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# Examining The Contribution Of Learning And Study Strategies On Reading Comprehension In Secondary Students With Dyslexia

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Secondary Students With Dyslexia

Nicholas William Gelbar

University of Connecticut

2013

Research from postsecondary and adult samples indicates that some individuals with dyslexia are able to develop age-appropriate reading comprehension and academic achievement skills and utilize a different pattern of self-regulated learning strategies than individuals without dyslexia. Few studies have examined the role of self-regulated learning strategies as a compensatory mechanism for secondary student students with dyslexia. This pilot study utilized hierarchical linear regression to examine the role of self-regulated learning strategies as a predictor of reading comprehension after controlling for oral reading fluency and cognitive ability by utilizing a sample of 51 secondary students from an independent school that serves individuals with learning disabilities or ADHD. The results of this pilot study indicate that self-regulated learning strategies do not predict reading comprehension over and above oral reading fluency and cognitive ability. However, the results demonstrate that 57% of these secondary students with dyslexia in this independent school are able to achieve age-appropriate reading comprehension scores. Limitations to the sample size, sampling procedures, and instrumentation are important to consider when interpreting the results of this study.

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Secondary Students With Dyslexia

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2013

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APPROVAL PAGE

Doctor of Philosophy Dissertation

Examining The Contribution Of Learning And Study Strategies On Reading Comprehension In  
Secondary Students With Dyslexia

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## CHAPTER 1

### INTRODUCTION AND FRAMEWORK OF THE STUDY

Developmental dyslexia affects between 5% and 17.5% of school age children (Shaywitz, 1998) and is “characterized by an unexpected difficulty in reading in children and adults who otherwise possess the intelligence and motivation considered necessary for accurate and fluent reading” (Shaywitz, Gruen, & Shaywitz, 2007, p. 609). The unexpected nature of the reading difficulties is central to definitions of dyslexia (Shaywitz, Morris, & Shaywitz, 2008). Dyslexia is defined by the International Dyslexia Association (formerly the Orton Dyslexia Association; 2002) as:

Difficulties with accurate and / or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge.

It is best conceptualized as the lower tail of a normal distribution of reading achievement (Shaywitz, Escobar, & Shaywitz, 1992) and its effects have been documented across the lifespan (Bruck, 1992; Francis et al., 1996). Longitudinal studies of individuals with dyslexia have indicated that some individuals are able to compensate for the reading difficulties associated with developmental dyslexia (Bruck, 1992; Francis et al., 1996; Hoeft et al., 2010; Shaywitz et al. 1995). Behavioral variables to predict whether individuals with dyslexia will compensate for their difficulties have not been identified, but a longitudinal fMRI study (that compared the role of behavioral variables and brain activation) has indicated key differences in the areas of the brains that are activated during reading for compensated versus non compensated individuals with dyslexia (Hoeft et al., 2010). The pilot study documented in this dissertation examines a

potential behavioral variable, self-regulated learning strategies, that could influence reading comprehension (an indicator of compensation) in individuals with dyslexia.

This chapter provides an overview of the pilot study and is divided into three sections. The first section provides specific background information about the nature of the deficits present in individuals with dyslexia. The second section provides a detailed overview of the study, and the final section provides an overview of the entire dissertation.

### **Characteristics of Dyslexia**

The objective of this section is to explain the role of phonological processing in describing the underlying deficits in reading for individuals with dyslexia. There is strong evidence documenting the differences in how brain structures are utilized by individuals with and without dyslexia during reading (Maisog, Einbinder, Flowers, Turkeltaub, & Eden, 2008; Richlan, Kronbichler, & Wimmer, 2009; Sun, Lee, & Kirby, 2010). These differences indicate a neuro-psychological basis for developmental dyslexia, and explain the underlying deficit present in the disorder. Shaywitz, Gruen, and Shaywitz (2003) have asserted that “there is now a strong consensus that the central difficulty in dyslexia reflects a deficit within the language system and, more particularly, in a lower levels component, phonology” (p. 25). Phonology involves understanding the “underlying sound structure of words” (Shaywitz et al., 2003, p. 25). Reading involves connecting the smallest unit of sound (phonemes) with the alphabetic combinations of letters and vowels (graphemes; Perfetti, Nelson, Liu, Fiez, & Tan, 2010). The 40 phonemes utilized in the English language are represented by 1120 graphemes (Coulmas, 1996). Table 1-1 compares the phoneme-grapheme relationship across languages and indicates the irregular nature of the relationship between phonemes and graphemes in English. This irregular relationship is thought to affect the prevalence rates of dyslexia among speakers of English (Paulesu et al.,

2001; Lindgren, Renzi, & Richman, 1985); individuals with dyslexia struggle to connect phonemes with graphemes (Shaywitz et al., 2003). This difficulty of connecting phonemes with graphemes makes reading novel words especially problematic.

Table 1-1

*Relationship of Phonemes to Graphemes Across Languages*

Language (Citation)	Number of phonemes	Number of graphemes
English (Coulmas, 1996) <sup>a</sup>	40	1120
French (Catach, 1980) <sup>a</sup>	35	130
German (Valtin, 1989) <sup>a</sup>	40	85
Spanish (Sprenger-Charolles 2004)	29-32	45
Italian (Lepschy & Lepschy, 1981) <sup>b</sup>	25	33

<sup>a</sup> As cited in Sprenger-Charolles (2004).

<sup>b</sup> As cited in Paulesu et al. (2000).

Thus, many students with dyslexia face substantive issues in the text-based environment of school (McNulty, 2003). Their overall school achievement can be negatively affected by their inability to fluently read text (Meisinger, Bloom, & Hynd, 2010). Many strategies for helping these students in the school environment have focused on interventions designed to improve students' phonological or word-level abilities. Some researchers caution that focusing on these skills "may actually contribute to reading failure by diverting the child's attention away from more productive strategies" (Tunmer & Greaney, 2010, p. 230). In other words, strategies that focus on building students' overall reading comprehension skills, such as instruction in high utility words, the use of context clues, and other self-regulated strategies as opposed to solely teaching phonological skills, may be more appropriate for these students.

The development of these strategies, in addition to phonological skills, may help to improve the academic success of students with dyslexia (Tunmer & Greaney, 2010). These individuals are subsequently able to achieve at high levels within our society and some research indicates that the development of compensation strategies may be particularly beneficial to

academically talented students with dyslexia (Fink, 1998). Individuals who are high-functioning or who have “compensated” with dyslexia are individuals who have achieved reading comprehension abilities that are comparable to same-age peers without dyslexia. Research into the exact nature and importance of these strategies is crucial to understanding why some individuals compensate for the difficulties associated with dyslexia and others do not.

### **Overview of the Study**

This pilot study seeks to understand the role of learning and study strategies (self-regulated learning strategies) as a potential compensatory mechanism for individuals with dyslexia. Specifically, this study makes a new contribution to the research base by employing quantitative methods and using a sample from a secondary school in the United States. This section defines the problem addressed by this study, presents research questions, details the research methodology and instrumentation utilized, and discusses the importance and limitations of this study.

### **Statement of the Problem**

This pilot study explored learning and study strategies as factors contributing to reading comprehension in secondary students with dyslexia. The current research on high-functioning (compensated) individuals with dyslexia is sparse and what exists has been gathered from postsecondary samples. The research base that does exist has demonstrated that some people with dyslexia learn to compensate for their reading difficulties (Birch & Chase, 2004; Braten, Amundsen, & Samuelstein, 2010; Coleman, Gregg, McCain, & Bellair, 2009; Fink, 1998). This research indicated that some individuals with dyslexia are able to utilize strategies to compensate for their word decoding difficulties and can achieve reading comprehension levels that are comparable to same age peers (Corkett, Parrila, & Hein, 2006; Deacon, Parrila, & Kirby, 2006;

Murray & Wren, 2003). The problem investigated in this study involves studying the role of learning and study strategies in enabling individuals with dyslexia in grades 9-12 to comprehend what they read. The current research base has not utilized this population.

### **Purpose of Study**

The purpose of this pilot study is to investigate the relationship between reported study strategy use by secondary students with dyslexia and their reading comprehension. The reported strategies, as measured by this study, are based on Zimmerman's (1989) definition of self-regulated learning strategies. Zimmerman defined self-regulated learning strategies as "actions and processes directed at acquiring information or skill that involve agency, purpose, and instrumentality perceptions by learners" (p. 329). These strategies include "such methods as organizing and transforming information, self-consequencing, seeking information, and rehearsing or using memory aids" (Zimmerman, 1989, p. 329).

**Research Question.** The primary research question for this pilot study explores the extent that variance in reading comprehension in secondary students with dyslexia can be explained by intellectual ability, oral reading fluency, and reported study strategy use. The hypothesis is that reported study strategy use is predictive of reading comprehension in secondary students with dyslexia over and above intellectual ability and oral reading fluency.

**Research Methods.** A sample of students with dyslexia from an independent secondary school in the Northeast United States was utilized for this study. Participants in this study completed the reading comprehension and study strategies measures during group sessions and completed the oral reading fluency measure during individual sessions. The researcher gathered the following information from the student's school records: first language, most recent cognitive assessment, and a confirmation of a dyslexia diagnosis as evidenced by a history of

phonological processing difficulties. To investigate the primary research question, a hierarchical regression analysis was performed comparing the overall variance in reading comprehension as explained by learning and study strategies over and above intellectual ability and oral reading fluency. Hierarchical linear regression allows a researcher to investigate the relationship between variables, but does not allow for casual inferences. It is an appropriate methodology for this study, because the research question guiding this study is seeking to understand a relationship.

**Instrumentation.** The following measures were utilized in this study. Reading comprehension was measured using the reading comprehension subtest of Gate-MacGinitie Reading Tests-Fourth Edition (Form 10/12; 2007). Learning and study strategies were measured using the three subscales (managing environments and behavior, seeking and learning information, and maladaptive regulatory behavior) of the Self-Regulation Strategy Inventory—Self-Report (SRSI; Cleary, 2006). This instrument was developed utilizing Zimmerman’s definition of self-regulated learning strategies (1989). Oral reading fluency was measured using three 10<sup>th</sup> grade passages from Rasinski (2003). These measures have shown adequate reliability for use with this population based on previous studies. To ensure their reliability in this study, Cronbach’s alpha is reported for the SRSI and inter-observed agreement is reported for the oral reading fluency passages.

### **Importance**

It is hoped that this pilot study will contribute an important component to the extant research on individuals with dyslexia because it focuses on secondary students rather than college students or selected adults from the population. This research examines the learning and study strategies by students with dyslexia to compensate for their reading difficulties, utilizing

quantitative research methods and reliable measures and will extend the current research in the field. Study strategies elicited from the quantitative results of this study may lead to different directions for future research that would explore their viability as potential intervention strategies. Overall, this study adds to our understanding of how students with dyslexia compensate for their reading difficulties.

### **Limitations**

This pilot study utilized regression analysis, which does not enable causal inferences to be drawn. Thus, it is only be able to conclude that there is or is not a relationship between reading comprehension and their use of study strategies. This information is needed to understand the role that self-regulated learning strategies have in compensating for the phonological deficits of dyslexia. Given that this study only utilizes one measure for each construct being explored, issues related to measurement error could potentially bias the results. Similarly, the use of a convenience sample may limit generalizability of the results.

### **Overview of the Dissertation**

In the following chapter, a more detailed review of the literature is summarized relating to the learning and study strategies utilized by individuals with dyslexia. The chapter is divided into four sections. The first section details evidence of compensation by individuals with dyslexia and the second section explains the nature of phonological processing and reading comprehension in individuals with dyslexia. The third section describes the relationship between learning and study strategies that have been documented from adult and postsecondary samples. The fourth and final section describes the relationship between learning and study strategies that have been documented from secondary samples.

In Chapter 3, a detailed overview of the research methods and procedures utilized in this study are summarized. This chapter is divided into four sections. The first section outlines the sampling procedures, and the second section provides detailed information regarding the instrumentation utilized in the study. The third section explains the procedures utilized to guide data collection in this study, while the fourth section describes the statistical analyses utilized in this study. In Chapter 4, the results of the statistical analyses are summarized, focusing on the presence or absence of suppressor effects among the variables and the results of the hierarchical linear regression model utilized to answer the primary research question. In Chapter 5, the theoretical implications of this study are presented, the research findings discussed, and the limitations of the study are described. The dissertation concludes with suggestions for future research.

## **CHAPTER 2**

### **BACKGROUND OF THE STUDY**

This review of research includes an overview of factors underlying reading comprehension in individuals with dyslexia, as well as the impact of study or other strategies on the ways in which individuals with dyslexia learn to compensate for their reading difficulties. In the first section, current understandings of compensatory mechanism in individuals with dyslexia are summarized. The next sections discuss the relationship between phonological processing and reading comprehension in individuals with dyslexia, and provides a review of the literature on the role of learning and study strategies as a compensatory mechanism with students in postsecondary and secondary populations respectively.

#### **Dyslexia and Compensation**

Definitions of dyslexia focus on the idea of unexpected underachievement in reading relative to intelligence and motivation (Shaywitz et al., 2008). This underachievement in individuals with dyslexia is due to issues in processing the units of sound within a language (phonological processing; Fletcher et al., 1994; Morris et al. 1998; Shaywitz, 1996; Wagner & Torgesen, 1987). These difficulties make it particularly difficult for individual with dyslexia to read unfamiliar words (Shaywitz, 1998). Early identification and remediation is thus essential for this population (Torgesen, 2000). However, Torgesen (2000) asserted based on the results of five early intervention studies that it does not matter where the cutoff for reading difficulty is defined because over 50% of the individuals below the cutoff will eventually compensate for their reading difficulties. Currently, no characteristic has been isolated that eventually predicts compensation.

For example, one longitudinal study compared 25 students with dyslexia with 20 students without dyslexia on 17 behavioral variables and two measures of brain imaging (fMRI and diffusion tensor imaging; Hoeft et al., 2010). These measures were delivered 2 ½ years apart and were used to determine which variables significantly predicted which individuals with dyslexia would compensate for their difficulties compared to the control group. The behavioral variables included the Wechsler Abbreviated Scale of Intelligence Matrix Reasoning subtest, the Woodcock Reading Mastery Test, the subtests of the Gray Oral Reading Test, subtests of the Test of Word Reading Efficiency, the Comprehensive Test of Phonological Processing Memory for Digits subtest, and the Peabody Picture Vocabulary Test. Further, a measure of rapid automated naming (averaged across several trials) was also included in addition to the spelling and writing fluency subtests of the Woodcock Johnson Tests of Achievement-III. While these behavioral variables were correlated, the magnitude of the correlation did not indicate suppressor effects. These behavioral variables were not found to predict which individuals with dyslexia would compensate for their difficulties over the course of the study; none of these variables was significant at the 0.05 level. The researchers even chose not to adjust for experiment-wise error to liberally identify predictors. Only the brain imaging variables were found to have a relationship with significant reading improvements for the individuals with dyslexia. This study corroborated the results of other studies finding few differences in the performance of individuals with dyslexia versus individuals without dyslexia on behavioral variables.

One such study compared 13 children with dyslexia with 13 children without dyslexia and found that the students' scores on a test of general intelligence were not significantly different (Beneventi, Tonnessen, Ersland, & Hugdahl, 2010). In a similar study, Gregg et al. (2008) found that scores on the Woodcock Johnson Tests of Achievement-III did not

differentiate between 101 students with dyslexia and 101 students without dyslexia enrolled at the University of Georgia. In other words, the results of this study suggest postsecondary students with and without dyslexia have similar patterns of academic achievement. The same study found that the only significant difference between the two groups was in spelling performance (Gregg et al., 2005).

A related study also indicated that the misspelling rates in essays and on the Wide Range Achievement Test—Third Edition (WRAT-3) spelling subtest were significantly different for university students with dyslexia versus students without dyslexia (Coleman, McCain, Flaherty, Gregg, & Bellair, 2009). Further, one study found that there were significant differences in phonological processing, but not in other reading processes, between students without and with dyslexia (Wilson & Lesaux, 2001). This research suggests that the problems in phonological processing may continue even as students develop reading comprehension strategies that enable them to succeed in higher education settings.

### **The Nature of Phonological Compensation and Reading Comprehension**

Other studies have probed the underlying mechanisms to explain why reading comprehension is not fully linked to phonological awareness. For example, Deacon, Parrila, and Kirby (2006) explored the processing of derived forms (words derived from base-words) in high-functioning individuals with dyslexia, defined as university students with a history of reading difficulties who had developed age-appropriate reading comprehension skills. These researchers found that the high functioning students in this group demonstrated serious word level and reading rate difficulties in addition to phonological processing difficulties, but were still able to achieve age-appropriate levels of reading comprehension specifically when they were tested in an untimed manner (Deacon, Parrila, & Kirby, 2006). This group was compared with 28

participants (nine males and 19 females) who reported having no history of reading difficulties. All participants were then tested using the word identification and word attack subtests from the Woodcock Reading Mastery Test-Revised, the comprehension sub-test from the Nelson-Denny Reading Test, and the Rosner Auditory Analysis Test. The control participants performed better when the relationship between the base and derived forms was clear, but demonstrated slower response time when the relationship was less apparent. The high-functioning participants with dyslexia performed similarly across both levels of complexity. Their speed when the relationship between the base and derived forms was clear was found to be slower than the comparison group. This study found that the high-functioning participants with dyslexia demonstrated evidence of reading at a slower rate, but with the same level of reading comprehension compared to students without dyslexia.

A similar study investigated the word and nonword reading performance of 41 adult participants in the campus communities of two private and one public colleges in the same geographic area (Birch & Chase, 2004). These participants, of whom all but two were enrolled at a college or university, had a mean age of 23, and achieved full-scale WAIS-R scores of 85 or higher. They were all given the Adult Reading History Questionnaire, the comprehension subtest of the Nelson-Denny, and the word identification and word attack tests of the Woodcock Johnson Reading Mastery Test-Revised. The researchers divided the participants into three groups. The first included 13 adults with no history of reading issues who served as the control group. In the second group were 14 participants, called compensated readers, who had been able to compensate for dyslexia. The third group of 14 students, labeled as uncompensated readers, was unable to compensate well as indicated by their reading comprehension scores. The compensated readers with dyslexia showed word and non-word reading performance that was

below the performance of the control group but better than the uncompensated group. Their deficits relative to controls on irregular and nonword reading were similar in size, unlike uncompensated readers, who showed particular deficits in nonword reading. The compensated readers did not perform significantly lower than the control group readers, although they did perform slower on Pig Latin translation, an indicator of one's ability to read nonwords (phonological processing). Together, these results suggest that the deficits of the compensated readers in phonological coding and analysis were not as great as the uncompensated readers. The researchers concluded that stronger phonological awareness is a good prognosis for reading success at the college level, but they also suggested that the absence of this skill is not obviously detrimental although the "uncompensated" students had been accepted into a competitive college. This study, like similar studies cited earlier, provides evidence that people can compensate for dyslexia, but does not indicate how and when these individuals developed either phonological or other compensation strategies. The aforementioned studies also do not identify the compensation strategies that would facilitate comprehension processes to help participants gain greater phonological awareness and/or reading comprehension and thus access to the content of the secondary/postsecondary curriculum.

Another study examined the role of phonological processing in more depth by comparing two competing compensation models (Ransby & Swanson, 2003). One model tested whether phonological processing mediated the influence of higher order processes on reading comprehension. The competing model that was investigated suggested that both higher and lower level processes mediate reading comprehension equally. Twenty students aged 17-23 with cognitive disabilities (specifically reading difficulties) were compared with 20 age-matched skilled readers, and 20 younger students matched by scores on the word recognition test. The

researchers used multiple fluency and comprehension measured with a multiple regression design to test the competing models. They found little support for the first model, but the second model was shown to be statistically significant, indicating that both word level and higher order processes were found to mediate the process of comprehension for dyslexia. This study did not address the processes by which people utilize these higher order strategies and thus did not identify interventions that would help students to develop these higher order strategies. Future work is needed to gain an understanding of the role of non-phonological based strategies on compensating for the reading difficulties faced by people with dyslexia.

Although the core deficits present in individuals with dyslexia are phonological in nature, several studies have demonstrated that these deficits are not necessarily detrimental to these individuals' reading comprehension performance. This research indicates that individuals with disabilities utilize other strategies to gain access to text-based information. However, the samples utilized in most of the research summarized have included samples of postsecondary students or adults. Learning and study strategies are one such category of strategies that these individuals may use to compensate for their reading difficulties. Further research is necessary to investigate how some individuals with dyslexia use these strategies to compensate for their phonological difficulties.

### **Learning and Study Strategies Used by Postsecondary Students with Dyslexia**

Some studies have sought to understand the relationship between learning and study strategies and the performance of high-achieving individuals with dyslexia. These strategies can be conceptualized as aiding students in their self-regulation. Zimmerman (1989) defined self-regulated learning strategies as “actions and processes directed at acquiring information or skill that involve agency, purpose, and instrumentality perceptions by learners” (p. 329). These

strategies include “such methods as organizing and transforming information, self-consequencing, seeking information, and rehearsing or using memory aids” (Zimmerman, 1989, p. 329). Several studies have found a difference in the study strategies utilized by postsecondary students with dyslexia (Kirby et al., 2008; Kovach & Wilgosh, 1999; Murray & Wren, 2003; Norton, 1992; Proctor, Prevatt, Adams, & Reaser, 2006).

Kirby et al. (2008) asserted that “students with dyslexia who have reached postsecondary education are likely to have developed or been taught strategies for coping with their difficulties, and, thus, are likely to report more use of compensation strategies such as relying on study aids” (p. 87). To test this hypothesis, these researchers compared students with dyslexia ( $n=36$ ) to students without dyslexia ( $n=66$ ) across four Canadian universities, using the Woodcock Johnson Reading Mastery Test-Revised to assess word reading ability, the Adult Reading History Questionnaire to assess the participants’ experiences in learning how to read, the Study Process Questionnaire to assess their use of surface (superficial) and deep study strategies, the Learning and Study Strategy Inventory to assess their use of study strategies, and the Nelson-Denny Reading Test to assess their reading rate and comprehension. On these measures, students without dyslexia demonstrated higher performance on reading rate and comprehension when compared to students with dyslexia. When comparing these groups on the Study Process Questionnaire-Revised, the two groups did not differ on their use of either deep or surface approach study processes. When comparing the groups on the Learning and Study Strategy Inventory (LASSI-II), the students with dyslexia reported more use of selecting main ideas and test-taking strategies, and some evidence of using more study aids. These results indicated that students with dyslexia tend to use different strategies such as selecting main ideas and specific

test-taking strategies, but the study did not analyze the process by which these students developed this differential pattern of study strategy use.

Likewise, Kovach and Wilgosh (1999) found that university students with learning disabilities (LD) performed slightly below norms on motivation, selecting main ideas, self-testing, test-taking, and showing higher levels of anxiety and attitudes towards success (subtests of the LASSI-II; Kovach & Wilgosh, 1999). A more recent study using a similar methodology compared 45 Canadian students with learning disabilities attending a four-year university with LASSI-II norms and found a significant difference between this group and the norms in their subtest scores on anxiety, attitude towards success, concentration, selecting main ideas, study aids, and test strategies (Abrue-Ellis, Ellis, & Hayes, 2009).

In another study in which the LASSI was administered, 50 undergraduate students were placed into three groups: students with ADHD, students with LD, and a control group (Corkett, Parrilla, & Hein, 2006). The researchers found that students with LD reported using more study aids than students in the control group. The results regarding students with LD on concentration, selecting main idea, study aids, test strategies, and time management subtests were higher than students with ADHD. The difference between the findings of these studies and Kirby et al. (2008) can be partially explained given the fact that these studies were not exclusively focused on students with dyslexia, but rather examined a large group of students with varied learning disabilities including, but not limited to dyslexia. Accordingly, this research cannot be used to identify interventions that could be helpful for specific learning difficulties, such as dyslexia.

Another study compared a group of individuals who had a history of reading difficulties with a group with no history of reading difficulties (Reaser, Prevatt, Petscher, & Proctor, 2007). The researchers found significant differences between the two groups on most of the subtests of

the Nelson-Denny Reading Test, with the exception of the comprehension subtest. These results indicated that although students with a history of reading difficulties still struggle with some of the component processes of reading, their overall comprehension are not affected. The researchers also administered a questionnaire based on the Adult Reading History Questionnaire to gather qualitative data on the strategies used by the group that had a history of reading difficulty to compensate for their reading difficulties. Comprehension monitoring, flash cards, outlining readings, and participation in class discussion were highlighted as important strategies. The authors note “the HRD (history of reading difficulties) participants, as a group, reported using a wider variety of study strategies in their post-secondary education than the NRD (no history of reading difficulties)” (p. 58). This study supports the results of another qualitative analysis of Australian university students with dyslexia who reported developing compensating strategies, and hiding their disability (Tanner, 2009). Other qualitative studies have also demonstrated the importance of the compensation strategies utilized by postsecondary students with dyslexia (Corkett, Hein, & Parrila, 2008; Cowen, 1988). This research evidence using samples of post-secondary students with reading difficulties found that some participants could compensate for their disabilities, providing some information about potentially effective strategies. The process of how these students developed these strategies, however, was not addressed in this research.

Another mixed-method study was conducted with a group of 60 successful men and women who had been diagnosed with dyslexia (Fink, 1998). The researcher confirmed the participants’ diagnosis of dyslexia utilizing the Nelson-Denny Reading Test, as well as the Adult Reading History Questionnaire. The researcher quantitatively analyzed the participants’ results from the Diagnostic Assessments of Reading with Trial Teaching Strategies (DARTTS) and

found that 95% of the participants reached the ceiling of the test. This demonstrates that “most of the individuals with dyslexia demonstrated the ability to read silently and comprehend text at high collegiate and postgraduate levels that were only slightly lower than those of the non-dyslexic control group” (Fink, 1998, p. 327). From these results, Fink created three profiles of compensation strategies. Seventeen (less than one third) of the participants fully compensated as indicated by their high scores across all subtests. Seventeen of the participants were found to have partially compensated as indicated by their low scores on the spelling subtest. Seventeen of the participants partially compensated as indicated by jagged profiles across the subtests, but they reached the ceiling on silent comprehension and knowledge of word meaning. These results indicated that individuals varied in their ability to compensate for their unique profile of their reading difficulties though this sample consisted of a successful group of individuals.

These results were further investigated using interviews that indicated that most of the participants developed basic reading fluency by 10-11 years of age (Fink, 1998). They reported that reading in an interest area developed this literacy. In essence, it scaffolded the process of their development of compensation strategies. The model of compensation proposed by Fink (1998) focused on developing higher meaning skills, not lower print (phonological) skills. These higher meaning skills are developed by focusing on a passionate personal interest in a content area requiring reading, reading avidly in this content area, developing deep schema knowledge, and using of contextual strategies. Although the results of this study are interesting, selection bias may have occurred as the researcher did not randomly select these participants, but sought people who had compensated for their dyslexia and who achieved at a high level. Most participants had completed graduate school and this research may simply indicate that high-ability individuals are able to more readily compensate for their reading difficulties. Some

limitations may also exist in this study as the evidence that these people achieved fluency was derived from self-report measures administered at a later point in time. It does support findings suggesting that some people are able to compensate for phonological processing issues (Corkett, Parrila, & Hein, 2006) and provides interesting evidence of this compensation, similar to the reported studies thus far.

### **Learning and Study Strategies Used by Secondary Students with Dyslexia**

Few investigators have examined the study strategies used by middle or high school students. One qualitative study of 20 Israeli students with learning disabilities found the emotional-cognitive strategies they utilized to cope with their learning issues included avoidance, rebellion, reconciliation, and determination (Givon & Court, 2010). Although this information is useful, it does not necessarily lead to interventions to promote these beliefs or help students to compensate for their specific manifestation of a specific learning disability. Another study utilized a quantitative framework to study eight Norwegian 10<sup>th</sup>-grade students with dyslexia (Braten, Amundsen, & Samelstuen, 2010). This study sought to understand whether higher-level processes (such as strategy use) could compensate for decoding issues. These students were selected because they performed well in school despite of their diagnosis with dyslexia. The students were compared on a researcher created comprehension test with six students scoring at or above the average of the comparison group. The students' prior knowledge was tested before the comprehension test. Since these students did not have extensive prior knowledge of the passage, this indicates that their reading comprehension results were not biased by familiarity with the topic in the passage. Using an inventory based on the LASSI, the six students who were shown to have effectively compensated for their dyslexia also reported relatively high levels of strategy use with respect to one or more of the deeper processing strategies. The qualitative

analysis of the results identified two themes. The first was that these successful students make strategic use of personal resources such as not paying equal attention to all learning materials or in all situations. They made and used notes on the most important information and reported strategically using school resources. Second, this study provides interesting information about a cohort of international students. However, the small sample size limits its generalizability. Given the small number of studies with secondary students, additional data-based research is needed to understand the mechanisms of why and how some secondary students with dyslexia compensate for their phonological processing difficulties and are able to demonstrate reading comprehension that is comparable to their peers without dyslexia.

### **Summary**

A combination of both quantitative and qualitative research has confirmed that some individuals are able to compensate for the phonological processing deficits that are at the core of their dyslexia. Evidence that some of these individuals are able to comprehend text at adequate levels to attend and succeed in higher education indicates that these students probably are developing effective study and compensation strategies before they enter the postsecondary environment. The research in this field has primarily focused on postsecondary students. Further, this research has not explored how secondary students with dyslexia utilize strategies to be able to succeed in the text-dense secondary curriculum and thus gain access to higher education environments. Studying the relationship between learning and study strategies and the reading comprehension of a group of secondary students with dyslexia is necessary to understand why some students are able to compensate for their reading difficulties whereas others are not.

## CHAPTER 3

### RESEARCH METHODS

A detailed overview of the research methodology used in this pilot study is presented in this chapter, in which the first section describes the procedures used to recruit a sample of secondary students with dyslexia as well as the demographics of the final sample. In the second section, the instrumentation utilized is described, as is the psychometric information for several of the instruments. In the final section, the data analysis procedures are summarized.

#### Sample

In this section, the procedures that were implemented to recruit the sample for this pilot study is introduced, as is a description of the sample's demographic characteristics. The sampling procedures including research site recruitment, a description of the research setting, and participant recruitment procedures including participant flow and inclusion criteria are described in the first subsection.

#### Sampling Procedure

After receiving HS-IRB permission to conduct this study, administrators of several large public high schools in the Northeast United States were contacted to seek permission to have their students participate in the study; but none of these contacted administrators granted permission to recruit their students for the study. Administrators of independent high schools serving students with learning disabilities in the Northeast United States were then contacted to seek permission to recruit participants for this study. Permission was received from one small independent high school that is known for serving students with learning disabilities.

**Setting.** The setting of this study was an independent high school in the Northeast United States that serves students with learning disabilities. Approximately 175 students attend

this school as both residential and day students. To meet the school's eligibility criteria, students must have recently undergone a comprehensive psycho-educational or neuropsychological evaluation including a recent cognitive assessment, considered necessary to provide evidence of a learning disability. While the majority of the students at this school are from the Northeastern part of United States, many of the students represent a geographical diversity of the United States. In addition to small class sizes (4-6 students on average) and an extensive tutoring program, the students participate in 4 years of learning and study strategy instruction. Some graduates of this school attend the best colleges in the United States including Ivy League schools and most graduates report that this school was the source of their personal, professional, and educational success.

**Sample Recruitment.** Permission forms were provided to the parents of all students who attend this independent school and 70 parents granted permission for their children to participate in this study. These students were invited to participate in a group testing and information sessions where their assent was sought and obtained. Students who completed all of the group-administered measures were invited to individual testing sessions to assess their oral reading fluency. The educational records of the students who completed the individual testing session were also reviewed to determine if they met the inclusion criteria (see below) for this study and to collect the results of their most recent cognitive assessment. In Figure 3-1, the criteria for all participants who participated in this study are depicted; in summary, 51 participants met the criteria for inclusion and for subsequent data analysis.

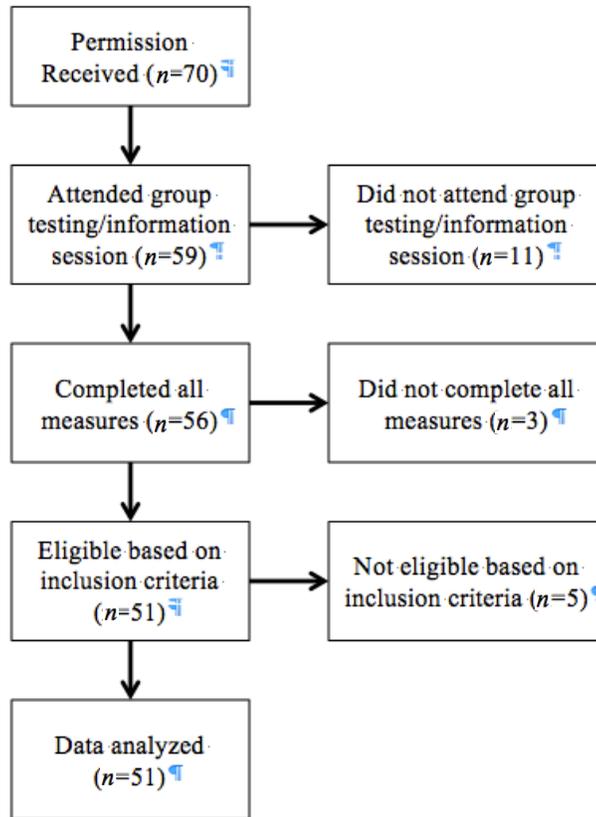


Figure 3-1. Participant flow in study

**Inclusion criteria.** The following inclusion criteria were utilized to determine if the students displayed evidence of the reading difficulties associated with dyslexia. The students' educational records had to include: *n*

- A diagnosis of dyslexia, or
- A diagnosis of reading disorder (315.00) using the *Diagnostic and Statistical Manual of Mental Disorders: Fourth Edition—Text Revised* (DSM IV-TR; 2000) criteria, or
- A designation on their IEP of Specific Learning Disability—Reading and a history of phonological processing such as a history of below average decoding or fluency scores relative to same age peers.

All participants also had to have a minimum full-scale intellectual quotient of at least 85 on a recent cognitive assessment, have evidence that English was their first language, and have completed all of the study's measures in order to be included in the study. These sample selection procedures align with current definitions of dyslexia (International Dyslexia Association, 2002; Shaywitz, Morris, & Shaywitz, 2008).

### **Sample Demographics**

The demographics of the 51 participants who met the eligibility criteria indicate that this group is representative of the setting from which they were sampled (see Table 3-1) as the school population consists of predominantly male students with complex profiles often due to the presence of multiple learning disabilities and/or Attention Deficit Hyperactivity Disorder (ADHD). The maleness and presence of other diagnosed learning disabilities indicate that this sample may not be representative of all individuals with dyslexia, as the prevalence rates of dyslexia have been found in more recent research to be comparable for males and females (Shaywitz, 1998). Males may be overrepresented as they may tend to act out more in school in response to frustrations over their learning disabilities (Baum & Owen, 1988). While socio-economic data was not available for this sample, the tuition and the availability of scholarships further indicate that this sample may not be representative of all individuals with dyslexia . These sample limitations should be taken into account for this pilot study and will be discussed in Chapter 5 relative to this study's limitations and also for directions for future research.

Table 3-1

*Summary of Sample Characteristics*

Characteristic	Number
Gender	
Male	37
Female	14
Grade level	
9	10
10	16
11	16
12	9
First language	
English	51
Learning disability <sup>a</sup>	
Reading	51
Math	3
Writing	11
ADHD	30
Language or auditory processing	12
Other	3
Cognitive assessment utilized	
WAIS	9
WISC	40
WJ Cog.	1
DAS	1

<sup>a</sup> Individuals could be identified with multiple learning disabilities.

The sampling procedures and inclusion criteria for this study were designed to ensure that the students had a history of reading difficulties associated with current definitions of dyslexia. The use of a sample from an independent school may have skewed the sample demographics. These limitations are noted in the limitations section of Chapter 5.

### **Instrumentation**

Instruments were selected for this study based on their applicability and psychometric characteristics. An additional consideration utilized in this study was the amount of time required to administer the instrument. Data were collected for these instruments in three ways: a group

testing session lasting approximately 45 minutes, an individual testing session lasting 5 minutes, and a review of educational records. The group testing session assessed the dependent variable (reading comprehension) and one of the independent variables (self-regulated learning strategies as measured by the three factors of the SRSI). The individual testing session measured another independent variable (oral reading fluency) while the review of educational records collected data on the final independent variable (cognitive ability). The instruments utilized in this study are discussed below, and this is divided into two sections based on the instruments use as independent or dependent variables.

### **Dependent Variable**

Reading comprehension was utilized as the dependent variable as it aligns with studies of compensation in postsecondary samples of students with dyslexia. Because the correlation between reading comprehension and overall academic achievement is quite high, reading comprehension served as a proxy of academic achievement in this study (Bray, Pascarella, & Pierson, 2004; Jackson, 2005).

**Reading comprehension.** Reading comprehension was measured using the comprehension subtest of the Gates-MacGinitie Reading Test (GMRT; 2007), which has been normed for individuals in kindergarten through adults. The specific form (Form10/12) of the subtest was designed and normed on high schools students and includes 11 passages and 48 reading comprehension questions. This measure is considered reliable for this sample (secondary students) and enables comparison to national norms. The K-R 20 reliability coefficients for this subtest are 0.93, 0.91, 0.92, and 0.93 for grades 9-12 respectively. While students with learning disabilities typically are eligible for extended time on standardized assessments, this study utilized the standard administration time of 35 minutes in order to to

allow comparison of scores to the standardization sample and to accommodate the request of the school to limit the length of time required for the group testing session.

The GMRT provides national norms for the ninth grade students who are technically taking this test “out of level” in the form of extended scale scores (ESS). These scores allow longitudinal data to track students as they are assessed using different forms of the GMRT as the ESS provides data on a single, continuous scale. The Scoring and Interpretation Manual (MacGinitie, MacGinitie, Maria, Dreyer, & Hughes, 2007) suggests that researchers use these scores since they are on a scale that can be averaged; in addition, they are the only scaled scores available for this measure. The raw scores were converted to extended scale scores using the procedure described in the Scoring and Interpretation Manual (MacGinitie et al., 2007). The mean ESS by grade level is presented in Table 3-2. Fifty-seven percent of the sample’s reading comprehension scores were above the median, which indicates that the participants’ performance on this measure of reading comprehension is comparable to same-age peers (see Evidence of compensation section of Chapter 5 for further discussion).

Table 3-2

*Mean and Standard Deviation by Grade Level for GMRT ESS (Median Score for Standardization Sample in Parentheses)*

Grade	Mean	SD
9	549.40 (544)	12.79
10	559.00 (551)	36.42
11	567.19 (556)	30.40
12	560.44 (561)	42.04

### **Independent Variables**

Two sets of independent variables were utilized in this study. The first represented the control variables (intellectual ability and oral reading fluency), and the second set of variables

represented hypothesized predictors (the three factors of the SRSI-a measure of self-regulated learning strategies) of reading comprehension over and above the control variables.

### **Control Variables**

The following control variables enabled the investigation of the effects of the predictor variables. These were variables that previous researchers (Cain, Oakhill, & Bryant, 2004; Jenkins, Fuchs, van der Broek, Espin, & Deno, 2003; Swanson & O'Connor, 2009) have found to be important predictors of reading comprehension.

**Intellectual ability.** Intellectual ability, as measured by a cognitive assessment, is a strong predictor of reading comprehension (especially verbal ability; Hatcher & Hulme, 1999). Data on participants' intellectual ability, specifically their most recent Full Scale Intellectual Quotient or equivalent score (FSIQ), was collected from a review of their educational records. Four cognitive assessments were found in participants' educational records: the Weschler Adult Intelligence Scale (WAIS; Weschler, 1997), the Weschler Intelligence Scale for Children (WISC; Weschler, 1991), the Woodcock Johnson Tests of Cognitive Abilities (WJ Cog.; Woodcock, McGrew, & Mather, 2001), and the Differential Ability Scales (DAS; Elliot, 1990). The number of students whose educational records were reviewed to find one of these cognitive assessments is summarized in Table 3-1. The FSIQ for all four assessments uses the same scaling procedures—a standard score with a mean of 100 and a standard deviation of 15. This scale equivalence enabled the comparison of scores without the need to convert the standard scores to Z scores. The means and standard deviations for the participants' FSIQ are presented in Table 4-1.

**Oral reading fluency.** Oral reading fluency (ORF) is second control variable utilized in this study due to its relationship with reading comprehension (Fuchs, Fuchs, Hosp, & Jenkins,

2001; Pikulski & Chard, 2005). It is assessed by having the participant read a passage aloud for a minute while a rater records the number of errors the student makes. The procedures in this study involved the participants reading three passages created by Rasinski (2003). The passages were drawn from high school textbooks and their grade level appropriateness was assessed using the Flesch-Kincaid and Dale-Chall readability formulas. These passages were pilot tested by the author and revised to further ensure their reliability and validity. The three passages selected were rated at the 10th-grade level to align with the reading comprehension test and to enable comparisons across passages. The number of errors in reading was subtracted from the total number of words read to calculate the Words Correct Per Minute (WCPM). The errors in reading and overall scoring methods followed procedures developed by Rasinski (2003).

To ensure the reliability of the procedure utilized and to allow for efficient data collection, two raters were employed. The raters independently reviewed the “Directions for Administering the Graded Passages” (Rasinski 2003) and then rated oral reading fluency passages during an hour-long training session. The training session ended once both raters had 100% agreement across three consecutive passages. The duration of this training procedure was appropriate since both raters had extensive experience and training in oral reading fluency procedures from their coursework and involvement in previous research studies. The two raters simultaneously rated the Oral Reading Fluency of 22 participants (43% of the sample) to provide an indication of the reliability of the Oral reading scores. The percent agreement for the two raters was calculated using the following formula:

$$\text{Percent agreement} = \frac{\text{Total words} - \text{disagreements}}{\text{Total words}}$$

Of the 8663 total words, both raters agreed on 8607 of the words for a percent agreement of 99.4%, indicating that Oral Reading Fluency was measured with a high degree of consistency

within this study. For the participants who were rated by both raters, the score for one of the raters was randomly selected to be included in the study. The oral reading fluency scores for the three passages were averaged for each participant; this average ORF was used as a predictor in the regression model being analyzed in this study. The mean and standard deviation for the sample's ORF is presented in Table 4-1.

### **Predictor Variables**

Self-regulated learning strategies were hypothesized to predict reading comprehension over and above the control variables in this study. These strategies were measured utilizing the three factors of the Self-Regulation Strategy Inventory (SRSI; Cleary, 2006).

**Self-regulated learning strategies.** A slight adaptation of the Self-Regulation Strategy Inventory (SRSI) was used as a self-report indicator of self-regulated learning strategies (Cleary, 2006) as it is a 28-item instrument that measures three factors: managing environment/behavior (Factor 1), seeking and learning information (Factor 2), and maladaptive regulatory behaviors (Factor 3). The adaptation included slight changes to 10 of the items; these items referenced the use of study strategies in science classes and their content was changed to be more general (see Table 3-3). The items were then randomized and placed on the 7 point Likert scale ranging from *strongly disagree* to *strongly agree* as described by Cleary (2006; see Appendix A).

This measure was originally normed on 9<sup>th</sup> and 10<sup>th</sup> grade students and the three factors were found to have adequate reliabilities (ranging from .72 to .88), in addition to directly aligning with Zimmerman's definition of self-regulated learning strategies (1989). Further, preliminary evidence was gathered that this instrument differentiates low and high achievers (Cleary, 2006). Since this measure was adapted for the present study, Cronbach's alpha (1951) for the three subscales was calculated to confirm their reliability (see Table 3-4). The means and

standard deviations for each of the items are included in Table 3-5 (see Appendix A for item stems).

Table 3-3

*Adaptation of SRSI Items*

Original Item	Adaptation
<b>Managing Environment and Behavior Scale</b>	
I use binders or folders to organize my science study materials.	I use binders or folders to organize my study materials.
<b>Seeking and Learning Information Scale</b>	
I try to see how my notes from science class relates to things I already know.	I try to see how my notes relate to things I already know.
I make pictures or drawings to help me learn science concepts.	I make pictures or drawings to help me learn new concepts.
I ask my science teacher about the topics that will be on upcoming tests.	I ask my teachers about the topics that will be on upcoming tests.
I rely on my science class notes to study.	I rely on my class notes to study.
I try to identify the format of upcoming science tests.	I try to identify the format of upcoming tests.
<b>Maladaptive Regulatory Behavior Scale</b>	
I forget to bring home my science materials when I need to study.	I forget to bring home my materials when I need to study.
I avoid going to extra-help sessions in science.	I avoid going to extra-help sessions.
I lose important science dittos or materials.	I lose important dittos or materials.
I wait to the last minute to study for science tests.	I wait to the last minute to study for tests.

The reliabilities found in this study are comparable to the reliabilities observed in the original study (Cleary, 2006). The reliability of the second factor (.70) did not meet the standard convention for research ( $\alpha=0.8$ ; Cortina, 1993). However, the 95% confidence interval for this estimate did include 0.8. Based on the means and standard deviations for Factor 2 items, the removal of any item(s) would not have drastically improved the reliability of this scale for this

sample. Further, the alpha if removed statistic from SPSS did not indicate a significant improvement for any of the items so all items were retained for this scale.

Table 3-4

*Observed Cronbach's Alpha for the Three Factors of the Self-Regulated Strategy Inventory (SRSI; Cleary, 2006)*

Factor	A	95% CI	Number of Items
Factor 1 <sup>a</sup>	0.86	[0.80, 0.91]	12
Factor 2 <sup>b</sup>	0.71	[0.57, 0.81]	8
Factor 3 <sup>c</sup>	0.81	[0.72, 0.88]	8

<sup>a</sup> Managing Environment and Behavior Scale.

<sup>b</sup> Seeking and Learning Information Scale.

<sup>c</sup> Maladaptive Regulatory Behavior Scale.

Mean scores were calculated for the three factors for each of the study's participants as mean scores are a better representation of the scales and control for the different number of items across scales (DiStefeno, Zhu, & Mîndrilâ, 2009). The three mean scores were included in the regression model tested in this study. Sample means and standard deviation for the mean scores of the three SRSI factors are included in Table 4-1.

The instruments in this study were selected for their previous reliability in samples of secondary students as well as the amount of time required to administer, and the study considerations necessitated the use of these instruments. Oral reading fluency was measured reliably across the two raters in this study while two of the three factors of the SRSI were measured with acceptable reliability. The potential limitations of the SRSI are noted in the limitations section of Chapter 5.

Table 3-5

*Means and Standard Deviations for SRSI Items*

Item	Mean	SD
Factor 1 <sup>a</sup>		
Item 1	4.76	1.70
Item 2	4.39	1.72
Item 4	5.31	1.40
Item 5	5.51	1.75
Item 6	5.22	1.65
Item 13	4.92	1.61
Item 15	4.51	1.78
Item 16	5.47	1.64
Item 19	4.75	1.65
Item 20	4.45	1.50
Item 26	3.67	1.77
Item 27	5.02	1.58
Factor 2 <sup>b</sup>		
Item 3	5.59	1.15
Item 9	4.94	1.59
Item 11	4.63	1.72
Item 12	5.27	1.27
Item 17	5.67	1.37
Item 18	4.88	1.55
Item 22	5.37	1.54
Item 24	3.63	1.78
Factor 3 <sup>c</sup>		
Item 7	2.92	1.63
Item 8	3.90	2.05
Item 10	2.61	1.66
Item 14	3.16	1.70
Item 21	3.27	1.82
Item 23	3.59	1.60
Item 25	2.78	1.70
Item 28	3.63	1.83

Note: See Appendix A for item stems

<sup>a</sup> Managing Environment and Behavior Scale

<sup>b</sup> Seeking and Learning Information Scale

<sup>c</sup> Maladaptive Regulatory Behavior Scale

### Analysis

Hierarchical linear regression was used to analyze the data in this study, and this procedure involves the comparison of two or more sets of predictors of a dependent variable.

The sets of predictors are added one at a time and the fit of these increasingly complex models to the data is analyzed to determine the least complex model necessary to account for the most significant variance in the dependent variables. In other words, hierarchical linear regression seeks to find the least complex model that has the most power to predict the dependent variable.

In this study, two models were compared to predict reading comprehension. The first model predicts reading comprehension from intellectual ability (cog) and oral reading fluency (ORF; the control variables) while the second model predicts reading comprehension from the control variables and the three factors of the SRSI (indicators of self-regulated learning strategies). These hierarchical models analyze the contribution of self-regulated learning strategies in predicting reading comprehension over and above the control variables. The equations for the two models are:

$$\text{Model 1: } Y = \beta_0 + \beta_1 * Cog + \beta_2 * ORF$$

$$\text{Model 2: } Y = \beta_0 + \beta_1 * Cog + \beta_2 * ORF + \beta_3 * SRSI1 + \beta_4 * SRSI2 + \beta_5 * SRSI3$$

The regression coefficients in these models would be interpreted as indicated in Table 3-6.

Thus, the regression coefficients represent the effects of the predictor variables after controlling for the other predictors in the model; they indicate the relative predictive power of each variable in the model compared with the other predictors in the model. The following two sections describe the statistical power considerations for comparing these models and the specific steps for the regression analysis utilized in this study.

Table 3-6

*Interpretation of regression coefficients*

Coefficient	Interpretation
$\beta_0$	The expected value of reading comprehension after controlling for the other predictors in the model.
$\beta_1$	The predicted change in reading comprehension for one unit change in cognitive ability after controlling for the other predictors in the model.
$\beta_2$	The predicted change in reading comprehension for one unit change in oral reading fluency after controlling for the other predictors in the model.
$\beta_3$	The predicted change in reading comprehension for one unit change in <i>Managing Environment and Behavior Scale</i> after controlling for the other predictors in the model.
$\beta_4$	The predicted change in reading comprehension for one unit change in <i>Seeking and Learning Information Scale</i> after controlling for the other predictors in the model.
$\beta_5$	The predicted change in reading comprehension for one unit change in <i>Maladaptive Regulatory Behavior Scale</i> after controlling for the other predictors in the model.

**Statistical Power Considerations**

To determine the appropriate statistical power to utilize hierarchical regression, two approaches were used to determine the minimum sample size required. The first method involves applying rules of thumb with the most common involving having at least 10 participants

per predictor variable (Wampold & Freund, 1987). This study achieved the minimum statistical power according to this rule of thumb. The second method to determine the minimum effect size required to achieve an acceptable level of statistical power is to conduct a power analysis. The a priori power analysis found that a minimum sample size of 78 was necessary to detect a medium effect ( $f^2=0.15$ ) for the difference between a model with two factors as opposed to a model with three additional predictive factors for a correctly powered hierarchical regression study (Soper, 2011). This study failed to recruit the minimum number of participants to achieve the minimally acceptable level of statistical power ( $1-\beta=0.8$ ; Cohen, 1988). The limitations of this study due to statistical power are noted in the limitations section of Chapter 5.

### **Data-analysis Procedures**

The first step during data analysis was to score the measures and enter the information into an electronic database. The descriptive statistics for this database were then analyzed to determine any errors in data entry. Next, the reliability of the three factors of the SRSI was then calculated and mean scores for each of the scales were created. Before interpreting the regression analysis, the following plots were graphed using SPSS after computing the residuals from Model 2 to confirm that the assumptions necessary to conduct regression analyses had been met (Chatterjee & Simonoff, 2013):

1. The plot of residuals versus predicted values should not have an apparent pattern indicating homoscedasticity.
2. The plot of residuals versus each predictor should not have an apparent pattern indicating that the errors are uncorrelated with each other.
3. The normal plot of residuals should approximate a straight line indicating that the errors are normally distributed.

After confirming the necessary assumptions had been met, the correlation matrix for all of the variables was analyzed to detect suppression or enhancement effects due to strong correlations between control and predictor variables. The variance inflation factor for each predictor was also analyzed to determine if multi-collinearity was present in the data ( $VIF < \max(10, \frac{1}{1-R^2})$ ; Chatterjee & Simonoff, 2013). Then, a comparison of the two models was analyzed by using the ENTER command in SPSS to enter the control variables as Block 1 and the predictor variables as Block 2 and then examining the  $R^2$  change statistic. Finally, the two blocks of predictors were entered into a regression using the TEST command since this command compares the blocks of predictors to each other as opposed to comparing them to a model with no predictors and then the regression coefficients were analyzed.

### **Summary**

Fifty-one participants were recruited from an independent high school for students with learning disabilities in the Northeast United States. The participants in this pilot study were primarily male and met the criteria for dyslexia according to recent definitions of the disorder, but also met the criteria for a variety of other learning disabilities including ADHD and language processing difficulties. The participants who completed all of the measures during the group and individual testing sessions were included in the regression analysis. The instrumentation was chosen for its previous reliability with secondary students and the time required to administer. One scale of the SRSI instrument did not achieve minimally acceptable reliability. The other two scales of the SRSI and the oral reading fluency procedure achieved minimally acceptable reliability. Appropriate procedures were utilized to determine if the assumptions necessary to analyze the data with hierarchical linear regression had been met. The procedures for comparing a model predicting reading comprehension from intellectual ability and oral reading fluency to a

model predicting reading comprehension from intellectual ability, oral reading fluency, and the three factors of the SRSI (representing self-regulated learning strategies) using hierarchical linear regression were described in this chapter. The next chapter presents the results of these analyses.

## CHAPTER 4

### RESULTS

Multiple regression is a statistical procedure for determining the relative predictive power of independent variables on one dependent variable (Chatterjee & Simonoff, 2013). This procedure capitalizes on the use of residuals, the remaining variance in the dependent variable after the effects predictor variables have been modeled (Pinker, 2011, Kindle Location 6240). These residuals allow the effects of the individual predictors on the dependent variable to be estimated over and above the other predictors in the model (the regression coefficients) and allow an overall indication of how much variance in the dependent variable can be explained by the model ( $R^2$ ). Lower residual values indicate that the regression model explains more of the variance in the dependent variable, while higher residual values indicate the regression model does not explain a significant amount of the variance in the dependent variable. This procedure does not enable causal inferences to be drawn, such as the ability to prove that a variable caused a change in the dependent variable, but does allow for the strength of predictors to be estimated. Several assumptions need to be met in order to appropriately utilize multiple regression procedures; the preliminary analyses described in the first section of this chapter detail how the assumptions necessary to conduct multiple regression were achieved. The final section describes the results of the planned multiple regression analysis necessary to answer the research question for this pilot study.

#### Preliminary Analyses

Preliminary analyses were conducted on the data from this sample in order to ensure that hierarchical linear regression was an appropriate data analysis procedure. The first analysis consisted of analyzing the data for the presence of suppression. The second analysis involved

analyzing residual plots and the variance inflation factor for each factor to determine if the assumptions necessary to conduct multiple regression had been met.

### Suppression Analysis

One concern when utilizing multiple regression is the presence of suppression (Cohen, 1968; Friedman & Wall, 2005). Suppression occurs when one of the major assumptions of multiple regression is violated: The assumption that predictors in the model are independent (Chatterjee & Simonoff, 2013). In other words, the issue of suppression arises when predictors have moderate correlations with each other. These correlations indicate that the correlated predictors are competing with each other to explain variance in the dependent variable. This competition to explain variance may inflate the resulting predictive value of other predictors in the model and thus suppress the relative predictive value of the correlated predictors in the model. To begin the suppression analysis, one must first examine the correlation matrix presented in Table 4-1.

Table 4-1

*Summary of Intercorrelations, Means, and Standard Deviations for Scores on Reading Comprehension, Cognitive Ability, Oral Reading Fluency, and SRSI factors*

Measure	1	2	3	4	5	6	<i>M</i>	<i>SD</i>
1. Reading Comprehension	—						559.94	32.04
2. Cognitive	.558*	—					102.39	10.34
3. Oral Reading Fluency	.214	.125	—				117.67	24.00
4. SRSI Factor 1	-.110	-.056	.156	—			4.83	1.04
5. SRSI Factor 2	-.114	-.004	.165	.710*	—		5.00	0.86
6. SRSI Factor 3	-.107	-.200	-.037	-.621*	-.644*	—	3.23	1.15

\* $p < .001$ .

The moderate to strong correlations among the three factors of the SRSI could indicate the presence of suppression in these data. SRSI Factor 3 has a weak correlation with cognitive ability and SRSI Factor 1 and SRSI Factor 2 have weak correlations with oral reading fluency. Even these weak correlations could indicate suppression in the regression model so the relative predictive power as indicated by the regression coefficients for cognitive ability and oral reading fluency were compared with and without the presence of the three SRSI factors (see Table 4-2). Cognitive ability was a significant predictor ( $p < 0.001$ ) in both models and oral reading fluency was not a significant predictor in either model ( $p = 0.22$  and  $p = 0.13$  respectively). Overall, these findings indicate that suppression was not present in the regression model so the relative predictive power of each predictor can be interpreted independently even though the three SRSI factors were moderately correlated.

### **Regression Assumptions Analysis**

In order to determine if the assumptions necessary to utilize multiple regression had been met, several plots as described in Chapter 3 were analyzed. In order to create the plots, the planned regression analysis was conducted and the residuals, which are the difference between the observed and predicted values for each participant in the study, were then calculated as a new variable that was used to plot the following graphs. The plot of residuals versus predicted values indicates if a relationship exists between residuals and predictive values (see figure 4-1); a relationship should not be apparent. The plots of the residuals were plotted versus each of the predictors to determine if there was a relationship between the residuals and the predictors (see Figures 4-2, 4-3, 4-4, 4-5, 4-6); again, a relationship should not be apparent. Finally, the plot of normal plot of residuals should approximate a straight line indicating that the data are approximately normally distributed (see figure 4-7).

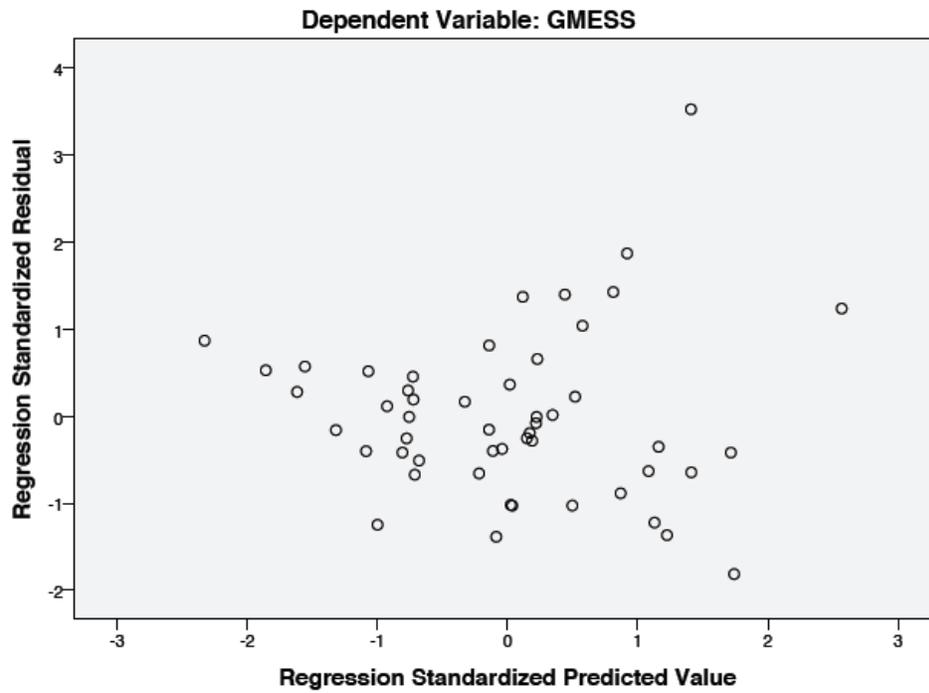


Figure 4-1. Plot of residual versus predicted value

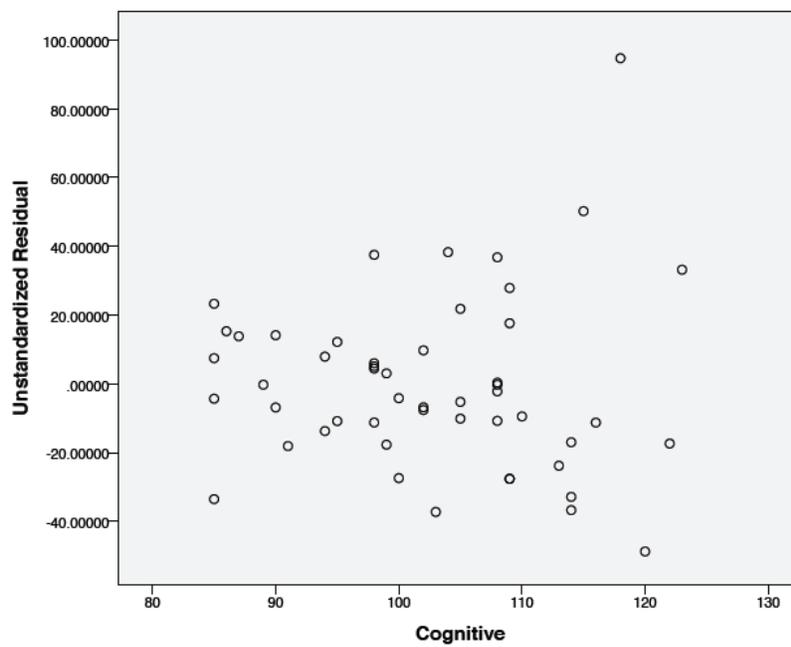


Figure 4-2. Plot of residuals versus cognitive ability

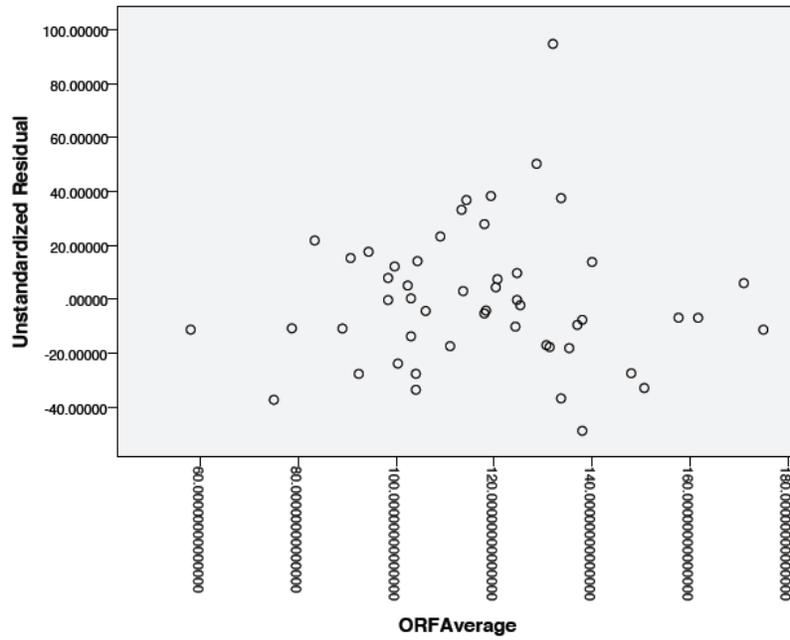


Figure 4-3. Plot of residuals versus oral reading fluency

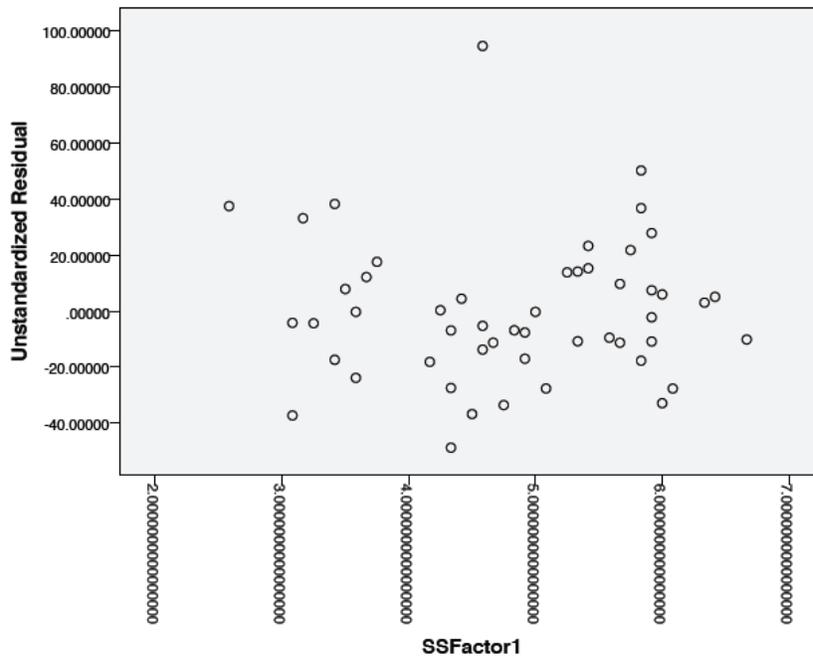


Figure 4-4. Plot of residuals versus SRSI factor 1

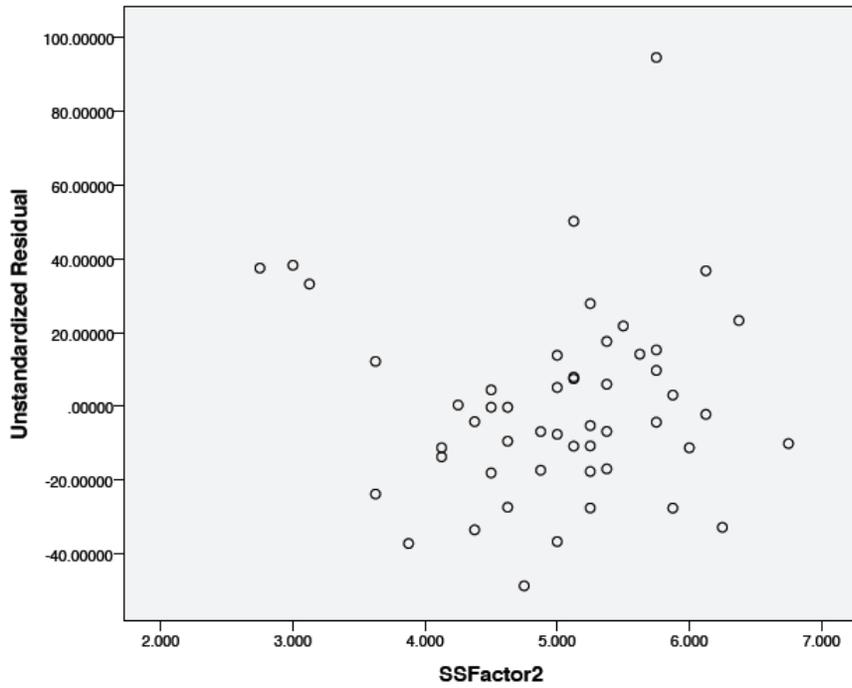


Figure 4-5. Plot of residuals versus SRSI factor 2

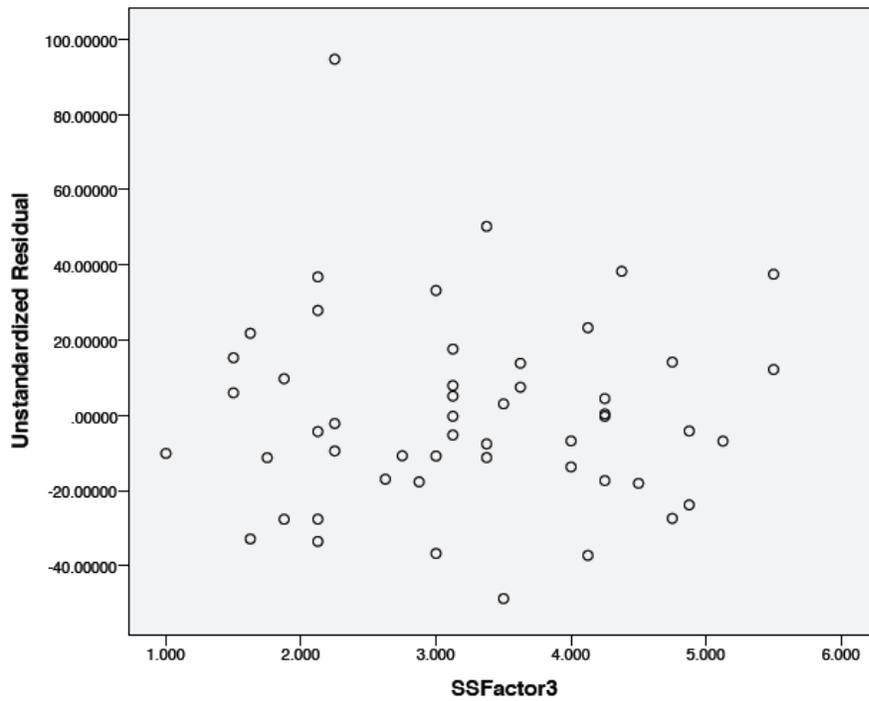


Figure 4-6. Plot of residuals versus SRSI factor 3

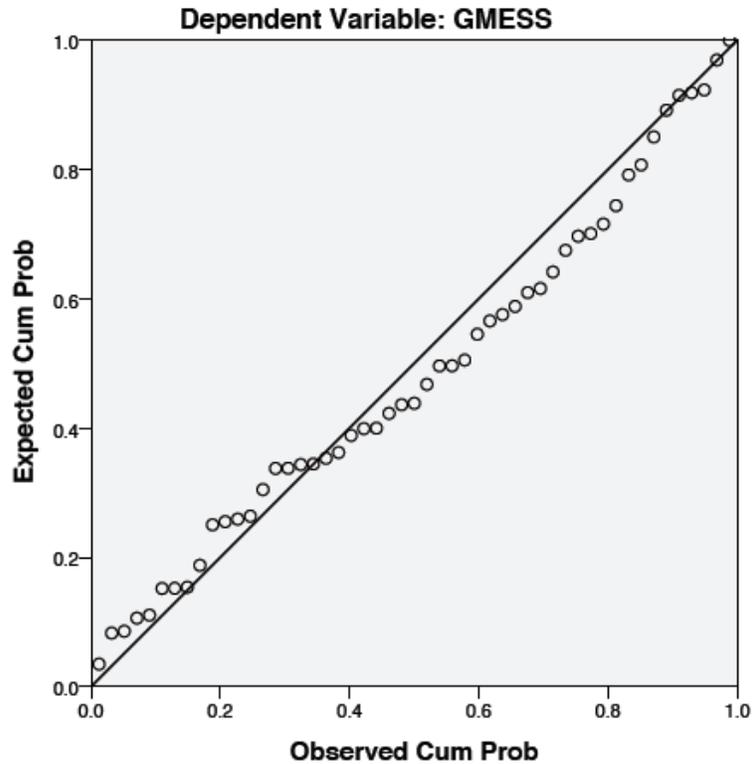


Figure 4-7. Normal plot of residuals

Figure 4-1 indicates that there no relationship exists between the residuals and the predicted values so the assumption of homoscedasticity has been met. Figures 4-2 through 4-6 confirm that there is no relationship between the residuals and predictor indicating the assumption of the independence of predictors has been met as indicated by the absence of relationship between the residuals and the actual values. Finally, Figure 4-7 approximates a straight line indicating that the errors were normally distributed. These plots indicate that the assumptions necessary to conduct multiple regression were met for this sample.

**Variance inflation factor.** In addition, the variance inflation factors for each of the predictor variables were analyzed to determine if multi-collinearity was present in the data. Collinearity refers to a linear relationship between predictor variables that indicates that they are related as opposed to independent predictors of the dependent variable. Thus, the VIF serves as

another indicator of the independence of the predictors in the model. The “rule of thumb” is that the VIF should be below 10 for each predictor (Chatterjee & Simonoff, 2013); values above 10 may indicate the presence of multi-collinearity. The VIF for each of the predictors are presented in Table 4-2. None of the variables had VIFs above three so the presence of multi-collinearity is not present in this data indicating the relative independence of the predictors. Further, the correlations between the three SRSI factors and their low VIF scores signify that they are related but independent predictors.

Overall, the preliminary analyses indicate that the assumptions for utilizing multiple regression were met for this data sample. The planned multiple regression was conducted and the results are presented in the next section.

### **Regression Results**

As the assumptions necessary for multiple regression were met, the planned hierarchical linear regression analysis described in detail in Chapter 3 was conducted to answer the research question for this study. The research question involved the relative contribution of self-regulated learning strategies (as measured by the three factors of the SRSI) on reading comprehension over and above the effect of intellectual ability and oral reading fluency. The results of the hierarchical linear regression procedure are presented in the next subsection followed by a subsection detailing the relative predictive value of the predictor variables as indicated by the regression coefficients and their significance.

#### **Hierarchical Linear Regression**

A hierarchical linear regression comparing two models was necessary to answer the research question for this study. The first model involved the prediction of reading comprehension from intellectual ability and oral reading fluency while the second model

involved the prediction of reading comprehension from intellectual ability, oral reading fluency, and self-regulated learning strategies (as measured by the three factors of the SRSI). The two sets of predictors were entered into the regression using the ENTER function in SPSS and the results of this analysis are depicted in Table 4-2.

Table 4-2

*Predictors of Reading Comprehension in Secondary Students with Dyslexia*

Variable	Reading Comprehension			
	Model 1 <i>B</i>	<i>B</i>	Model 2 95% CI	VIF
Constant	365.77*	440.31*	[307.71, 572.92]	
Cognitive ability	1.67*	1.52*	[0.733, 2.31]	1.14
Oral reading fluency	0.20	0.26	[-0.74, 0.59]	1.08
SRSI Factor 1		-2.49	[-13.68, 8.69]	2.32
SRSI Factor 2		-7.61	[-21.30, 6.09]	2.38
SRSISRSI Factor 3		-5.11	[-14.81, 4.59]	2.13
$R^2$	.33	.37		
$\Delta R^2$		.04		

\* $I < .001$ .

The first model predicts approximately 33% of the variance in reading comprehension while the second model predicts approximately 37% of the variance in reading comprehension, an improvement of only 4% of the variance in reading comprehension ( $R^2$  change=0.04). The first model adds to the prediction of reading comprehension with statistical significance over a model with no predictors ( $F=11.94$ ,  $p<0.001$ ); the second model also adds to the prediction of reading comprehension with statistical significance over a model with no predictors ( $F=5.23$ ,  $p<0.001$ ). However, these comparisons to a model without predictors and the  $R^2$  change do not

indicate if self-regulated learning strategies aid in the prediction of reading comprehension with statistical significance over and above the other predictors in the model. To determine the statistical significance of the contribution of these two blocks versus each other, the TEST function in SPSS was utilized to compare the statistical significance of the blocks of predictor variables on the prediction of reading comprehension. This procedure indicated that intellectual ability and oral reading fluency predicts reading comprehension with statistical significance ( $F=10.13, p<0.001$ ) over and above self-regulated learning strategies when all of these variables are present in the regression model. Self-regulated learning strategies did not add to the prediction of reading comprehension with statistical significance ( $F=0.83, p=0.423$ ) over and above intellectual ability and oral reading fluency when all of these variables are present in the regression model. Overall, these results indicated that self-regulated learning strategies did not improve the prediction of reading comprehension over and above intellectual ability and oral reading fluency.

### **Regression Coefficients as Indicators of Relative Predictive Value**

Beyond considering the relative effects of competing models and/or blocks of variables in predicting dependent variables, multiple regression enables the statistical comparison of the relative predictive power of individual variables within the model over and above the other predictors in the model. The control and predictor variables in this analysis all represent continuous variables so the regression coefficients represent the correlation between each variable and reading comprehension after controlling for the effects of the other variables in the model on reading comprehension. The significance of the regression coefficients indicates the relative predictive power of each variable over and above the other predictors in the model.

As depicted in Table 4-2, oral reading fluency and the three factors of the SRSI are not statistically significant predictors of reading comprehension over and above the other predictors in the model because the 95% confidence intervals for these variables contains 0, signifying there may not be a relationship between these variables and reading comprehension. The 95% confidence interval for cognitive ability did not contain zero indicating that cognitive ability is a significant predictor of reading comprehension over and above the other predictors in the model ( $t=3.88, p<0.001$ ).

The results of the regression analysis indicate that self-regulated learning strategies did not add to the prediction of reading comprehension over and above intellectual ability and oral reading fluency with statistical significance. In a model containing all of the predictor variables, cognitive ability was the only variable that predicted reading comprehension with statistical significance over and above the other variables in the model.

### **Summary**

Preliminary analyses indicated that the assumptions to conduct multiple regression were met for this sample. Further, multi-collinearity and suppression were ruled out as confounding factors to the direct interpretation of the regression model being tested. The results of the regression analysis indicate that the hypothesized predictors (the three factors of the SRSI as indicators of self-regulated learning strategies) did not contribute to the prediction of reading comprehension with statistical significance over and above the other predictors in the model. In the model containing all of the independent variables, cognitive ability was the only predictor of reading comprehension to achieve statistical significance over and above the other predictors in the model. The next chapter discusses the theoretical implications of these results as well as the limitations of this study, and proposes future directions for research.

## CHAPTER 5

### DISCUSSION AND IMPLICATIONS

One purpose of psychological science is to observe and investigate causal or correlation relationships among variables, but also to develop relevant theories to explain and predict the experiences of individuals as well as improve their outcomes (Danzinger, 1990). Thus, it is essential to address the theoretical implications of research, one goal of this study. This chapter offers a rationale for this investigation and then, a discussion of the relevance of the findings is presented. The limitations of this study are discussed, followed by suggestions for future research that address these limitations.

#### **Rationale for this Investigation**

Reading difficulties account for 80% of specific learning disability diagnoses in American special education (Shaywitz, 1998). While many causes exist to explain students' reading difficulties, recent policies surrounding the diagnosis and provision of services for these individuals, known as response to intervention, have aligned with current definitions of dyslexia (Shaywitz et al. 2008). Dyslexia is a neuro-psychological disorder characterized by deficits in phonemic awareness that make it difficult for individuals to make the connection between phonemes (sounds) and graphemes (letter combinations; Shaywitz et al. 2003). The current literature base on compensated or high-functioning individuals with dyslexia, those who have achieved reading comprehension scores that are comparable to their same age peers, has been gathered from samples of postsecondary or adult samples (Birch & Chase, 2004; Deacon et al. 2006; Fink, 1998). This evidence base indicates that many individuals with dyslexia can and do achieve reading comprehension and academic achievement results that are comparable to their chronological peers (Corkett, Parrila, & Hein, 2006; Deacon, Parrila, & Kirby, 2006; Murray &

Wren, 2003). Qualitative studies in the research literature indicate that individuals with dyslexia can successfully navigate the higher education environment at the undergraduate and graduate levels and provide retrospective indications of how these individuals were able to compensate for the reading difficulties associated with dyslexia (Pink, 1998). The retrospective nature of these studies, in addition to the small sample size, does not enable researchers to generalize these findings. This pilot study sought to address this deficit in the literature by utilizing quantitative methods with a younger population allowing a snapshot of the reading comprehension abilities of this sample, while also investigating potential compensatory mechanisms, as they are being developed and implemented by these students. Specifically, the goal of this pilot study was to examine the role of self-regulated learning strategies as a potential compensatory mechanism utilized by secondary students with dyslexia and to probe how many students with dyslexia who attend a specialized independent high school for student with learning disabilities had reading comprehension scores that were above the median of the standardization sample

Self-regulated learning was chosen as an independent variable for this study because evidence from postsecondary samples of students with dyslexia indicates that these students report using different study strategies than same age peers without dyslexia (Kirby et al., 2008; Kovach & Wilgosh, 1999; Murray & Wren, 2003; Norton, 1992; Proctor, Prevatt, Adams, & Reaser, 2006). This utilization of different study strategies may indicate how these individuals were able to gain access to the text-dense environments of the secondary and postsecondary curriculums. Further, postsecondary studies indicate the phonemic awareness difficulties persist even as these students are able to achieve reading comprehension scores that are comparable to same age peers (Wilson & Lesaux, 2001). Traditional interventions for this population have focused on building phonemic awareness, but the persistence of these phonemic awareness

difficulties indicate that the compensatory mechanism for this population may exist above the word level (Tunmer & Greaney, 2010). In addition, a recent study has found that the only significant predictor of compensation was brain imaging, specifically the use of certain brain areas when reading, whereas the 17 behavioral variables (including cognitive and achievement measures) were not significant predictors of compensation (Hoeft et al., 2010). Thus, this pilot study investigated the potential compensatory role of self-regulated learning strategies (a variable not present in Hoeft et al., 2010) over and above traditional indicators of reading comprehension (intellectual ability and oral reading fluency).

The two studies on compensation for secondary students with dyslexia presented in this dissertation had a small sample size (Braten et al. 2010) or utilized qualitative methods (Givon & Court, 2010). This pilot study replicated the results of the postsecondary and adult studies by using a relatively large sample of secondary students with dyslexia and by employing quantitative methods. The investigation of self-regulated learning strategies as a compensatory mechanism utilized by secondary students is a novel contribution to the research literature because it has not been investigated with this population. The use of self-regulated learning strategies is an example of a behavioral variable that exists “above the word level” (Tunmer & Greaney, 2010) that may contribute to the development of reading comprehension abilities that are comparable to same age peers. Reading comprehension was selected as a dependent variable since it is a proxy for academic achievement (Bray et al., 2004; Jackson, 2005) and is the domain of academic achievement in which individuals with dyslexia theoretically have difficulty (Shaywitz, et al., 1999; Shaywitz et al., 2008). Overall, this pilot study systematically replicated earlier research utilizing postsecondary and adult samples, using quantitative research methods to

investigate self-regulated learning strategies as a potential compensatory mechanism. The next section presents a discussion of the results.

### **Discussion of Results**

This section details how the results of this study align with previous research. Specifically, it examines the effects of adding self-regulated learning strategies to a model predicting reading comprehension from intellectual ability and oral reading fluency (model comparison subsection). A brief discussion of the relative predictive power of each independent variable is also presented in relation to earlier studies (regression coefficients subsection). Finally, an explanation of how the results of this pilot study provide preliminary evidence that students with dyslexia can achieve age appropriate reading comprehension scores is provided, extending studies of reading comprehension in postsecondary students with dyslexia (evidence of compensation subsection).

#### **Model Comparison**

Previous research has explored the importance of metacognition or self-regulated learning strategies on reading comprehension (Bernacki, Byrnes, Cromley, 2012; Law, 2009). These studies have not utilized control variables such as intellectual ability or oral reading fluency. Other studies (Cain, Oakhill, & Bryant, 2004; Jenkins, Fuchs, van der Broek, Espin, & Deno, 2003; Swanson & O'Connor, 2009) have established these variables as effective predictors of reading comprehension. In addition, studies of postsecondary samples have found that individuals with dyslexia or other learning disabilities utilize different study strategies than peers with dyslexia (Kirby et al., 2008; Kovach & Wilgosh, 1999; Murray & Wren, 2003; Norton, 1992; Proctor, Prevatt, Adams, & Reaser, 2006). These studies hypothesized that these learning and study strategies are a potential compensatory mechanism allowing individuals with

dyslexia to achieve in both their secondary and postsecondary school experiences and thus to have comparable academic achievement (grades and other standardized measures) to same age peers. While this study did not compare the self-regulated learning strategies utilized by individuals with dyslexia with those used by individuals without dyslexia, it did explore the role of self-regulated learning strategies as a potential compensatory mechanism for predicting reading comprehension. Self-regulated learning strategies as measured in this study did not contribute to reading comprehension. These results indicated that the theoretical importance of self-regulated learning strategies may not have as strong of a relationship to a specific academic competency such as reading comprehension.

The results of this study provide preliminary evidence that self-regulated learning strategies may not serve as a compensatory mechanism in secondary individuals with dyslexia for developing reading comprehension abilities. However, this finding should be interpreted with caution as the limitations exist related to the self-regulated learning strategies measure utilized in this study and the use of reading comprehension as a dependent variable are noted in the limitations section of this chapter. These limitations and the other limitations of this study should be considered when examining the theoretical importance of the results of this study.

### **Regression Coefficients**

The statistical significance of specific regression coefficients indicates if these variables are significant predictors of the dependent variable over and above the other predictors. Specifically, examining the regression coefficients in this study allowed for a comparison of their importance in predicting reading comprehension over and above the other predictors in the model. The results of the regression coefficient analysis paradoxically align and challenge the results of previous studies. However, the statistical power and measurement limitations of this

study as noted in the limitations section of this chapter require that caution be utilized when interpreting the theoretical importance of these predictors relative to each other.

**Intellectual ability.** The results of this study indicated that intellectual ability was the only significant predictor of reading comprehension over and above the other variables including in this regression model. Cognitive ability was the only predictor variable that was moderately correlated ( $r=0.558$ ) with reading comprehension. The resulting  $r^2$  value of cognitive ability is 0.31 indicating that cognitive ability explains 31% of the variance in reading comprehension. The theoretical importance of cognitive ability for predictor reading and other academic outcomes is debated in the literature. At one extreme, some researchers believe that cognitive ability and reading comprehension have a strong relationship (Rathvon, 2004). At the other extreme, some researchers believe that cognitive ability should not be utilized as a co-variate in reading studies (Dennis et al., 2009). Empirical evidence supports both positions; a longitudinal study of individuals with and without dyslexia found that the word finding, digit span, and socio-economic status were the only significant predictors of reading comprehension over time (Shaywitz et al., 1999). However, another study estimated that cognitive ability explains 41% of the variance in reading comprehension utilizing a sample of 166 students with and without a diagnosis of dyslexia (Flanagan, 2000).

This percent of the variance serves as an indication of the highest possible estimate of cognitive ability's predictor power for reading comprehension as this estimate does not indicate the impact of the other variables over and above cognitive ability. The current study indicated that cognitive ability was the only statistical significant predictor. This provides evidence for the relationship between cognitive ability and reading comprehension, which provides evidence for the former position in addition to explaining 31% of the variance in reading comprehension.

**Oral reading fluency.** The relationship between oral reading fluency and reading comprehension has been established in early elementary school (Fuchs et al. 2001; Pikulski & Chard, 2005). The relationship becomes more complex as children become older, since decoding becomes necessary but not sufficient for explaining reading comprehension (Fuchs et al. 2001; Pikulski & Chard, 2005). In other words, decoding of words is a prerequisite for comprehension. As children age, their ability to decode multi-syllabic words does not indicate that they understand those words. The results of this study align with these previous findings. Oral reading fluency was not a statistically significant predictor of reading comprehension, but given the age of the students in this study, it would not be expected to be as it is only a prerequisite skill for developing comprehension.

**Self-regulated learning strategies.** Evidence from studies about postsecondary samples suggests that self-reported learning and study strategies are predictive of academic outcomes at this level (Vrugt & Oort, 2008). Other studies have found that individuals with and without dyslexia utilize different patterns of strategies (Kirby et al., 2008; Kovach & Wilgosh, 1999; Murray & Wren, 2003; Norton, 1992; Proctor, Prevatt, Adams, & Reaser, 2006). The individual factors of the SRSISRSI were not statistically significant predictors of reading comprehension over and above cognitive ability and oral reading fluency. These results challenge the theoretical importance of self-regulated learning strategies as a predictor of academic achievement. As noted above, these results should be interpreted with caution, however, given the sample size and reliability of the instrument.

### **Evidence of Compensation**

Several studies on postsecondary students with dyslexia have found that at least a portion of these students are able to achieve reading comprehension scores that are comparable to same

age peers (Birch & Chase, 2004; Deacon et al., 2006). This study provides preliminary evidence that the process of compensation for the reading difficulties develops before postsecondary settings as 57% of students at each grade level in this study achieved reading comprehension scores that were above the median scores in the standardization sample (see Table 3-2). In this study, the independent variable of self-regulation did not explain how these students developed compensation strategies; it did indicate that by high school, the student in this independent school who had dyslexia had learned to develop strategies for mitigating their reading difficulties. This finding should be interpreted with appropriate caution as noted in the limitations section of this chapter, especially given the low sample size per grade level.

### **Implications**

The major finding of this study is that a sample of secondary students with dyslexia demonstrated reading comprehension abilities that were comparable to same age peers. It is also important to recognize that the standard administration procedures of this reading comprehension measure were utilized. This finding extends the findings of postsecondary and adult studies that have found that individuals with dyslexia are able to demonstrate reading comprehension that is comparable to same age peers (Birch & Chase, 2004; Deacon et al. 2006; Fink, 1998). This study indicated that at least some students have already developed effective compensation strategies for the phonological deficits of dyslexia by the time they have reached high school. This finding further indicates the importance of early intervention or perhaps intense intervention in a small setting. However, the exact nature of how these students developed compensation strategies has not been indicated. Overall, the major theoretical implication is that some individuals with dyslexia can access the reading materials present in the secondary curriculum.

Given the limitations noted in the next section of this chapter, it is appropriate to use caution when interpreting the theoretical implications of this study.

### **Limitations**

The limitations of this study are noted in this section and should be considered when interpreting both the results and the implications of this study. Concerns related to the learning and study strategies instrumentation, the statistical power of this study, and the representativeness of the sample are noted in separate subsections of this section.

#### **Learning and Study Strategies Instrumentation**

The Self-regulated Strategies Inventory (SRSI; Cleary, 2006) was selected for this study since it yielded a parsimonious number of factors (3) and required a relatively small number of items (28). The parsimonious nature of this instrument may mean that it did not have the necessary numbers of items to achieve the sensitivity required to differentiate individual's learning and study strategies because it did not sample enough items from this construct. In addition, the second factor (seeking and learning information) did not achieve the minimally acceptable Cronbach's alpha (Cortina, 1993), indicating concerns related to the consistency of individuals responses to these items. The limitations of this instrument indicate measurement error may have biased the results of this study and that appropriate caution is necessary when interpreting the results of this instrument in the context of this study. The sample size and representativeness of the sample are also important limitations of this study.

#### **Statistical Power**

This study did not achieve the minimum sample size in order to test the model comparison with the appropriate level of statistical power. A priori, the target sample size had been set at 90 to achieve the minimum sample size of 78 that is required to detect a medium

effect in the model comparison. The actual sample size for this study was below both the target and the minimally accepted sample size benchmarks. While the actual sample size satisfied the “rule of thumb” for determining the minimum number of participants per predictor variable (Wampold & Freund, 1987), the observed statistical power for detecting medium effect sizes was 0.68. This observed statistical power is below the minimally acceptable value of 0.8 (Cohen, 1988) and indicates that more participants would be necessary to reach conclusions regarding the results of the model comparison utilized in this study. This limitation indicates that extreme caution should be utilized when interpreting the results of this study.

### **Representativeness of Sample**

The sample utilized for this study may not have been representative of all individuals with dyslexia. In particular, this study’s sample was predominantly male while other studies have indicated that the prevalence rates of dyslexia equally affect both genders. The presence of other learning disabilities and ADHD in the sample may have also affected the results of this study. While the study did not collect data on the relative socioeconomic status of the sample, drawing the sample from a small independent school may indicate that it is not representative of all individuals with dyslexia. Beyond the concerns related to the socioeconomic status of the sample, the nature of this independent school, such as the small classes, extensive tutoring, and intensive learning and study strategy instruction, may have also affected the representativeness of this sample as this sample’s school experience are not comparable to those students in public schools. Overall, this sample may not have been representative of all individuals with dyslexia, but was appropriate for such a pilot study.

### **Suggestions for Future Research**

While the results of this pilot study did not indicate a relationship between self-regulated learning strategies and reading comprehension, the limitations of this study indicate several promising areas for future research to explore the nature of compensatory strategies in individuals with dyslexia. The methods utilized in this study examined the relationship between academic achievement and self-regulated learning strategies. This relationship and other proposed relationships have not been explored in the postsecondary/adult literature. The current research has simply compared average academic achievement or learning strategies and has not explored the relationship between the two. This section is divided into two subsections; the first details potential systematic replications of this study while the second proposes longitudinal research questions.

### **Replication**

Several areas for systematically replicating this study using specific modifications to the procedures, sampling, and instrumentation are offered in this subsection. Specifically, concerns related to the sample size and sampling procedures will be addressed. Potential dependent variables to explore beyond reading comprehension will be offered. Suggestions to improve the instrumentation related to self-regulated learning strategies will also be provided. Finally, a proposed replication with a population that has not been extensively study will be proposed.

**Sample size and sampling concerns.** This study failed to achieve the minimally acceptable statistical power to detect the hypothesized effect size for the proposed model comparison. Thus, a potential future direction for research is to use this study's procedure with a sample of at least 78 participants. In addition, the limitations section of this chapter addressed several concerns related to the representativeness of this sample. To address these concerns, future research should draw random samples from public schools in order to obtain samples that

are more representative. Overall, a replication with a larger and more representative sample will potentially yield a better understanding of self-regulated learning strategies as compensatory mechanisms in individuals with dyslexia.

**Dependent variables.** This study hypothesized a relationship between self-regulated learning strategies and reading comprehension. Reading comprehension was utilized because it served as a proxy of academic achievement and because it represented a variable that would theoretically be challenging for individuals with dyslexia due to their difficulties with phonological processing. By the time some students with dyslexia are in high school, they may have already compensated for their phonological difficulties and thus reading comprehension may not have been an appropriate measure of academic achievement. It is suggested that future research explore grade point average and/or broader measures of academic achievement as dependent variables. In summary, the use of reading comprehension as the sole dependent variable may not have allowed this study to explore self-regulated learning strategies as a compensatory mechanism and the use of additional dependent variables is recommended.

**Instrumentation.** This study utilized the SRSI as a measure of self-regulated learning strategies due to its parsimoniousness. However, the brevity of this measure (28 items) and its three factors may have limited its sensitivity. In addition, the observed reliability for the second factor of this measure did not achieve the recommended minimum value. These concerns indicate that future research should utilize broader measures of self-regulated learning strategies that have more established psychometric properties.

**Middle school students.** As noted earlier in this section, high school students may have already developed compensatory strategies so it may have been difficult to detect the effects of learning and study strategies on reading comprehension. It is suggested that future research

replicate the procedures of this study with a sample of middle school students to explore how self-regulated learning strategies may serve as a compensatory mechanism. This study indicated that SOME secondary students with dyslexia have developed reading comprehension abilities that are comparable to same age peers. Exploring whether middle school students with dyslexia have developed reading comprehension abilities that are comparable to same age peers would be an important contribution to this field. Extending these methods to a different age population also speaks to the importance of conducting longitudinal research on individuals with dyslexia as they develop compensatory strategies.

### **Longitudinal Research into Compensation**

To be able to understand how individuals with dyslexia develop compensatory strategies, it is essential to pursue longitudinal research that does not have the limitations of sampling from different age groups to determine how and when these students develop effective compensation strategies. Exploring the factors that contribute to the reading comprehension abilities of individuals with dyslexia over time is essential to understanding how compensatory mechanisms develop and the relative importance of specific independent variables as compensatory mechanism. A simple study that collected data on oral reading fluency, reading comprehension, cognitive ability, and self-regulated learning strategies over time could explore their relationship. Further, it would allow the exploration of potential mediator and moderator variables. Hoelt and colleagues (2010) found that traditional variables (cognitive and academic variables) did not predict compensation in individuals with dyslexia in a longitudinal study, but functional brain imaging did predict compensation. Another potential direction for future research into compensation would be to add self-regulated learning strategies to the variables explored by

Hoelt and colleagues (2010). Overall, this study provided several potential future research questions exploring the nature of compensation in individuals with dyslexia.

### **Summary**

This dissertation explored the relationship of self-regulated learning strategies as a potential compensatory mechanism for secondary students with dyslexia. Specifically, the relationship between self-regulated learning strategies and reading comprehension after controlling for cognitive ability and oral reading fluency was investigated. Reading comprehension was chosen as a proxy of academic achievement. This study found that cognitive ability was the only significant predictor of reading comprehension. While this study did not find that self-regulated learning strategies were a significant predictor of reading comprehension over and above cognitive ability and oral reading fluency, it did demonstrate that the sample's reading comprehension was comparable to same age peers using the standard administration of the instrument. The theoretical importance of this finding is that it indicates that compensatory strategies are developed before students enter high school. Issues related to instrumentation and sample size were noted as limitations of this study. Potential areas systematic replication of this study addressing these limitations and potential longitudinal research question to explore the nature of compensatory mechanisms in individuals with dyslexia were offered as suggestions for future research.

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## **APPENDICES**

**Appendix A: Self-Regulation Strategy Inventory—Self-Report (Adapted from Cleary, 2006)**

For each of the following statements, please rate how often you agree with the following statements by checking the appropriate box. Please select only one response choice per question (see example below).

		Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
	Example	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	I finish all of my studying before I play video games or with my friends.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	I study hard even when there are more fun things to do at home.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	I think about the types of questions that might be on a test.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	I tell myself to keep trying when I can't learn a topic or idea.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	I use binders or folders to organize my study materials.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>





