COLLEGE STUDENTS WITH DYSLEXIA: A CASE FOR EXAMINING PHONEME MANIPULATION, RAPID AUTOMATIZED NAMING AND TIMED SINGLE-WORD READING

By

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To my parents, Mary Ann and Joseph Matthew DiFino, and my brother, Leslie Matthew DiFino

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The purpose of this study was to (1) investigate the same core deficits of phonological processing and word-level reading in college students with dyslexia that have been repeatedly reported in the literature on children with dyslexia and (2) compare the performance of college students with and without dyslexia on five key diagnostic measures. Two groups of college students 43 in total were studied: 23 students with developmental dyslexia and 20 students without dyslexia.

Five experimental questions were addressed: (1) How do the scores of the dyslexic group compare with scores of the control group on the variables of verbal comprehension, elision, rapid naming, word reading efficiency and phonemic decoding efficiency?; (2) Which of the five variables best differentiates the dyslexic group from the control group?;(3) What are the relationships between measures of phonological processing and measures of word-level reading for the dyslexic and control groups, respectively?; (4) Do dyslexic students with double deficits have lower word reading scores than dyslexic students with only a single deficit?; (5) What predicts the single-word reading scores of dyslexic students the best: single deficits or combined deficits?

College students with dyslexia performed lower on all five variables of verbal comprehension, elision, rapid naming, word reading efficiency and phonemic decoding efficiency than their non-reading impaired peers. Rapid naming and decoding measures best discriminated between these two groups. Finally, while students with double deficits appeared to perform more poorly than students with single deficit, the sample size was not large enough to test this hypothesis adequately.

CHAPTER 1
INTRODUCTION

Dyslexia, a specific reading disability, has been recognized as a neurobiological deficit since the nineteenth century when it was described in medical journals as well as monographs. The first observations were made by European physicians in England (late 1800s) and Germany (as early as the late 1600s). They documented cases of healthy children whose vision was intact, but who, in spite of adequate intelligence and motivation, had difficulty mastering reading (Shaywitz, 2003). The underlying problem for the children appeared to be an inability to recognize familiar words in print and to decode unfamiliar words in print. Thus, the term "word-blindness," derived from the German "Wortblindheit" (as described by Dr. Adolf Kussmaul in his 1885 book Die Stoerungen der Sprache [Disturbances of Speech]), was used to characterize this unexplained and unexpected difficulty with reading. Physicians in nineteenth century Europe were describing what we now refer to as developmental dyslexia.

The word-blindness seen in the healthy children in the nineteenth century distinguished itself from the word-blindness that the German physician, Dr. Rudolf Berlin, discovered in his adult patients who lost their ability to read following trauma to the brain. This reading disability was secondary to a specific brain lesion dysfunction and was called "dyslexia" by Dr. Berlin (Shaywitz, 2003, p. 15). Prior to brain injury these patients experienced no difficulty reading printed words. Thus, it became evident that an inability to read normally could result from both acquired and developmental factors. In an article by Grigorenko (2001) she notes that, in addition to word-blindness, many different names for dyslexia have been used over the past two centuries: "congenital word-blindness" (Hinshelwood, 1917; Morgan, 1896), "strephosymbolia"

(Orton, 1925, 1928, 1937), “unexpected reading failure” (Symmes & Rapoport, 1972), “specific reading retardation” (Berger, Yule & Rutter, 1975) and “poor reading” (Olson, Kliegel, Davidson, & Foltz, 1985) to name a few. The list of various names of dyslexia is intended to illustrate the complexity of the disorder.

CHAPTER 2
LITERATURE REVIEW

Defining Developmental Dyslexia

The International Dyslexia Association (IDA) Board of Directors (henceforth IDABoD, 2002) defines dyslexia as a specific learning disability that is neurological in origin and characterized by difficulties with fluent word recognition, spelling and decoding. These difficulties are unexpected given the individual's cognitive abilities, socio-cultural experiences, and motivation to learn to read. Furthermore, this definition has also been adopted by the National Institutes of Child Health and Human Development (2002). The British Psychological Society (BPS) working definition of 1999, describes the disorder as "a learning difficulty that primarily affects the skills involved in accurate and fluent word reading and spelling". Both the IDA and the British definitions clearly identify speed (or the lack thereof) and accuracy of word reading as key characteristics of dyslexia. While dyslexia persists throughout adulthood (Ramus et al., 2003), many individuals learn to compensate for this disability by using strategies that allow them to read with relative accuracy and sufficient speed for academic success in most instances.

Characteristics of Dyslexia in Children

In general, children with dyslexia experience a wide range of difficulties. Their reading skills are characterized by slow and inaccurate word recognition and word decoding, spelling, and oral reading fluency. They also show deficits in non-reading skills often associated with skilled reading such as phonological processing, verbal working memory and processing speed (Lombardino, 2012). Of the above listed

difficulties a deficiency in phonemic awareness appears to be the core deficit associated with dyslexia.

Children who present with dyslexia have better oral language than reading skills. They often exhibit verbal knowledge and reasoning abilities that that range from average to superior range, and these skills are always superior to their word-reading fluency skills (Lombardino, 2012). Further, as their decoding skills improve, children with dyslexia typically show better reading comprehension than reading accuracy for single words. They do well with contextual cues and “world knowledge” that together facilitate their comprehension even though their word-level reading speed and accuracy remains impaired (Lombardino, 2012).

Skilled reading requires the integration of numerous abilities. The component skills of reading that are most challenging for individuals with dyslexia are described below. The heading above shows that if you have a subheading of a certain level, you must have more than one. The rationale is that you cannot have a list of only one item.

Phonemic Awareness

Phonemic awareness, which enables individuals to isolate individual sounds in words such as in tasks of sound deletion (Lombardino, 2012), is the key skill that children must acquire in order to learn to read (Shaywitz, 2003). As children discover that words are broken down into phonemes and further that phonemes are linked to letters, children start to make valuable connections between the phonological and orthographic components of words in print (Shaywitz, 2003). According to Shaywitz (2003) and among scholars of the science of reading, this is the path to cracking the reading code.

Word Decoding

Decoding is a lower-level linguistic skill, as compared to reading comprehension, because it only requires an individual to segment words into their phonological segments and then to recombine them to create a word (Moats, 1995). As suggested above, the ability to decode is tightly linked to reading fluency (rate and accuracy) as the process of decoding allows different stored phonemes in areas of our brain to be rapidly retrieved together with their semantic representations, allowing for the identification of words in print. Any flaw in a child's phonologic processing will ultimately influence his ability to segment both words spoken and words in print into their corresponding sounds (Shaywitz, 2003). Unless a child is able to decode, he will not become efficient and proficient at rapidly recognizing words in print. A phonologic weakness, even at the most basic level in the system, will impair an individual's ability to decode (Shaywitz, 2003). Furthermore, when components of the lower-level representations of our language code are impaired, this disruption interferes with the ability to efficiently access higher level language processes (i.e., comprehension) that give meaning to these lower-level codes (Shaywitz, 2003).

In listening to speech, individuals develop an "implicit awareness of the segmental nature of language," but in reading, they must acquire a more rigorous cognitive engagement or "an explicit awareness of sounds" (Lombardino, 2012, p. 4). The explicit awareness demands an ability to segment words, phoneme by phoneme, a skill that develops reciprocally with acquiring sound-letter associations (Liberman, Shankweiler, Fischer, & Carter, 1974 as cited by Lombardino, 2012). As already established, the phoneme by phoneme segmentation is a core deficit for individuals who present with dyslexia.

Spelling

Deficits in decoding impact spelling; hence children with dyslexia always show deficits in spelling (Berninger et al.,2000; Moats, 1995, as cited by Lombardino, 2012) and these difficulties are most evident in their written compositions (Berninger & Wolf, 2009; Firth, 1980, Snowling, 2000, as cited by Lombardino, 2012). Lombardino (2012) states that the reason for weak spelling skills is due to a sole reliance upon “their phonological or orthographic memories” as they produce a written word, “rather than rapidly integrating phonological and orthographic memories” (Lombardino, 2012, p. 128).

Word Recognition

Word recognition can be best described as a highly complex, interdependent chain of cognitive-linguistic events which involves recognition of and associations between orthographic, phonological, and meaningful units of language. All of these associations among phonology, orthography and semantics play a crucial role in single-word reading. Models of single-word reading processes in adult readers, who have normal word-level reading or who had normal word-level reading prior to a cerebral trauma (Coltheart, 1980; Castles & Coltheart, 1996; Coltheart & Rastle, 1994; Coltheart, 2005; Plaut, McClelland, Seidenberg & Patterson, 1996b; Seidenberg & McClelland, 1989), have been extrapolated to explain word-level reading in children. However, the applicability of such models to developmental reading disorders remains undetermined. In a survey of models used to explain word-level reading, Seymour (2008) identified four types: (1) causal models of reading that identify specific areas of difficulty; (2) computational models that posit parallel interactions between component processes (i.e., phonological, orthographic, and semantic modules); (3) stage models pinpointing

qualitative difference between stages of reading development"; and (4) models that "identify overlapping phases of development" (Seymour, 2008, p. 1).

Of the many models and theories, the three-phase framework proposed by Ehri (1995, 2005) is most widely cited in the childhood literature on dyslexia. According to Lombardino (2012), Ehri's three-phase framework illustrates the key stages in word-reading development: the pre-alphabetic phase, in which the recognition of visual word patterns are essential "rather than letter-sound connections," the partial alphabetic phase, whereby learners rely upon "limited knowledge of letter names and letter-sound connections to read words," and lastly, the phase in which learners have obtained "knowledge of most letter-sound associations, which is called the full alphabetic phase. Lombardino (2012) points out that at this stage in development, learners should be able to rapidly retrieve the pronunciations for learned words that have strengthened their neural connections with repeated visual exposure and oral rehearsal. The value of these neural connections is immeasurable as they provide "consolidation of a word's sounds, spelling, and meaning into whole word units" and "allow the learner to read individual words accurately and quickly" (Lombardino, 2012, p. 49).

Oral Reading Fluency

Accurate and fluent reading is the hallmark of skilled reading. Children with dyslexia, when asked to read aloud, exhibit difficulties in both their reading rate and accuracy (Wolf, Bally & Morris, 1986). In general, children will learn to read a word accurately and fluently with time and practice. The neural circuits of the brain work syncronistically to integrate words' phonological, orthographic, and semantic features, allowing fluent readers to quickly recognize familiar words and to recall their spellings (Shaywitz, 2003).

Research conducted by Ehri (1997) on sight word learning revealed that sight-word reading relies on whole word analysis which is achieved with 'connections between graphemes seen in the spellings of specific words and phonemes detected in their pronunciations' (pp. 169-170). The outcome of this study suggested that less skillful readers "do not form these complete connections" (Speece & Ritchey, 2005).

Epidemology of Dyslexia

The Role of Genes and Genetics

Dyslexia is a "common neurobehavioral disorder affecting children, with prevalence rates ranging from 5 to 10 per cent to 17.5 per cent" (Shaywitz, 1998, p. 307). Contrary to the earlier belief, that dyslexia was more prevalent in males than females, dyslexia is now believed to not be gender biased as it effects males and females equally (Shaywitz, ibid). Furthermore, research supports dyslexia as highly heritable and children, whose family history is positive for dyslexia are at risk "with 23 per cent to as much as 65 per cent of children who have a parent with dyslexia reported to have the disorder" (Shaywitz, ibid). Genetic studies conducted over the past two decades have investigated genetic markers in dyslexia and the results of such studies suggest that chromosome 15 (Smith, Kimberling, Pennington & Lubs, 1983) and chromosome 6 (Fisher, Marlow, Lamb, Maestrini, Williams, Richardson, Weeks, Stein, & Monaco, 1999) are linked to this reading disability. Smith (2011, p.240) states that a "genetic contribution to reading phenotypes, such as single word reading and spelling, and cognitive endophenotypes, such as orthographic coding, phonologic decoding, and phoneme awareness, and the segregation analyses indicate that there are a fairly small number of genes that have major influence on the phenotypes".

Contributions of Neuroimaging to Our Understanding of Dyslexia

With the evolution of sophisticated technology, neuroimaging studies have made a major impact on the overall understanding of how the brain functions in both normal and disabled readers. Imaging studies have revealed anatomical discrepancies in the brains of dyslexic individuals compared to those who do not present with dyslexia (specifically in the temporo-parieto-occipital areas) (Shaywitz, ibid). Over the last decade, several studies on anatomical structures in the brains of children (those with developmental disorders compared with typical children) were conducted by Leonard et al. (2002) and revealed that anatomical risk factors observed on MRI scans (e.g., cerebral volume, cerebral asymmetry, and planum asymmetry) appear to be risk indices for impaired spoken and written language.

In addition to the anatomical differences between dyslexic and normal readers, issues of neuronal connectivity have been investigated. The first seminal study to make the "neuronal connection" dates as far back at 1965 when Geschwind proposed that dyslexia might be viewed as a "disconnection syndrome," due to either the failure of neurons to arrive at the appropriate synaptic cleft to make their connections or a deficiency in synaptic connections (quoted in Smith, 2011). In 2001 Pugh et al. expanded upon Geschwind's connectivity concept as they "developed a model of the neural pathways involved in reading" (Lombardino, 2012, p.24). The investigators examined the loci of the pathways in the brain and the connection between these pathways and radiographic images of localized brain lesions in adults along with functional imaging of normally developing and dyslexic individuals (children and adults) (Lombardino, 2012). Pugh et al. (2001) identified three distinct circuits in the left hemisphere implicated in reading activities of the brain: (1) the temporoparietal area

linked with the phonological and lexical information as well as the integration of print; (2) the occipitemporal area linked with rapid word identification and; (3) the inferior-frontal area associated with articulatory gestures in the brain.

Studies of the neural pathways involved in reading have paved the way for a better understanding of the differences in the brain activity of dyslexic readers. Contrary to good readers, dyslexic readers show an under-activation of neural pathways in the posterior portion of the left hemisphere, resulting in deficient abilities for analyzing words and transforming letters into sounds (Shaywitz, 2003). These difficulties persist throughout life to some degree regardless of intervention and level of education (Bruck, 1990, Shaywitz, 2003).

Non-reading Characteristics of Individuals with Dyslexia

Over the centuries, the complexity of developmental dyslexia has attracted professionals from across several disciplines in an attempt to identify and classify the disorder as a unitary deficit (Papadopoulos, Georgiou & Douklias, 2009). Consequently, a large body of literature across disciplines had yielded both converging and diverging hypotheses about the etiology and nature of this disability. One historical trend in the conceptualization of reading disabilities is the recurrent perspective that different types of reading disabilities exist (O'Brien, Wolf, Lovett, 2012, p. 16). Also, intense scientific study of dyslexia has uncovered repeatedly validated links between dyslexia and phonological processing (Lyon, Shaywitz & Shaywitz, 2003).

While dyslexia is a heterogeneous disorder, the most widespread perspective on its cause is a dysfunction in the processing of phonological information, especially when phonological information is aligned with orthographic symbols (i.e. print). Hence the primary behavioral deficit that underlies this reading disability is identified as a

"phonological deficit" (PD) that affects both the manipulation and retrieval of phonological information (Manis & Bailey, 2008; O'Brien et al., 2012). Phonological deficits associated with phoneme manipulations are typically assessed on tasks of phoneme segmentation, phoneme counting, and phoneme deletion whereas phonological tasks associated with lexical retrieval are typically assessed with the task of rapid automatized naming. Whether these two types of skills, phonemic manipulation and rapid naming, represent similar or different processes has been a consistent topic of debate in the reading literature for over a decade (e.g. Vukovic & Siegel, 2006; Vaessen, Gerretsen & Blomert, 2009; O'Brien et al., 2012).

Additionally, individuals with dyslexia most often exhibit behavioral discrepancies between their reading skills and their other cognitive and achievement skill profiles. In other words, while individuals with dyslexia exhibit areas of weakness, they also exhibit skills in which they function comparable to or better than their peers. As stated previously, individuals with dyslexia often display good verbal knowledge and reasoning abilities that can range from average to superior; these skills are always paramount compared to their word-reading fluency skills (Lombardino, 2012).

Areas of weakness as outlined by Lombardino are: verbal working memory ("often depressed"), processing speed, word retrieval, morphosyntactic knowledge ("typically not well tested but has been reported to be somewhat depressed in some individuals"), phonological awareness ("core deficit area"), decoding (timed and untimed), word recognition ("automaticity of word recognition is a hallmark, especially in the less transparent languages such as English"), spelling ("hallmark deficit area"), reading fluency, punctuation, handwriting, and composition (Lombardino, 2012, p. 143-

145). However, in spite of this characteristic pattern of deficits, Lombardino cautions that “there is not a one-size-fits-all diagnosis” diagnostic profile (Lombardino, 2012)

Phonological Processing and Word Reading Characteristics of College Students with Dyslexia

College students with dyslexia are commonly very intelligent, highly motivated, and often have a history of academic success otherwise they would not have made it to higher education. Shaywitz (2003) describes the college students with dyslexia that she studied at Yale as being like a ‘sea of brilliance interspersed with isolated islands of weaknesses' from over two decades of work and research (p. 152). What constitutes these isolated islands of weakness? How can we identify specific weaknesses for this population? How do these weaknesses manifest in everyday academic life?

The fact that dyslexic college students are slow and inefficient readers is nothing new. In fact, research studies have revealed that because of their phonologic deficits, college students take a much longer time to identify words, a difficulty that results in much slower rates of reading than expected for their overall academic abilities (Bruck, 1992). The question of whether or not the phonological skills of dyslexics, who continue to read throughout life, improve with experience has not been systematically addressed in the literature.

According to Grigorenko (2001), an individual’s difficulty in managing single words is the “gold standard definition of dyslexia” (Grigorenko, p. 93) and sufficient studies on adults back up this theory (Perfetti & Lesgold, 1979). Furthermore, research in the area of reading science has identified processes which can affect the ability to master single-word reading and “form the core cluster” (Grigorenko 2001, p. 93). The two main procedural deficits identified by Grigorenko (2001) and other scholars of

reading science are phonological manipulation as in tasks of phoneme deletion or elision and automatized lexical retrieval as in tasks of rapid naming for digits and letters.

Snowling, Nation, Moxham, Gallagher & Firth (1997) compared college students with a history of dyslexia and complaints of reading problems to a control group of peers with no reading problems and with similar IQ on standardized tests of phonological processing, word reordering, and spelling. The dyslexic group reported difficulty with reading which was confirmed by their scores on *Wide Range Achievement Test-Revised* (WRAT-R), a test of single word reading and spelling. According to the authors, their 14 dyslexic college students obtained a mean standard score of 84.5 for reading (range 63-100) and 73.5 for spelling (range 48-103). Their 19 controls with no history of reading difficulty and attending the same institution, performed slightly above averages on the WRAT Reordering (mean score of 111.2, range 96-121) and spelling (mean of 107.9, range 72-123) tests. Also, the dyslexic subjects had significantly lower scores on a test of phoneme deletion than their control peers (dyslexic mean score of 9.00, standard deviation of 2.4; control mean score of 11.32, standard deviation of 1.2). The authors concluded that while the two groups were well matched on non-verbal ability on the *Wechsler Adult Intelligent Scale-Revised* (WAIS-R), the dyslexic group's scores were significantly lower in reading, spelling, and phonemic awareness (Snowling et al., 1997).

Academic Success and Foreign Language Challenge

In the 1970s, interest in the discrepancy between cognitive ability and academic inadequacy started to appear in research literature. Margaret Rawson published the first of this kind in 1968 with her report on the achievements obtained by dyslexic boys who graduated from college (Hughes & Smith, 1990). Rawson's findings drew attention to

individuals who, regardless of learning disabilities (specifically dyslexia), demonstrated academic success at the university level.

Within a period of three years these findings were succeeded by Kenneth Dinklage's publication of his findings about college students who were unable to graduate from Harvard University due to their inability to learn a foreign language (Dinklage, 1971). Dinklage found that these students were successful in all other areas of their studies but could not fulfill the mandatory foreign language requirement, a necessary component to the completion of their academic degrees. This precipitated heated discussions on the necessity of learning a second language among individuals who present with dyslexia and other learning disabilities. At the core of the debate was the tenet that difficulties in one's native language would naturally hinder success in the acquisition of a second language. Individuals with dyslexia have weak phonological representations of sounds in their native language (Vellutino, 1979; Snowling, 1981; Brady & Shankweiler, 1991; Ramus et al., 2003; DiFino & Lombardino, 2004). A foreign language waiver resolved the problem for the students at Harvard during Dinklage's study (DiFino & Lombardino, 2004).

From the Dinklage era to the present there have been many studies conducted and published in connection with learning disabilities and second language acquisition (DiFino, Johnson & Lombardino, 2008; DiFino & Lombardino, 2004; Gajar, 1987; Ganschow, Sparks & Javorsky, 1998; Ganschow, Sparks, Javorsky & Pohlman, 1991; Leons, Herbert & Gobbo, 2009; Shaw, 1999; Sparks, Ganschow, Fluharty & Little, 1996). Some of these studies indicate that second language acquisition is too daunting of a task for those with weak phonological decoding skills. Others propose alternative

instructional strategies to enhance success with learning a second language (such as multi-modality approaches), while many more support the waiver/substitution of the foreign language requirement. The tendency toward globalization places the study of foreign languages today in a precarious position. On the one hand, international collaboration would most certainly necessitate the study of a second language for most Americans; on the other hand, English is very rapidly becoming a lingua franca. While the foreign language requirement has become less of an issue in secondary education, the problem of dyslexia persists.

Rationale and Purpose of the Study

Single-word reading deficits pose the greatest risk for college students who present with dyslexia because slow and inaccurate word reading both slows down the rate of text reading and requires attentional resources that should be allocated for higher level reading tasks such as comprehension (Stanovich as cited by Lombardino, 2012, p. 52) Lombardino(personal communication 2013) notes that deficits in word recognition and phonemic decoding tested under time conditions are invariably found in college students with dyslexia regardless of their overall intelligence and their ability to compensate for their reading disability.

Consequences of deficit word-level reading are often evident when the demands of a college curriculum include large amounts of reading and written papers expected to be completed in short periods of time. Assignments of this nature place dyslexic students at great risk for either falling behind in the curriculum or obtaining grades that are below their levels of knowledge.

The purpose of this study was to investigate the same core deficits of phonological processing and word-level reading in college students with dyslexia that

have been repeatedly reported in the literature on children with dyslexia . The following experimental questions were addressed in this study:

1. How do the scores of a dyslexic group of college students compare with scores of a control group of college students on the variables of verbal comprehension, elision, rapid naming, word reading efficiency and phonemic decoding efficiency?

2. Which of these five variables best differentiates the dyslexic group from the control group?

3. What relationships exist between measures of phonological processing (elision, rapid naming) and measures of word-level reading (word recognition, phonemic decoding) for the dyslexic and control groups, respectively?

4. Do dyslexic students with double deficits (elision & rapid naming) have lower word reading scores than dyslexic students with only a single deficit (elision or rapid naming)?

5. Do elision deficits alone, rapid naming deficits alone or combined elision and rapid naming deficits best predict the single- word reading scores of dyslexic students than single deficits?

CHAPTER 3
METHODS

The purpose of this study was to (1) investigate the same core deficits of phonological processing and word-level reading in college students with dyslexia that have been repeatedly reported in the literature on children with dyslexia (Lovett, 1987; Moats, 1983; Shaywitz, 2003; Shaywitz, Morris, & Shaywitz, 2008) and (2) compare the performance of college students with and without dyslexia on five key diagnostic measures.

Participants

Two groups of college students from 18 to 30 years of age were selected from a larger data base for college students tested in the Department of Communication Science Disorders at the University of Florida between 2006 and 2012. A total of 43 college students' profiles were chosen for the present study: twenty-three students with developmental dyslexia and twenty students without dyslexia.

For the students diagnosed with dyslexia, all reading evaluations were supervised by certified Speech Language Pathologists with an expertise in reading disabilities at the University of Florida, Speech and Hearing Clinic, Gainesville, Florida. The participants were diagnosed with developmental dyslexia if they met the following criterion: (1) demonstrated deficits on standardized tests of phonological and/or orthographic processing that included phonological awareness, rapid naming, word decoding, word reading, and/or reading fluency unexpected for their educational levels, cognitive abilities, and socio-cultural opportunities; (2) self-reported persistent difficulties and/or remarkable lack of progress in reading, spelling, and/or writing along with a positive family history for reading disabilities; (3) received relatively high scores on

standardized test of comprehension even though they had impaired word decoding, weak word recognition, and/or spelling scores; (4) received relatively high scores on standardized test of oral language; and (5) presented with no developmental history of diagnosis and/or therapy in spoken language with the exception of some minor difficulties in articulation.

The selection criteria used for choosing this specific cohort of subjects with dyslexia and the cohort of control subjects were that they: (1) had been enrolled in college when the data were collected and (2) had been given the identical battery of five tests: elision and rapid naming from the *Comprehensive Test of Phonological Processing*; timed word reading and timed non-word decoding from the *Test of Word Reading Efficiency*; and the verbal Ability Composite from the *Woodcock-Johnson Tests-III Tests of Cognition*. These test measures are shown in table 2-1.

Table 2-1. A list of evaluation domain and five test measures

Domain	Test	Subtests
Phonological processing	Comprehensive test of phonological processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999)	Elision (sound deletion and sound transposition) Rapid digit naming (rapid serial naming of closed set of familiar symbols)
Word reading efficiency	Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999)	Word reading efficiency (number of words read in 45 seconds) Phonemic decoding efficiency (number of nonword decoded in 45 seconds)
Oral language comprehension	Woodcock-Johnson tests of cognitive abilities - 3rd edition (WJ-COG-III; Woodcock, McGrew, & Mather, 2002)	Verbal ability composite (vocabulary, antonyms, synonyms

A total of twenty-three college students with developmental dyslexia were included in the final data analysis. This group with dyslexia was 61% male (Female = 9, Male = 14). They ranged in age from 18 to 30 years (Mean = 21.47). A total of twenty college students with typical reading skills were included in the data analysis. In this group 90% of the students were female (Male = 2, Female = 18). They ranged in age from 18 to 24 years (Mean = 19.72). Table 2-2 presents mean standard scores on the diagnostic reading tests for both the control group and the dyslexic group and tables 2-3 and 2-4 show the individual scores for each participant in the dyslexic and control groups.

Data Collection Procedure

All testing was conducted by a doctoral student in Speech-language Pathology with expertise in assessing and diagnosing dyslexia. All tests used were norm-referenced and administered as described in the test manuals. Testing was administered over one-two testing sessions depending on the nature of the study in which the subjects participated. Tests were administered in a random order to the participants.

Verbal Comprehension Ability Test

The verbal ability test comprised of Picture Vocabulary, Synonyms, Antonyms, and Verbal Analogies subtests were taken from the *Woodcock Johnson III Test of Cognitive Abilities* (WJ-III-COG; Woodcock, McGrew, & Mather, 2002) to evaluate students' verbal ability. The Picture Vocabulary task required participants to identify picture of objects. The Synonyms task required participants to provide a synonym of a given word (e.g., "tell me another word for *car*."). The Antonyms task required participants to create an antonym of a given word (e.g., "tell me the opposite of *floor*.").

The Verbal Analogies task required to state a word to complete a two pair analogy (e.g., "*coat* is to *wear* as *apple* is to ____"). Prior to each subtest two to three training items were administered; testing was completed when a participant missed three items in a row.

Phonological Awareness Assessment

The Elision subtest from the *Comprehensive Test of Phonological Processing* (CTOPP; Wagner, Torgesen & Rashotte, 1999) was administered to evaluate each participant's phonological awareness skills. The Elision subtest required the participant to listen to and repeat a word, and then say the word without a specified syllable or sound (e.g., "say the word spider without saying der; say the word split without saying [p]). The testing process was discontinued when the participant missed three items in a row. The score was recorded as the total number of all items answered correctly and then converted to a scaled score.

Rapid Automized Naming Test

Rapid digit naming was a subtest from the *Comprehensive Test of Phonological Processing* (CTOPP; Wagner, et al., 1999). The participant was given an 8 x 12 card showing the 6 items in 4 rows of 9 randomly repeated items and required to name each stimulus item (digits in this test) as quickly as possible without producing any mistakes. The total time taken to name the stimulus set was calculated with a hand-held digital stop watch and then converted to a scaled score.

Word Reading Fluency Assessment

The Sight Word Efficiency (SWE) and Phonemic Decoding Efficiency (PDE) subtests from *Test of Word Reading Efficiency* (TOWRE; Torgesen, Wagner, & Roshotte, 1999) were used to assess each student's ability to read real and pseudo-

words fluently. Practice items were administered for each of these subtests and then the participant was administered a series of real (SWE) or pseudo-words (PDE) and required to read aloud as many words as possible in 45 seconds. Inaccurate words were deducted so that the final score reflected only the total number of words read correctly within the given 45 timeframe of 45 seconds and then converted to a scaled score.

Statistical Analysis

First, an Analysis of Variance (ANOVA) was used to compare the performance of the two groups on each of the five measures. Second, a discriminate function analysis was used to determine which of the five measure best differentiates the group and dyslexic groups. Finally, Pearson correlations were used to examine relationships among the phonological processing and word reading variables and multiple regression analyses were used to determine whether single (i.e., elision or rapid naming) or double deficits (elision and rapid naming) best predict the word reading scores of the dyslexic group.

Table 2-2. Mean scores on all test measures for the control and dyslexic groups

	Elision		Rapid naming		Word reading		Decoding		Verbal comprehension	
	MSS	SD*	MSS*	SD	MSS	SD	MSS	SD	MSS	SD
Control group	9.75	8.28	11.75	1.48	103.70	9.18	101.25	7.58	102.05	8.28
Dyslexic group	7.52	2.71	7.17	2.22	82.26	7.60	75.73	11.42	96.47	9.19

* MSS: mean standard score, SD: standard deviation.

Table 2-3. Individual scores for twenty-three dyslexic subjects

	WJ-COG	CTOPP		TOWRE	
Subject	Verbal comp. std. score	Elision std. score	RAN-D std. score	Sight word std. score	Decoding std. score
1	113	9	6	86	73
2	105	10	12	99	48
3	89	7	6	79	78
4	100	10	6	67	77
5	92	7	7	84	86
6	99	12	5	76	79
7	96	9	6	86	73
8	112	8	5	83	92
9	85	4	10	83	78
10	97	8	9	73	72
11	99	8	8	94	92
12	97	9	4	86	95
13	82	4	10	79	76
14	81	3	4	67	55
15	97	10	6	82	64
16	88	7	11	92	71
17	111	11	5	90	95
18	91	4	6	80	72
19	109	7	9	84	75
20	91	4	6	80	72
21	102	8	8	82	73
22	94	3	9	83	77
23	89	11	7	77	69

Table 2-4. Individual test scores for twenty control subjects

Subject	WJ-COG Verbal comp. std. score	CTOPP Elision std. score	RAN-D std. score	TOWRE Sight word std. score	Decoding std. score
1	102	11	10	96	95
2	104	8	10	90	106
3	101	12	12	103	96
4	104	10	11	111	100
5	95	8	12	99	92
6	103	12	14	113	106
7	99	11	12	103	103
8	113	11	14	99	115
9	121	10	10	113	106
10	113	12	11	111	95
11	105	9	13	113	98
12	99	11	12	113	120
13	102	11	10	92	93
14	95	11	13	103	97
15	85	12	12	100	97
16	106	11	11	113	100
17	111	12	14	113	112
18	95	5	12	94	100
19	93	4	13	111	100
20	95	4	9	84	94

CHAPTER 3
RESULTS

The purpose of this study was to investigate the same core deficits of phonological processing and word-level reading in college students with dyslexia that have been repeatedly reported in the literature on children with dyslexia. The results described below are organized by experimental question.

Research Question 1

The first objective of the study was to determine how the scores of the dyslexic group compare with scores of the control group on the variables of verbal comprehension, elision, rapid naming, word reading efficiency and phonemic decoding efficiency? The statistical method employed was ANOVA. A 2 x 5 Analysis of variance was used to determine group differences between non-dyslexic and dyslexic students on the five variables studied: verbal ability, elision, rapid naming, sight word reading efficiency, and phonemic decoding efficiency.

For all the five variables, the non-dyslexic group outperformed the dyslexic group. According to the independent t statistics values to determine if there is any difference in the verbal comprehension variable, the non-dyslexic group significantly performed better than dyslexic group, VCom $t(41) = 2.074$, $p = .044$ ($< .05$), Elision $t(41) = 2.724$, $p = .009$ ($< .01$), RAN $t(41) = 7.798$, $p = .000$ ($< .01$), SWR $t(41) = 8.371$, $p = .000$ ($< .01$). Decoding $t(41) = 8.488$, $p = .000$ ($< .01$). Figures 3-1 and 3-2 display the results.

Research Question 2

The second objective in this study examined which of the five variables studied (verbal ability, elision, rapid naming, single word reading, decoding) best differentiate

the dyslexic group from the control group. To this means, a discriminant function analysis was used to measure the strength of the association between the discriminant function (all 5 independent variables) and the group (dependent) variable. Since there are two groups, the canonical correlation is the most useful measure. The correlation between the two groups and the five variables is .894 (see table 3.1). RAN (.580) and decoding (.710) had the greatest discriminating ability of the five variables (see table 3.2). Below are the results.

Table 3-1. Canonical correlation between the two groups and five variables

Eigenvalues				
Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	3.983	100.00	100.00	.894

Table 3-2. Standardized canonical discriminant function coefficients

	Function 1
VCom	-.152
Elision	.113
RAN	.580
SWR	.267
Decoding	.710

Research Question 3

The third objective of this study was to examine the strength of relationships between measures of phonological processing (elision, rapid naming) and measures of word-level reading (word recognition, phonemic decoding) for the dyslexic and control groups, respectively. To this means the Pearson Correlation statistic was used to examine the strength of relationships between word reading (word reading, decoding), and phonological processing variables (i.e., elision, naming). In the correlations of the

control (non-dyslexic) group, the only significant correlation was between Single Word Reading and Rapid Naming ($r = .489$, $p = .03$). The correlations for the dyslexic group revealed significant correlations between rapid naming and single word reading efficiency ($r = .423$, $p = .043$) and between verbal comprehension and elision ($r = .565$, $p = .004$).

Research Question 4

The fourth objective of this study was to compare word-reading scores for dyslexic students with only a single deficit (elision or rapid naming) with those who presented with a double deficit (elision and rapid naming). For this purpose, T-tests were used to compare the single word reading scores of the dyslexic students with single and double deficits in the domain of phonological processing. The results showed that there is no difference in word-reading scores between single and double deficits in the DYS group ($t (18) = .935$, $p = .055$). However, the p value is very close to less than .05 value and, perhaps, if the sample size were larger, this score might be changed into a significant difference. There were 13 subjects with single deficits but only 6 with double deficits; numbers was too small too to determine the answer to this question. Of interest to note, however, is that twice the number of students had only single deficits. Also, the mean single word score for the students with single deficits was 82 ($SD = 6.1$) and the mean for the students with double deficits was 79 ($SD = 6.2$). These data support the assertion that students with double-deficits are likely to have more severe reading deficits (Wolf, M. & Bowers, P. G., 1999).

Research Question 5

The final objective in the study was to determine if elision alone, rapid naming alone or elision and rapid naming combined best predicts a single word reading. A

stepwise regression analysis was used to examine the amount of variance explained by single or double deficits. According to the model summary, elision and rapid naming together explained better than 51per cent of variance in single word reading. However, the amount of variance contributed by elision was not significant in the stepwise regression.

Summary of the Results of Research Questions

For all the five variables, the non-dyslexic group outperformed the dyslexic group. The regression analysis for non-reading variables showed that phonemic awareness and rapid naming scores *together* best predicted single word reading scores in the dyslexic subjects with rapid naming accounting for most of the variance in the single word reading score. The correlation between elision and single word reading, when controlling for rapid naming, was .438. The correlation between rapid naming and single word reading, when controlling for elision, was .645. These data indicate that not just the PA score alone or the RAN score on its own best predict reading scores in the dyslexic group but the PA and the RAN scores together.

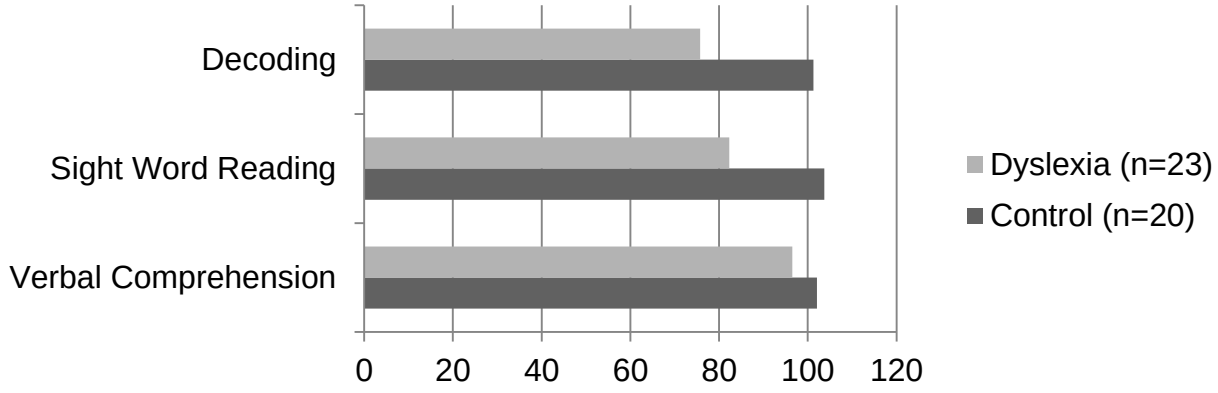

Figure 3-1. Comparison of the dyslexic and control groups on three variables

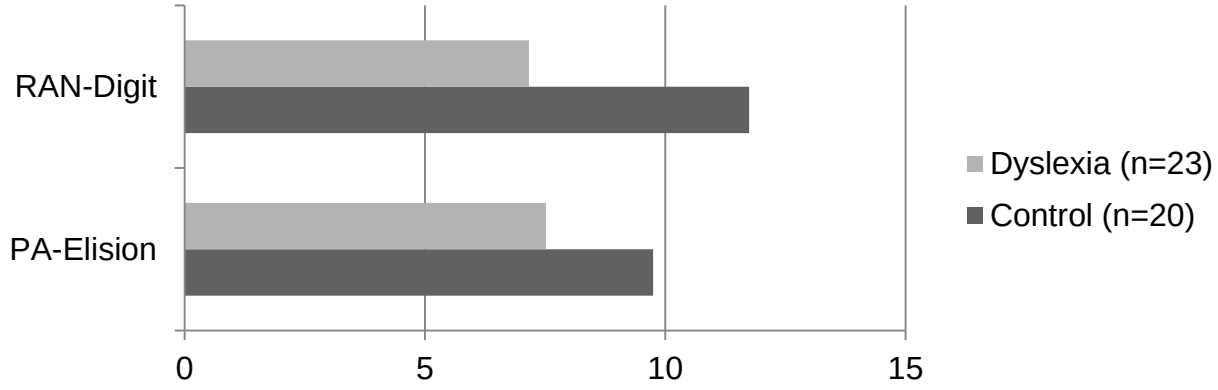

Figure 3-2. Comparison of the dyslexic and control groups on RAN-Digit and Elision variables

CHAPTER 4
DISCUSSION

Since the time of the Dinklage's (1971) publication, access to higher education has come a long way for students who have dyslexia. Federal legislation over the past years, beginning with Section 504 of the Vocational Rehabilitation Act of 1973, mandated that public institutions receiving federal funding provide appropriate curricular accommodations and modifications for students at public academic institutions. Federal laws assisting individuals with disabilities, make college education now more accessible to individuals who prior to legal advocacy would not have been possible. Specifically, institutions receiving federal funding in accordance with Section 504 of the Vocational Rehabilitation Act of 1973 are required to make university and college level accommodations for students who have been diagnosed with sensory, motor, or processing difficulties that could impede their progress in school. More recently, the Americans with Disabilities Act (ADA) of 1990 is recognized as the first comprehensive declaration of equality for people with disabilities as it protects the civil rights of all individuals with disabilities in many segments of society, and as such ensures access to public accommodations. In fact, public institutions employ individuals to insure that ADA policies are enforced.

Fortunately, as a result of ADA policies, more and more men and women with disabilities are accessing equal education like their non-disabled peers, graduating from institutions of higher education, and pursuing careers.

Common Deficits Found both in Children and College Adults

Over the last three decades, research scholars have generated much discussion in attempt to better understand the underlying nature of deficits in college students with

dyslexia and other types of learning disabilities. One such discussion by Hughes and Smith (1990) reported that at the time of their descriptive report there were 106 articles on college students with learning disabilities but only 26 of those articles described their cognitive and academic characteristics.

Of relevance to the topic for this thesis, two observations are particularly relevant. First, based on empirical evidence provided in Hughes and Smith's report, college students with learning disabilities were found to be comparable to their non-learning disabled peers on college campuses on their overall intellectual functioning. There was, however, more variability in terms of performance among the learning disabled group (1990, p. 69). Second, in comparison to non- learning disabled college students, those with learning disabilities did not read as well. Hughes and Smith concluded that "reading problems characteristic of school-aged students with learning problems are found to persist into adulthood (p. 71) and are most evident in the students' reading rate and reading comprehension. Hence, in spite of strengths in their overall cognitive abilities, the reading difficulties of students with learning disabilities place them at a clear disadvantage in college where rapid reading comprehension is of paramount importance for success in many courses.

While we have previously noted that children with dyslexia present with a range of reading difficulties, these children also experience pronounced deficits in non-reading skills which are frequently linked to skilled reading. Skilled reading involves a solid mechanism for phonological processing, a reliable verbal working memory and most of all, an efficient speed for processing symbolic information. As stated previously, the hallmark of dyslexia is a deficiency in phonemic awareness and the mapping of

phonemic codes onto orthographic codes. As noted by Nation et al. (1997), children with dyslexia “have poorly specified phonological representations at the time when they come to the task of learning to read” (p. 32), a perspective that has been supported time and again in the literature (Ehri, 1992; Rack, Hulme, Snowling, & Wightman, 1994; Seidenberg & McClelland, 1989). Nation et al. also noted that while children with dyslexia are usually able to develop a sight word vocabulary, they experience great difficulty in generalizing “their knowledge to the reading of novel words and persisting difficulties with non-word reading follow” (p.32).

Behavioral profiles of adults with dyslexia show similar deficit patterns. In the current study, in which twenty-three dyslexics were compared to twenty non-dyslexics (the control) group, data analysis revealed that all five scores of the dyslexic group were lower than the scores of the normal control group. The regression analysis for non-reading variables showed that phonemic awareness and rapid naming scores *together* best predicted sight word reading scores in the dyslexic subjects with rapid naming explaining much more of the variance. These finding support the argument that when testing the college dyslexic population, assessment batteries should include measures for phonemic awareness and rapid naming to insure greater precision when evaluating college students who have no diagnosis but are struggling academically.

Consistent with findings in current study Felton, Naylor, & Wood’s (1990) found that 115 adults that they studied with repeated histories of reading difficulties showed deficits on tasks of phonemic awareness, rapid naming and non-word reading when compared to age-matched controls. Similarly, Pennington, Van Orden, Smith, Green, & Haith (1990) reported that when adults with dyslexia were compared to both normal

reading adults of the same age and younger reading age-matched controls, the adult dyslexics showed inferior performance compared to both groups on tasks on a pig Latin test of phonemic awareness and on a task of non-word reading.

The take away message from these studies is that dyslexic children may make progress in acquiring reading skills but their phonological deficit persists throughout adulthood. The persistence of this deficit, that impacts reading accuracy, reading rate and reading comprehension, underscores the necessity of (a) understanding how to identify college students who have gone undiagnosed with this specific reading disability and (b) determining ways that university instructors can facilitate the success of these students in the classroom.

The Role of Context in Word Identification

Most readers depend on being able to understand an unfamiliar word or term based on its use in context. However, studies have shown that less skilled readers rely more on contextual cues than skilled readers (Schvaneveldt, Ackerman, & Semlear, 1977; Stanovich, 1984; Stanovich & West, 1981; West & Stanovich, 1978, as referenced by Ben-Dror, Pollatsek, & Scarpati, 1991). Ben-Dror, Pollatsek, & Scarpati (1991) evaluated the ability of college students with dyslexia to use context on a word identification task in comparison with two control groups, a control group matched on chronological age and another matched on reading age. The three groups were compared on the following tasks: (1) reading words and non-words for accuracy and speed, (2) reading regular and irregular words for accuracy and speed (3) reading a target word as a function of the congruence with previous word. Their data revealed that: (1) The dyslexic group was the slowest group on speed of word reading and slower than expected given their scores on a standardized measure of word reading; (2) A

striking difference was noted between the dyslexics' word and non-word reading "which was almost qualitatively different than their deficit with words" (p. 479); (3) The most marked difference was found for the rate of non-word reading between the dyslexic group and the reading-age control group. According to Ben-Dror et al., (1991) this means that the dyslexic group is significantly impaired when it comes to accessing dyslexics accessing "their indirect or non-lexical route to their lexicon" (p. 479). The authors stated that this difference "suggests a unique characteristic" for dyslexics "that cannot be accounted for by limited experience with written language in comparison to younger readers" (p. 487). They concluded that there are a number of college students with word decoding deficits, yet these students can become successful in the academic settings in spite of these challenges when they use context to compensate for their impaired word-level reading.

How do Data on Adult Dyslexics Inform the Assessment and Diagnosis of Dyslexia in Adults?

The data from the thesis study on twenty-three dyslexic college students support the phonological deficit theory that is most widely used to describe the underlying deficit in children with dyslexia (Bruck, 1992). Until recently, assessment of reading achievement relied solely on reading comprehension performance. However, more recently, research findings support single word reading, especially when timed, to be a more efficient assessment for capturing the fundamental deficit in dyslexia. Prior to this discovery, the brighter dyslexic students were under the radar and not being identified because their reading comprehension (due to using context and background knowledge) scores were often within the normal range in spite of their word-level deficits (Stanovich, 1991).

Furthermore, due to the heterogeneity of dyslexia associated with overall cognitive abilities, socio-cultural experiences, etc., it is crucial to seek information beyond test results when determining which students are struggling as the result of having dyslexia. It is important to look at the whole individual and to take into account his or her personal report on academic performance, history of reading difficulties as well as family history. An accurate diagnosis of dyslexia is highly dependent on the confluence of information including developmental history, family history, socio-cultural experiences and test data (Lombardino, 2012).

Academic Observational Behaviors and Instructional Recommendations for College Students with Dyslexia

Dyslexic college students sit in classrooms next to their peers who are unaware of the challenges (psychosocial as well as academic) that dyslexia brings to their classmates (Ryan, 1997). Often, college professors are unaware of which students have learning disabilities unless instructors are presented with official documentation from the Office of Disabilities on campus and required to provide auxiliary aids as in accordance with federal law.

Students with dyslexia are commonly very verbal and intelligent, highly motivated, well organized, but dislike courses requiring heavy reading such as literature, history, law, anthropology, political science, as well as foreign language courses to name a few. When enrolled in courses with heavy reading assignments, they will often either take much longer to complete the reading assignments, most likely at the risk of neglecting other college courses, or simply fail to complete readings even with the best intentions.

Students with dyslexia have a predictable attention pattern, which includes perfect to almost perfect attendance, hyper punctuality, and focused in the classroom. During class, they often put all of their energy into lectures/discussions and are fully engaged even if they have difficulty completely understanding the lecture content. They will often volunteer answers without being called upon and give the overall impression that they are on top of the curriculum. When called upon, they will often, but not always, pause before answering the question or commenting on the topic at hand. Sometimes students might even freeze, rendering them unable to make a contribution. Other times, they will know the answer but cannot find the right word(s) to formulate a rapid and cohesive response. Hesitations, overall lack of fluency as well as revisions are characteristics often observed in the speech patterns of dyslexic individuals and appear to be a consequence of word retrieval and formulate deficits (DiFino, Lombardino, & Johnson, 2008). Therefore, instructors should be sensitive to response times of their students and allow time for responses to questions that are cognitively loaded.

When engaging in group work, these students might not be able to follow the group activity if too many tasks are being addressed simultaneously and if the group is too large; however, they will benefit greatly if placed in a one-on-one situation with another peer (DiFino, Lombardino, & Johnson, 2008).

When required to deliver an oral presentation, the dyslexic individuals will devote far more time than needed for preparation and often will give a good presentation. In order for the successful delivery of a presentation, these students will need guidance from the instructor beforehand with the organization and the directions to complete the presentation. The oral presentation may be less fluent than peers and accompanied by

hesitations, and interruptions, that may distract listeners. Therefore, instructors might find it helpful to assist dyslexic students with summarizing the key points in order to keep the presentation delivery informative and cohesive.

Academic performance will depend on the nature of the course expectations. If testing is done in class and is timed, the dyslexic student typically requires extra time to successfully complete the test. Even when time extensions are given for writing assignments, students with dyslexia often find that organizing essays and papers can be taxing. Spelling accuracy is especially problematic when these students are asked to handwrite answers, and their handwriting is often barely legible. Instructors who allow the use of laptops and spelling checks will find that they will receive better quality work from their dyslexic students. This is confirmed in a Swedish study that incorporated a questionnaire designed to encourage dyslexic students to share their views on useful compensatory strategies and tools (Olofsson, Al, & Taube, 2012).

According to Olofsson, Al, & Taube (2012), dyslexic students are more likely to succeed academically when (1) printed material accompanies lectures in the form of handouts or printouts of the power point slides, (2) questions are read aloud to the student, (3) students are allowed to respond orally to written work, (4) discussion points are bulleted, (5) summaries of key points from lectures or chapters are provided, and (6) topics are presented in a systematic and logical sequence.

These students are often very adept at organizing course content by index cards, color coding class lecture notes, devising acronyms to memorize names, and often learn best when material is broken down in meaningful clusters/chunks. They will spend an inordinate amount of time outside of the class in order to be able to keep up with the

course material and pace. Time taken for one course often at the expense of their other class assignments places them at risk for an academic catastrophe at the end of the semester; therefore, it is highly important that instructors encourage these students to make use of instructors' office hours in order to clarify any unclear material, readings and assignments as well as understand the instructor's expectations.

While many dyslexic individuals graduate from college, they often take a long time to do so. The problems that they encountered in academic setting may persist in their professional careers. As noted in this study, speed will always remain a core deficit and therefore, dyslexics will always have difficulty in professions that include time sensitive tasks and deadlines. Spontaneous and unaided spelling will always pose problems and following multi-tiered tasks will remain problematic.

Summary and Conclusions

In this study, college students with dyslexia performed lower on all five variables of verbal comprehension, elision, rapid naming, word reading efficiency and phonemic decoding efficiency than their non-reading impaired peers. Furthermore, rapid naming and decoding measures best discriminated between these two groups. Rapid naming correlated significantly with single word reading and verbal ability correlated significantly with elision in the dyslexic group. In contrast, on rapid naming correlated with single word reading in the control group. These data suggest that both dimensions of oral language tested, phonemic awareness (i.e., elision) and rapid naming (automatic word retrieval) are important skills in automatic word level reading. Finally, while students with double deficits (phonemic awareness and rapid naming) appeared to perform more poorly that students with single deficits (phonemic awareness or rapid naming), the

sample size was not large enough (13 single, 6 double) to test this hypothesis adequately.

The take come message is that, while college students with a childhood history of dyslexia may perform as well as their non-dyslexic peers in some academic areas, their childhood diagnosis of dyslexia is still a part of their adult profile. These students have obtained admission into college because many have had opportunities to address their areas of weakness or have developed compensatory strategies to cope with their reading and phonological impairments. While we have gained a better understanding of dyslexia, much is still unknown and little is known about how the dyslexic child evolves into the successful dyslexic student. Some studies, albeit a few, have suggested that successful dyslexic adults acquired reading fluency by discovering a passion for a particular area or subject of interest. According to Fink (1998), by reading avidly on a specific topic, individuals are able to gain specialized vocabulary and knowledge that pertains to a specific field. Passion for the specific field helped these highly successful individuals improve their reading skills and succeed in their specialized fields. As instructors at universities and colleges in the United States and around the globe, we must remain sensitive to the various learning styles and differences that our students bring with them and we must approach students as individuals in order to address their specific academic needs.

Directions for Future Research

There is need for more research on college students with dyslexia in order to better understand their development of reading skills, particularly their processing skills associated with accessing the lexicon. There is a growing need to understand how such students have been able to compensate for their phonological weaknesses since their

childhood diagnosis. Future research should also address the extent to which college students with dyslexia rely upon context, especially in relationship to different types of academic tasks.

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