading is based on the idea that reading consists of two components: decoding, the word recognition process that transforms print into words; and linguistic comprehension, also referred to as listening comprehension, which is the process by which words sentences and discourses are interpreted. According to the simple view of reading, both components are necessary to have true reading. For example, decoding without comprehension is not reading. Catts and Kamhi (2005) reported that Perfetti in 1986 proposed that the simple view is more related to children learning to read, while as the broad definition, which is more associated with intelligent literacy, should be applied to children and adults who read to learn.

One of the main similarities between spoken and written language comprehension is phonological representation, which occurs in the word recognition phase. One must access the mental lexicon, which contains information on semantics and syntax, the content and structure of which are very similar for reading and spoken language. In reading there are two ways to discern word meaning, by phonological representation or by a direct visual approach. The phonological approach is valuable in learning to read an alphabetic script because of the grapheme-phoneme (i.e., letter-to-sound) correspondences, which allows children to read words they have never seen before. The phonological approach is especially associated with reading of nonsense words seen in the Test of Word Reading Efficiency (TOWRE) subtest, Phonetic Decoding Efficiency (PDE), which gives the child 45 seconds to name as many pronounceable non-words as possible (Torgesen et al., 1999). A direct visual approach is usually used on words the child sees consistently (Catts & Kamhi, 2005).

Although there are many similarities between reading and writing and spoken language, reading and writing is not a simple form of spoken language. “The analysis of speech by the listener is carried out below the level of consciousness by an evolutionarily old and highly adapted auditory perceptual process” which means humans are biologically adapted to process speech but the “human visual system is not biologically adapted to process written text.” (Catts & Kamhi, 2005, p. 17). Written text can be read and reread to gain further understanding, while spoken words, unless the listener asks for clarification are in the control of the speaker.

The Double Deficit Hypothesis of Dyslexia

Dyslexia, a commonly overused word for reading disability, is defined as having a “difficulty with words” (Catts & Kahmi, 2005, p. 54). In layman’s terms, this term usually refers to someone who makes reversal errors and reads and writes backwards, but this is only a small portion of errors made by children with dyslexia. A more elaborate definition was developed by Lyon, Shaywitz, and Shaywitz (2003) that describes dyslexia as “characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities” (p. 2). Usually these abilities are without a deficit in cognitive abilities. Wolf and Bowers (1999) proposed a theory regarding developmental dyslexia referred to as the Double Deficit Hypothesis. They proposed that dyslexia not only involved phonological deficits but also the process underlying naming speed deficits and that phonological processes and naming speed processes are separate sources of reading dysfunction. Previous to the idea of the double deficit hypothesis, the main feature behind dyslexia was thought to be impairment in phonological processes and therefore little attention was given to fluency and automaticity issues during treatment. The present study aims to discover if rapid naming, in addition to being related to reading disability, which we view as a language disorder, also predicts spoken language scores.

Rapid Automatized Naming

Naming speed has proven to be an important factor in determining the skill level of readers. One well-known measure of serial naming speed is the rapid automatized naming (RAN) test, designed by Denckla in 1972 (Wolf & Bowers, 1999). Naming speed is found to increase as the child ages, and there are many theories to account for this age-related change.

One theory, proposed by Kail and Hall (1994) stated that the naming–reading link reflects a global developmental change in processing speed. During childhood and adolescence, the speed of processing increases on a range of tasks, which indicates that a common, global mechanism is responsible for age-related change in processing speed

(Kail & Hall 1994). Therefore, access to name codes for digits, letters, and colors may become more rapid with age simply because of an age-related change in speed of retrieval. According to this view, the correlation between naming speed and reading reflects the fact that both are linked to age-related changes in processing speed. In Kail and Hall (1994) it was seen that naming time reflected speed of processing and that reading recognition was dependent on age, naming time and print exposure. Therefore it was concluded that the time to name familiar stimuli reflects a global developmental change in speed with which many other cognitive processes are also executed.

RAN Scores Predict Reading Abilities

As described by the double deficit hypothesis (Wolf & Bowers 1999) naming speed is one of two sources underlying developmental dyslexia. The present study attempts to investigate links between RAN and other measures in a group of children who are at risk for reading difficulties compared to those who are not. Our at risk readers will be will be defined as those whose reading difficulties have been recognized and have received some kind of services. Although some of the subjects to do not have a clear diagnosis, others have diagnoses such as dyslexia. As stated above it is known that as a typically developing child matures their processing speed increases. It has also been found that rapid naming is slower in those with poor reading skills when compared to their normal reading peers (Kail & Hall, 1994). But when comparing poor readers with their not at risk peer group, as they grow older, will the gap widen in terms of processing speed or stay the same?

Meyer, Wood, Hart, & Felton (1998) looked at two groups of students, those who were poor readers (were in the bottom tenth percentile of reading compared to their peers) and those who were non-disabled. The subjects were first assessed in 3rd grade with tests, notably RAN, to see if results would predict later reading in 5th and 8th grade. When IQ, socioeconomic status, and third-grade single-word reading were statistically controlled Meyer et al. (1998) found that naming speed was the only variable that strongly predicted later word identification in the poor reading group but not in the non-disabled group. The idea that rapid naming only is predictive in poor readers and not for average readers raised the idea that impaired readers are qualitatively different than the normal reading population, and not just the “tail” of the bell curve of reading ability, which was thought to be the case by many researchers previously. Finally this shows that difficulty acquiring basic reading skills in early elementary school and deficiencies in rapid serial naming are warning signs for those to fall behind their peers, even when tested five years later.

In contrast to the findings of Meyer et al. (1998), Torgesen, Wagner, Rashotte, Burgess, and Hecht (1997) when statistically controlling for vocabulary and the variance contributed by Grade 2 word recognition, found that Grade 2 phonemic awareness, but not naming speed, continued to contribute significant variance to Grade 4 word recognition in both the average sample and in the at risk reader subgroup**.** Wolf & Bowers (1999) remarked that possibly Torgesen et al. (1997) did not find significant naming speed deficits because they used at risk readers rather than a more clear definition of poor readers, such as Meyer et al. (1998) used, the bottom tenth percentile of reading compared to their peers. Although Torgesen et al. (1997) did not find the same results as Meyer et al. (1998); this might be due to the large population of garden variety poor readers, rather than the dyslexic readers featured in Meyer et al. (1998), which might have lower correlations between naming speeds than those with dyslexia. Because there are multiple subtypes of poor readers in the Torgesen et al. (1997) study, just like in the present one, it might be harder to find a stronger correlation between RAN and Core Language scores when the readers are not specifically defined and are given the "at risk readers" label.

Decoding Words and Nonsense Words as the Phonological Component of Reading

Another research question proposed by the present study was how some phonological measures such as processing novel words would predict spoken language scores of dyslexic and at risk readers. Wolf & Bowers (1999) recognized that phonological processes hinder the uptake of word recognition skills, which therefore disrupts the attainment of fluent reading. Rack, Snowling, and Olson (1992) reviewed how non-word reading was an accurate indication of phonological processing which can be related to word reading performance. Dyslexic children were compared to readers who were on the same reading level, rather than their peers, in a reading level match comparison to rule out the possibility of reading level affecting non-word reading. Rack et al. (1992) found that dyslexic readers were worse than reading-level- matched normal readers on measures of phonological reading skill. Also when reading non-words aloud, those with dyslexia were slower and more error prone than the reading-level-matched group. Although most studies reviewed by Rack et al. (1992) suggested that reading non words is a strong indicator of the disabled reader's impaired phonological-based decoding abilities there were a few studies reviewed that did not find a strong correlation between non-word deficits and dyslexia.

Research Questions

Overall the present study aims to evaluate the following questions:

1. Observe changes in Rapid Automatized Naming (RAN) scores and determine whether there is a gap between the scores of normal and at risk reader subgroups over time.
2. Observe whether RAN and Phonemic Decoding Efficiency subtests predict Core Language Scores independent of risk group, and if so, how strongly.

Methods

Participants The present sample included 49 students ranging in school year from second grade to eighth grade at the time of screening. Two age cohorts were established, those in-between the age of 7;4 years through 10;8 years old, and those between 11;0 through 13;9 years old. The age cohorts were further subdivided between at risk students and those who were typically developing. Inclusion for at risk students included those who were reported by their caregivers to be: dyslexic, a title I reading participant, in learning support for either reading or writing or those who were at least one grade level behind their peers in reading as reported by caregivers. These students also did not have any missing data on any of the subtests used for the present study. The tests were administered as part of a larger study, the Language and Literacy Research Initiative (LLRI). These students were recruited throughout the central Pennsylvania area through school contacts and advertisement with flyers. Subjects were then invited to participate in testing as part of the larger LLRI project.

Materials Scores from three standardized tests were used in the present study, : Phonemic Decoding Efficiency subtest (PDE) of the Test of Word Reading Efficiency

(TOWRE) (Torgesen, Wagner, & Rashotte, 1999), the Rapid Letter Naming (RAN letters) subtest of the Comprehensive Test of Phonological Processing (CTOPP) (Wagner, Torgesen, & Rashotte, 1999), and the Clinical Evaluation of Language Fundamentals (CELF) (Semel, Wigg, & Secord, 2003).

The TOWRE is a test for individuals from 6;0 to 24; 11 that measures the ability of the participant to pronounce printed words with accuracy and fluency. The main focus is to assess the ability to recognize familiar words as whole units in real word situation and to also sound out nonwords. There are two subtests, the Sight Word Efficiency Subtest (SWE) and the Phonemic Decoding Efficiency Subtest (PDE): The goal of the SWE is to assess the number of real words that can be accurately identified within 45 seconds time. The PDE assesses the number of pronounceable printed non-words (e.g., ip, ga, ko, ta, om, ig, ni, pim, wum…) that can be accurately decoded within 45 seconds time (Torgesen et al., 1999).

The CTOPP is a test designed to measure reading related phonological skills and provide the examiner with the strengths and weaknesses in phonological processing of the participant. Phonological awareness, phonological memory and rapid naming are assessed because deficits in these abilities are the most common cause of reading disabilities, according to the authors of the CTOPP. There are two versions, for ages 5-6 and the one used in the present study, for ages 7-24. This test includes six core subtests and six supplemental tests to better assess specific phonological strengths and weaknesses. The Rapid Letter Naming subtest, which is one of the main focuses of this study, is a test of rapid automatized naming. The individual is asked to name letters on two pages, of six randomly arranged letters in four rows and nine columns as quickly as possible. The score is derived by how long it takes for the client to name all of the letters. For example the student will be told to “name these letters as fast as you can: a, c, k, n, s, t” (Wagner et al., 1999).

The CELF 4 is a test is to evaluate phonological awareness, semantics, syntax, morphology, pragmatics and memory. Subtests are administered by age of participant in the age groups of 5-8, ages 9-12 and ages 13 to 21. The Core Language score, the score used in this study to represent general language ability, is a combination of many of the subtests in the CELF. If the child is between the ages of 5 and 8 his/her Core Language score is determined by Concepts and Following Directions, Recalling Sentences, Formulated Sentences and Word Structure subtests. If the participant is between the ages of 9 and 12 his/her Core Language score is determined by Concepts and Following Directions, Recalling Sentences, Formulated Sentences and Word Classes 2. Ages 13-21 use Recalling Sentences, Formulated Sentences, Word Classes 2 and Word Definition subtests to determine his/her Core Language score. In the Concepts and Following Directions subtest the participant points to an object in the stimulus book in response to oral directions. To complete the Recalling Sentences subtest, the participant imitates sentences presented orally by the examiner. In the Formulated Sentences subtest the student creates a sentence about visual stimuli presented using target words and phrases. During the Word Structure subtest the participant completes a sentence within the targeted structure. In the Word Classes 2 subtest, the student chooses the two words that are related and describes the relationship between them. The Word Definition subtest examines the student’s ability to define a word given to them by the examiner and use it in a sentence (Semel et al., 2003).

Procedure The tasks were individually administered by trained research assistants from the Pennsylvania State University as part of a larger protocol. The larger protocol included two sessions, each an hour and half in length. Tests that were included in the larger study, but not used in the present study included a hearing screening, vision screening, performance IQ, verbal working memory task and a sentence processing task. Research assistants were trained by reading test manuals and a manual of laboratory procedures, observing data collection, and collecting data under the supervision of an experienced examiner. They also receive training in scoring tests. Two independent scorers scored all tests and tasks.

Results

Descriptive statistics for the Rapid Automatized Naming (RAN) raw score are

Table 1: Descriptive Statistics for RAN Raw Scores and RAN raw score as the dependent variable

	Age Group		
Risk Group	Younger	Older	Both Ages
	Mean (Std. Dev.), N	Mean (Std. Dev.), N	Mean (Std. Dev.), N
At Risk	42.78 (11.27), 9	36.58 (8.31), 12	39.24 (9.93, 21
Not at Risk	46.20 (20.24), 15	28.17 (3.51), 12	38.19 (17.58), 27
Both Risk Groups	44.92 (17.21), 24	32.38 (7.58), 24	38.65 (14.40), 48

presented in Table 1. These statistics include means, standard deviations and numbers of participants in risk groups and age groups. Because the RAN score is determined by how long it takes for the child to name all of the letters, it was predicted that younger children would have higher scores (that is it would take longer) as well as those who were at risk. Inspection of Table 1 suggests that in the younger cohort scores are slightly lower (they finished the task more quickly) for the at risk group. In the older group, at risk children took substantially longer to name the letters than those who were not at risk.

Table 2 shows the results of a two way ANOVA with age group (younger and older) and risk group (at risk and not at risk), as independent between-subjects variables,

Table 2: ANOVA Results with RAN Raw score as dependent variable

	F value	Degrees of Freedom	p value
Risk Group	.417	1,44	.522
Age Group	9.811	1,44	.003
Risk Group x Age Group	2.343	1,44	.133

because it is a raw score, age differences are to be expected because age is not taken into consideration. This analysis showed a significant main effect of age ($F(1,44) = 9.81$, p =.003). Main effect of risk group was as well as the interaction of age and risk was deemed not significant.

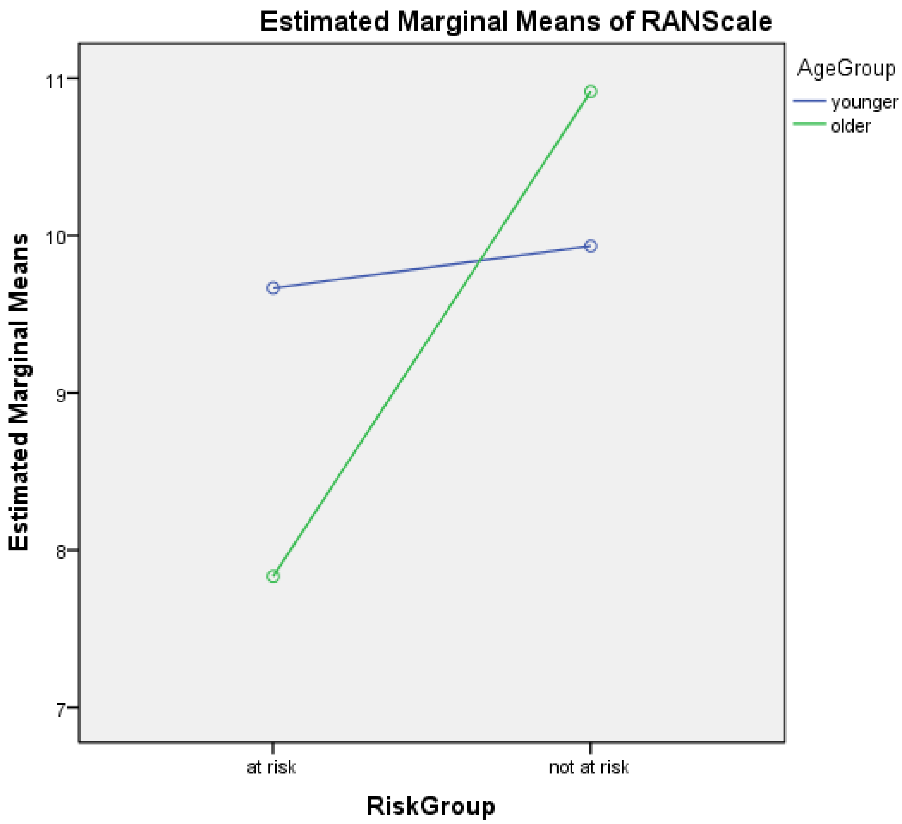
Participants in both younger and older cohorts who were at risk had lower RAN scaled scores than the not at risk peers. Children in the younger group showed a smaller difference between those who were not at risk and those who were at risk as demonstrated by Table 3. As the children became older, the gap between the at risk and

Table 3: Descriptive Statistics for RAN Scale scores

	Age Group		
Risk Group	Younger	Older	Both Ages
	Mean (Std. Dev.), N	Mean (Std. Dev.), N	Mean (Std. Dev.), N
At Risk	9.67 (2.69), 9	7.83 (2.91), 12	8.62 (2.90), 21
Not at Risk	9.93 (2.71), 15	10.92 (2.02), 12	10.37 (2.44), 27
Both Risk Groups	9.83 (2.65), 24	9.38 (2.92), 24	9.60 (2.77), 48

not at risk groups grew. This not only demonstrates a larger gap between the two cohorts but also shows that as children in the at risk group get older, their scaled scores see a noticeable decrease as demonstrated by Figure 1. As seen in Table 4, when RAN

Figure1: RAN Scaled scores plotted for Older and Younger Children by Risk Group



Scaled score was the dependent variable, the main effect of risk group was significant ($F(1,44) = 4.78$ $p = .034$). The interaction between risk group and age group was marginally statistically significant ($F(1,44) = 3.38$ $p = .073$) and the main effect of age was not significant, as expected.

Table 4: ANOVA Results with RAN Scale score as dependent variable

	F value	Degrees of Freedom	p value
Risk Group	4.786	1,44	.034
Age Group	.308	1,44	.582
Risk Group x Age Group	3.384	1,44	.073

Inspection of Table 5 also suggests that Core Language scores of younger children in the at risk and not at risk groups do not have a large gap between their scores. The gap between the average scores of those at risk and those not, widen substantially in the older cohort. As seen in Table 6, when Core Language was made the dependent

Table 5: Descriptive Statistics for Core Language scores

	Age Group		
Risk Group	Younger	Older	Both Ages
	Mean (Std. Dev.), N	Mean (Std. Dev.), N	Mean (Std. Dev.), N
At Risk	100.63 (8.94), 8	94.45 (20.68), 11	97.05 (16.69), 19
Not at Risk	102.92 (13.55), 13	115.62 (8.77), 13	109.27 (12.92), 26
Both Risk Groups	102.05 (11.91), 21	105.92 (18.50), 24	104.11 (15.685), 45

variable, risk group was a statistically significant predictor, with a value of ($F(1,41) = 7.66$, $p = .008$), while the age group was a poor predictor with a value of ($F(1,41) = .592$, $p = .446$). The interaction between risk group and age group however was statistically significant with a value of ($F(1,41)=4.96$, $p = .032$).

Table 6: ANOVA Results with Core Language score as dependent variable

	F value	Degrees of Freedom	p value
Risk Group	7.664	1,41	.008
Age Group	.592	1,41	.446
Risk Group x Age Group	4.955	1,41	.032

Bivariate correlations were computed between RAN scaled score, phonological decoding (PDE) scaled score and Core Language Score. There were significant correlations (p = <. 001) between Core Language and both Phonological Decoding scaled score (r =. 507) and RAN scaled score (r = .494). Also there was a significant correlation between Phonological Decoding scaled score and RAN scaled score (p =.000, r = .615). In order to examine the ability of the RAN scaled score and the Phonological Decoding scaled score to predict Core Language Scores, we performed a hierarchical regression analysis. Inspection of the normal probability plot of the residuals suggested that linear regression was appropriate. Risk group was entered first in the analysis and accounted for 15% of the variance in Core Language scores ($F(1,42) = 7.49$ $p = .009$). Phonological Decoding scaled score was entered next and it accounted for an additional 11% of the variance which was a significant change ($F(1,42) = 6.00$ $p =. 019$). RAN scaled score was added to the model last, and accounted for an additional 6% of the variance which was a marginally significant change ($F(1,40) = 3.54$ $p = .067$). In the final model the beta values for the 3 variables were Risk Group $\beta = .137$, Phonological Decoding Scale $\beta = .216$ and RAN Scale $\beta = .318$. Neither Risk group or Phonological Decoding was statistically significant; only the coefficient for RAN scaled score was marginally significant in this final model ($p = .067$)

Discussion

The main objectives of this study were two-fold. The first objective was to observe changes in Rapid Automatized Naming (RAN) scores and determine whether there is a growing gap between the scores of normal and at risk reader subgroups over time. The second objective was to observe how RAN and Phonemic Decoding Efficiency subtests predict Core Language Scores.

The first objective was completed through the analysis of descriptive statistics and ANOVA testing of RAN raw and scaled scores that showed that raw scores differed significantly for younger vs. older groups, whereas scaled scores differed significantly by risk group. Our hypothesis was supported because children in the younger cohort only showed a small gap between RAN raw scores for at risk and not at risk groups. The gap was so insignificant that at risk students on average scored better (were faster) than students who were not at risk. For older children, the average of RAN raw scores had a larger gap between the at risk and not at risk groups (although it did not reach statistical significance). When age was accounted for in scaled scores, there was a significant difference between the risk groups across ages, and a marginally significant interaction between age and risk. Also in line with our hypothesis was the idea that scaled scores over time would see a noticeable decrease. This goes along with the idea proposed by Wolf and Bowers (1999) that naming speed deficits are a core component of dyslexic readers. Because RAN scores are supposed to improve over time, whether by global development as proposed by Kail and Hall (1994) or by exposure to greater amounts of reading, students are supposed to have RAN abilities improve over time. If students are falling behind their peers in RAN, following the theory of developmental dyslexia proposed by Wolf and Bowers (1999) and applying it to at risk readers, one can reasonably conclude there would be deficits in overall reading ability.

Core Language scores were also examined. Core Language scores differed significantly by risk group. The Core Language scores of the younger children did not vary much across risk groups. However, for the older children, there was a larger difference in Core Language scores for the two risk groups. Although age group did not prove statistically significant in ANOVA, the interaction between age group and risk group was statistically significant. Core Language scores in this study were used to represent overall language ability. As described in the introduction, reading disability is viewed as a developmental language disorder. Therefore students who have low Core Language scores, can reasonably, according to this theory, be hypothesized to have poor reading abilities as well, and our results suggested that indeed, poor readers have lower language scores.

The second hypothesis, that RAN and Phonemic Decoding Efficiency subtests predict Core Language Scores has a less conclusive result. After looking at bivariate correlations, Core Language was significantly correlated with and both Phonological Decoding scaled score and RAN scaled score, and there was a significant correlation between RAN scaled score and Phonemic Decoding scaled score. Yet, when we performed a hierarchical regression analysis, only 32 percent of the Core Language score was determined by risk group, Phonemic Decoding scaled score and RAN scaled score. Although these results are deemed to be significant together, none of the variables on its own is a significant predictor. However in the final model, the Beta for RAN was marginally significant. We interpret these results to suggest that there is shared variance between the three predictor variables. Because naming speed, for so many years of diagnosing dyslexia was overlooked, it does not seem out of the ordinary for there to be some similarities in testing of both naming speed and phonological decoding. The idea that these two processes of dyslexia, naming speed and phonological decoding, are separate does not seem to agree with our results of at risk readers, because we believe there is an overlapping variable that they have in common.

This analysis did not clearly explain sufficiently the cause of variability in risk and non-at risk participants Core Language scores. Regression analysis showed that less than one third of variance of Core Language score could be accounted for by the three predictors, risk group, Phonemic Decoding scaled score and RAN scaled score. These predictors are reading-based while Core Language score is a measure of spoken language, therefore it is not surprising that these factors only account for 32% of variance, but are still able to show the link between spoken language and reading. Even when RAN, a reading measure, is used to predict other reading scores, the results of studies are mixed. In 1998 Meyer et al. (1998) showed that RAN scale score was able to predict word identification while Torgesen et al. (1997) did not find RAN to be a significant predictor of word recognition. According to Wolf & Bowers (1999), these results are accounted for because Torgesen et al. (1997) used garden variety poor readers, so the correlation to reading ability was not as strong. Following the same reasoning, our study with multiple subtypes of poor readers makes it even more difficult to find a relationship between reading scores and spoken language score, measured by Core Language

Overall it seems that the double deficit hypothesis of dyslexia may also be applied to some aspects of deficits in at risk readers. Although some of our participants, (3 of 49 total) had dyslexia, the majority did not have a specific diagnosis of reading disability. Because our at risk readers had lower RAN scaled scores in the older cohort that were statistically different from their not at risk peers, it can be concluded with caution, that perhaps deficits in RAN scores may have a diagnostic quality to them of not only dyslexic children but also with at risk readers. It is also important to note that our conclusions, may not be adapted to all age ranges, and can only be applied to those in our specific age periods examined.

The importance of naming speed deficits in dyslexia has only begun to be shown as a significant predictor of dyslexia in the past 12 years, since Wolf and Bowers (1999) described it as a second and equally important component in diagnosing children with dyslexia. We believe that it should continue to be accounted for in dyslexia diagnosis and should start to be applied, with caution, to other reading disorder diagnostic tests as well. Future research should focus more substantially on low RAN scaled scores as a predictor of at risk readers. In future studies we propose a more stringent definition of student's reading disabilities, to possibly find a stronger correlation between RAN performance and Core Language. Because our population was so diverse, it is hard to find more conclusive results. Another suggestion would be to find a larger population of readers with more similar diagnoses, which therefore might eliminate any small gaps that were seen between RAN raw scores with risk and not at risk in the younger cohort. Also, due to time constraints of this study, cross sectional data was used rather than longitudinal. Results from a longitudinal study, following the same children, might have a substantial effect on predictors and relationships between variables. Overall naming speed, measured specifically by RAN, is a relatively new topic of prediction for reading disorders and therefore should be given more attention in research.

References

Catts, H.W. & Kamhi, A.G., (2005). *Language and reading disabilities*. Boston, MA: Allyn & Bacon.

Kail, R., & Hall, L.K. (1994). Processing speed, naming speed, and reading. *Developmental Psychology, 30,* 949-954.

Lyon, G., Shaywitz, S. E., & Shaywitz, B. A. (2003). A definition of dyslexia. *Annals of Dyslexia, 53*, 14.

Meyer, M.S., Wood, F.B., Hart, L.A., & Felton, R.H. (1998). The selective predictive values in rapid automatized naming within poor readers. *Journal of Learning Disabilities*, *31*, 106-117.

Rack, J.P., Snowling, M.J., & Olson, R.K. (1992). The non-word reading deficit in developmental dyslexia. A review. *Reading Research Quarterly, 27,* 28-53.

Semel, E., Wigg, E.H., & Secord, W.A., (2003). *Clinical evaluation of language fundamentals fourth edition examiner's manual.* Harcourt Assessment, Inc.

Torgesen, J.K., Wagner, R.K., & Rashotte, C.A., (1999). *Test of word reading efficiency examiner's manual*. Austin: Pro Ed, Inc.

Torgesen, J.K., Wagner, R.K., Rashotte, C.A., Burgess, S.R. and Hecht, S.A. (1997). The contributions of phonological awareness and rapid automatic naming ability to the growth of word reading skills in second to fifth grade children. *Scientific Studies of Reading, 1,* 161-185.

Wagner, R.K., Torgesen, J.K., & Rashotte, C.A., (1999). *Comprehensive test of phonological processing.* Austin, TX.: Pro Ed, Inc.

Wolf M, & Bowers G. P., (1999). The double-deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology, 91,* 415-438.

Academic Vita of Victoria McGrath

Victoria McGrath
419 E Beaver Ave
State College, PA, 16801
vrm5015@psu.edu

Education:

Bachelor of Science Degree in Communication Sciences and Disorders, Penn State University, 2011
Minor in Health and Human Development
Honors in Communication Sciences and Disorders
Thesis Title: Double Deficit Hypothesis Applied to Poor Readers with Diverse Risk Factors
Thesis Supervisor: Dr. Carol Miller

Related Experience:

Internship at A.I. Dupont Children's Hospital (studying the language acquisition development of children with cochlear implants)
Supervisor: Dr. Tim Bunnell
Summer 2010

Awards:

Dean’s List
Health and Human Development Honors Society