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Descriptive Study of Reading Comprehension Skills in Individuals with Down Syndrome

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DESCRIPTIVE STUDY OF READING COMPREHENSION SKILLS IN INDIVIDUALS WITH DOWN SYNDROME

By
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A thesis submitted to the faculty of The University of Mississippi in partial fulfillment of the requirement of the Sally McDonnell Barksdale Honors College.

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DEDICATION

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ABSTRACT

KATHERINE JEAN HUBBARD: Reading Comprehension Skills
in Individuals with Down syndrome
(Under the direction of Dr. Susan Loveall)

Problem Statement: Previous research has documented that individuals with Down syndrome are able to read and have identified strengths and weakness demonstrated within the reading domain, but research on their reading comprehension abilities is scarce.

Purpose: The purpose of this study was to analyze strengths and weaknesses of reading comprehension in individuals with Down syndrome, including within the word identification and language comprehension subdomains.

Methods: Reading comprehension, word identification, phonological decoding, language comprehension, vocabulary, and syntax were the dependent variables in this study. Nine standardized assessments/subtests were used to measure these variables in 11 adolescents and adults with Down syndrome.

Results: The results of this study revealed relative strengths in word identification, phonological decoding, and vocabulary. Weaknesses were found in reading comprehension, language comprehension, and syntax. Significant correlations were found between language comprehension and reading comprehension.

Discussion: The results of this study suggest that language comprehension may have a strong impact on reading comprehension success in individuals with Down syndrome.

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LIST OF ABBREVIATIONS

CASL-2	Comprehensive Assessment of Spoken Language—2nd Edition
DS	Down syndrome
IQ	Intelligence Quotient
KBIT-2	Kaufman Brief Intelligence Test—2nd Edition
LC	Listening Comprehension
OWLS-II	Oral and Written Language Scales—2nd Edition
PC	Passage Comprehension
PPVT-4	Peabody Picture Vocabulary Test—4th Edition
SC	Sentence Comprehension
SRS-2	Social Responsiveness Scale—2nd Edition
TACL-4	Test of Auditory Comprehension of Language—4th Edition
UA-IDPR	University of Alabama Intellectual Disability Participant Registry
VK	Verbal Knowledge
NVK	Nonverbal Knowledge
WA	Word Attack
WC	Word Comprehension
WRMT-III	Woodcock Reading Mastery Tests—3rd Edition
WID	Word Identification

Chapter I

INTRODUCTION

Individuals with Down syndrome are living longer and achieving greater academic and independent living outcomes than ever before (see Channell & Loveall, 2018). However, many adolescents and young adults with Down syndrome desire greater independence, especially in employment opportunities and residential arrangements (Scott, Foley, Bourke, Leonard, & Girdler, 2013). Strong reading skills are one such way to help individuals with Down syndrome achieve this independence. While it was once believed that individuals with intellectual disabilities could not learn to read, (Singh & Singh, 1986), we now know that individuals with Down syndrome can successfully learn to read (Roch, Florit, & Levorato, 2011; Loveall & Conners, 2016). However, research on reading comprehension itself, the ultimate goal of reading (Catts & Kamhi, 1999), is scarce. The purpose of this study, therefore, was to investigate reading comprehension abilities, including its reading and linguistic subskills, in individuals with Down syndrome.

Down syndrome

Down syndrome is a neurodevelopmental disability caused by the triplication of chromosome 21 and is the leading genetic cause of intellectual disability (Centers for Disease Control and Prevention, 2006). Down syndrome is associated with a fairly unique phenotypic profile that includes patterns of strength and weakness across behavioral, cognitive, and linguistic domains, even relative to others with intellectual

disability (Abbeduto, Warren, & Conners, 2007, Chapman, 1997; Ricketts, 2011). Nonverbal skills are typically stronger than verbal skills, with relative strengths in adaptive functioning, social skills, and some aspects of visual processing, (Conners, Moore, Loveall, & Merrill, 2011; Fidler, 2005; Yang, Conners, & Merrill, 2014). Linguistically, individuals with Down syndrome have relative strengths in vocabulary and notable difficulties with syntax (Abbeduto, Warren, & Conners, 2007; McDuffie, Thurman, Channell, & Abbeduto, 2017). It is unknown, however, if this linguistic profile impacts reading development.

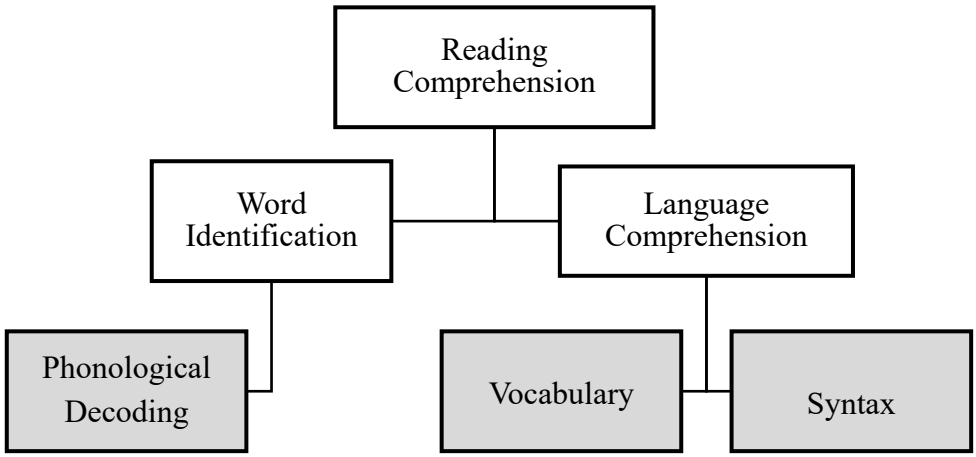
Typical Reading Development

According to the Simple View of Reading (Hoover & Gough, 1990), reading comprehension is the mathematical product of word identification and listening comprehension abilities. Word identification is the ability to identify printed words (Kamhi, Allen, & Catts, 2001). Language comprehension, in contrast, is the ability to understand the meaning of words (Kamhi et al., 2001). To become a skilled reader, an individual needs both strong word identification and strong language comprehension skills (Hoover & Gough, 1990; Ricketts, 2011). If either of these skills are absent, reading comprehension will not develop.

Although the Simple View of Reading (Hoover & Gough, 1990) has been used a model to describe the process of reading comprehension success, it fails to incorporate additional linguistic and cognitive subskills that contribute to word identification and language comprehension (Francis, Kulesz, & Benoit, 2018). Therefore, the original model has been expanded by several researchers to identify additional subskills that ultimately contribute to reading comprehension (Catts, 2018; Francis, Kulesz, & Benoit,

2018). In the current study, we will analyze phonological decoding, a subskill of word identification, as well as vocabulary and syntax, which are subskills of language comprehension.

Figure 1
Simple View of Reading, with Expanded View in Gray



In terms of word identification, phonological decoding is an important component of learning to identify printed words (Gough & Tunmer, 1986). Phonological decoding is the process of sounding out printed words by applying letter-sound correspondences in order to translate novel or unfamiliar words into speech (Fowler, Doherty, and Boynton 1995). Research on phonological decoding has indicated it is a significant, unique predictor of both word identification (Channell, Loveall, & Conners, 2013) and reading comprehension abilities (Catts, 2018).

The linguistic skills necessary for reading comprehension success include syntax and vocabulary. Vocabulary is the knowledge of the meaning of words, while syntax is understanding sentence modality and construction (Laws, Brown, & Main, 2016;

Chapman, Schwartz, & Bird, 1991). Limited vocabularies and syntactic skills can prevent individuals from understanding the meaning behind text, even if they can identify the printed words (Vellutino, Tunmer, Jaccard, & Chen, 2007).

While both word identification and language comprehension and their subskills are important, the relative impact of each on reading comprehension changes across development (Gough, Hoover, & Peterson, 1996; Vellutino et al., 2007). Decoding is particularly important in early grades when individuals are learning to coordinate letter-sound correspondences to identify printed words, that is are "learning to read". In later stages of reading development though, language comprehension becomes more important as individuals are expected to be "reading to learn", and materials involve higher-level vocabulary and more complex syntax (Catts, 2018).

Reading Skills in Down syndrome

Research to-date on reading skills in Down syndrome suggests a unique pattern of strengths and weaknesses. Notably, there have been documented strengths in word identification, despite seemingly great difficulties with phonological decoding (Hulme, Goetz, Brigstocke, Nash, Lervag, & Snowling, 2012). As previously noted, research has also identified that difficulties with syntax are common in Down syndrome, in contrast with relatively strong vocabulary skills (Chapman, Seung, Schwartz, & Bird, 1998). However, there has been very little research on reading comprehension in this population, including on how these linguistic subskills impact reading comprehension outcomes. Below, we outline research on each individual subskill.

Reading Comprehension. While scarce, research suggests that individuals with Down syndrome struggle with reading comprehension relative to typically developing

individuals matched on word identification ability and reading age (Laws, Brown & Main, 2015; Verucci, Menghini, & Vicari, 2006). Boudreau (2002) also found reading comprehension to be difficult for participants with Down syndrome, with only 9 of 20 participants in her study scoring at least one on her task. However, given the paucity of research on reading comprehension in Down syndrome, it is unknown if and how the reading and linguistic subskills that predict reading comprehension success in typical development also apply to Down syndrome.

Word Identification. A majority of the research that is available on reading in Down syndrome has focused on a seemingly isolated strength in word identification abilities despite difficulties with phonological decoding (Hulme et al., 2012). For example, in Boudreau's (2002) study 20 participants with Down syndrome were matched to typically developing peers on nonverbal mental age and assessed on reading abilities, phonological awareness, verbal memory, and language. Participants with Down syndrome scored poorly on reading comprehension and decoding but significantly better on word identification in comparison to the typically developing matched peers. These findings suggest that individuals with Down syndrome may be reading individual words without matching letters to sounds, that is they are memorizing whole sight words and not learning to sound out new or unfamiliar words via phonological decoding (Hulme et. al, 2012).

Language Comprehension. As noted, individuals with Down syndrome often have difficulties with language, beginning at an early age with the acquisition of first words (Rondal, 2003; Abbeduto, Warren, & Conners, 2007). Delays in language, particularly expressive language, then persist throughout childhood (Chapman et al.,

1998). As they age, individuals with Down syndrome often demonstrate weaknesses in syntactic abilities when compared to vocabulary level (Abbeduto et al., 2007; Chapman et al., 1998). However, there also appears to be a discrepancy between receptive and expressive vocabulary, with much stronger receptive than expressive abilities (Chapman et al., 1998; Chapman, Schwartz, & Bird, 1991).

Despite the plethora of research examining language outcomes in Down syndrome, there has been little research examining if and how language impacts reading comprehension in this population. A few studies have documented direct, systematic relationships between language and reading comprehension (e.g., Ricketts, 2011), but more research is needed to fully understand this nuanced relationship. Given the lack of research on reading comprehension as a whole and the unique patterns of reading and language strengths and weaknesses observed in Down syndrome, it is unknown if the Simple View also applies to this population.

Current Study

Much of the available research on reading comprehension in Down syndrome has focused on the word identification domain of the Simple View (Hoover & Gough, 1990). While word identification and phonological decoding are two major predictors of reading comprehension success, the research on these subskills has overshadowed research on the language comprehension domain. Many individuals with Down syndrome present relative strengths in word identification and vocabulary skills but weaknesses in measures of decoding and syntax (Verucci, Menghini, & Vicari, 2006; Abbeduto, Warren, and Conners, 2007; Ricketts, 2011). Research on typical reading development suggests that these skills may impact reading comprehension abilities. However, no research to date

has examined each of these subskills or provided evidence to support any causal relationships (Boudreau, 2002). The purpose of this study was to examine reading comprehension and its subskills in Down syndrome, including both word identification and listening comprehension domains.

To explore reading comprehension in Down syndrome, we posed the following research questions:

1. How do individuals with Down syndrome perform on standardized measures of reading comprehension, word identification, and listening comprehension?
2. How do individuals with Down syndrome perform on other subsequent word identification (phonological decoding) and linguistic (vocabulary and syntax) subskills?
3. Do these subskills correlate with reading comprehension in Down syndrome?

We hypothesized that:

1. Participants with Down syndrome would demonstrate relative strengths in word identification and weaknesses in listening comprehension and reading comprehension.
2. Participants with Down syndrome would demonstrate strengths in vocabulary and weaknesses in phonological decoding and syntax.
3. Phonological decoding, vocabulary, and syntax would correlate with reading comprehension in Down syndrome, and that language skills would be particularly strong correlates of reading comprehension success.

Chapter II

METHODS

Design

This study utilized a descriptive, within-group design, focusing on the reading comprehension abilities of individuals with Down syndrome. The dependent variables were reading comprehension (word comprehension and passage comprehension), word identification, phonological decoding, language comprehension, vocabulary, and syntax. All dependent variables were measured through the use of standardized assessments.

Participants

Recruiting. For this study, participants were recruited from parent support, social, and educational groups and organizations in and around Oxford, MS, and Memphis, TN. Participants were also recruited through the University of Alabama Intellectual Disability Participant Registry (UA-IDPR).

Inclusion/Exclusion Criteria. The criteria for participation in this study included parent/caregiver report of the following: Down syndrome diagnosis, verbal (i.e., uses speech as main way to communicate), some level of reading ability including reading comprehension capabilities, and no serious hearing or visual impairments that would impact the ability to complete study tasks. Participants also had to achieve a score of at least one or more on the Word Comprehension or Passage Comprehension subtest to be included in data analysis.

Demographics. A total of 13 participants participated in this study, and 11 participants were included in data analysis. Two participants received a score of 0 on both the word comprehension and passage comprehension subtests and were excluded from data analysis. The remaining participants ranged in age from 16-36 years. There were 8 females, 3 males and the participants were 90.9% Caucasian and 9.1% African American. Nine participants had completed high school, and two were still enrolled. Table 2 reports participant characteristics, including scores from IQ (i.e., KBIT-2) and social behavior (i.e., SRS-2) assessments.

Table 1
Participant Characteristics

	M	*SD*	*Range*
Chronological Age	24.42	7.08	16:2- 36:9
SRS-2 Raw Score	34.8	23.36	8-80
SRS-2 T-Score	51.9	10.14	41-72
KBIT-2 Verbal Raw Score	23.91	5.05	13-31
KBIT-2 Verbal Standard Score	51.73	8.83	40-63
KBIT-2 Verbal Age-Equivalent	7.38	1.28	4:10-9:3
KBIT-2 Nonverbal Raw Score	16.73	3.55	10-25
KBIT-2 Nonverbal Standard Score	52	9.21	40-74
KBIT-2 Nonverbal Age Equivalent	5.5	1.05	3:11-8:3
KBIT-2 IQ	47.36	5.75	40-61

**Note: SRS-2 Scores are out of 10 participants*

Measures

Parent Measures.

Background Questionnaire. Parents were asked to fill out a brief questionnaire about their child's date of birth, sex, current grade level, highest completed education level, high school completion date, and race and ethnicity.

Social Behaviors and Autism Symptomatology: (15-20 minutes). The Social Responsiveness Scale—2nd Edition (SRS-2; Constantino & Gruber, 2012) was used to measure symptoms associated with autism. This standardized assessment is 65 items and uses a Likert-scale to assess behaviors exhibited in the last six months. For the current study, the School-Age Parent Report form was used and completed by the parent or caregiver. Raw scores and T-scores (i.e., standard scores based on chronological age and sex) were used in data analysis. Higher T-scores indicate a greater degree of difficulty. T-scores from 60-65 are considered mild, 66-75 are considered moderate, and 76-90+ are considered severe (SRS-2; Constantino & Gruber, 2012). The internal-consistency reliability coefficients of the SRS-2 School-Age Parent Report Form had a mean of .95. Studies comparing the SRS-2 to the Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2001) have reported correlation coefficients with a mean of .63 (Bölte, Poustka, & Constantino, 2008; Charman et al., 2007)

Participant Assessments.

IQ (15-30 minutes). The Kaufman Brief Intelligence Test, Second Edition (KBIT-2; Kaufman & Kaufman, 2014) was used to measure nonverbal and verbal intelligence. The test is normed for ages 4-90 years and yields three types of scores: Verbal, Nonverbal, and Overall IQ. Verbal abilities are determined via two subtests: Verbal

Knowledge and Riddles. Nonverbal abilities are determined via the Matrices subtest. Verbal and Nonverbal scores can also be combined into an overall IQ composite. For this study, raw scores, standard scores, and age-equivalent scores were used to describe the sample of participants. The KBIT-2 has good internal consistency, ranging from .86-.93 for the full test, and good test-retest reliability, ranging from .83-.91 for the full test (KBIT-2; Kaufman & Kaufman, 2014). The KBIT-2 also correlates with the Wechsler Intelligence Scale for Children-Fourth Edition with a mean of .71 for Nonverbal Intelligence, .83 for Verbal Intelligence, and .86 for IQ (WASI; Weschler, 1999).

Word Identification (5 minutes). The Word Identification subtest, Form B, of the Woodcock Reading Mastery Tests—3rd Edition (WRMT-III; Woodcock, 2011) was used to measure word identification skills. The subtest measures an examinee's ability to read aloud individually printed words that increase in difficulty as the examinee progresses through the task. The examinee is not required to know the meaning of the identified word. This subtest was audio recorded due to concerns with poor articulation or intelligibility. Raw, standard, age-equivalent, and growth score values (GSV; i.e., raw scores weighted for item difficulty) were used in data analysis. For the Word Identification subtest, the split-half reliability coefficient has a mean of .92 across ages 4-79 years for Form B (WRMT-III; Woodcock, 2011). The WRMT-III correlates with the Woodcock-Johnson Tests of Achievement (WJ-III; Woodcock, McGrew, & Mather, 2001) .69 for word identification in grades 7-12 (WRMT-III; Woodcock, 2011).

Phonological Decoding (5 minutes). The Word Attack subtest, Form B, of the Woodcock Reading Mastery Tests—3rd Edition (WRMT-III; Woodcock, 2011) was used to measure phonological decoding skills. This subtest requires examinees to read

individually printed nonsense words (e.g., “ree”) aloud that increase in difficulty. The use of nonsense words allows the test to examine the examinee’s ability to read or sound out words they are unfamiliar with. For this subtest raw, standard, age-equivalent, and GSV scores were used in data analysis. For the Word Attack subtest, the split-half reliability coefficients have a mean of .87 for Form B across ages 4-79 years (Woodcock, 2011). The WRMT-III correlates with the Woodcock-Johnson Tests of Achievement (WJ-III; Woodcock, McGrew, & Mather, 2001) at .55 for Word Attack in grades 7-12 (WRMT-III; Woodcock, 2011).

Scores from both the Word Identification and Word Attack subtests can also be used to calculate an overall Basic Skills Cluster. From the cluster, raw, standard, age-equivalent, and GSV scores were used in data analysis. The split-half reliability coefficients have a mean of .94 across ages 4-79 years for Form B. The cluster also correlates with the Woodcock-Johnson Tests of Achievement (WJ-III; Woodcock, McGrew, & Mather, 2001) at .68 for grades 7-12 (WRMT-III; Woodcock, 2011).

Basic Reading Comprehension Skills (15-20 minutes). Reading comprehension was measured via two separate tasks in the WRMT-III: Word Comprehension and Passage Comprehension (WRMT-III; Woodcock, 2011). Both used Form B. The Word Comprehension subtest consists of three sections: Antonyms, Synonyms, and Analogies, and takes approximately 10 minutes to administer. The Antonym section requires examinees to read aloud a printed word and then provide an antonym (e.g. “big – <u>little</u>”). The Synonym section of the subtest requires examinees to read aloud a printed word and then provide a synonym (e.g. “look – <u>see</u>”). For the Analogies section, examinees are required to read aloud a pair of words and ascertain the relationship between the pair of

words. They then read the first word of a second pair and supply a word to complete the analogy appropriately (e.g. “snow—cold; sun—hot”; WRMT-III; Woodcock, 2011). Scores from Synonyms, Antonyms, and Analogies are summed to create a total raw score for Word Comprehension. For this subtest, the split-half reliability coefficients have a mean of .94 across ages 4-79 years for Form B (WRMT-III, Woodcock, 2011).

The Passage Comprehension subtest of the WRMT-III was the second subtest used to measure reading comprehension skills. The test takes approximately 5-10 minutes to administer. This subtest requires the examinee to read a sentence or short passage silently and identify a missing word. It measures the examinee’s reading ability, as well as their ability to comprehend the entire passage. For the Passage Comprehension subtest, the split-half reliability coefficients have a mean of .86 across ages 4-79 years for Form B (WRMT-III; Woodcock, 2011).

For both the Word Comprehension and Passage Comprehension subtests, raw, standard, age-equivalent, and GSV scores were used in data analysis. The WRMT-III Word Comprehension and Passage Comprehension subtests correlate with the Woodcock-Johnson Tests of Achievement’s Passage Comprehension (WJ-III; Woodcock, McGrew, & Mather, 2001) subtest at .71 for grades 7-12 (Woodcock, 2011).

Scores from both subtests can also be used to calculate an overall Reading Comprehension Cluster. From this cluster, raw, standard, age-equivalent, and GSV scores were used in data analysis. For the Reading Comprehension Cluster, the split-half reliability coefficients have a mean of .94 across ages 4-79 years for Form B (Woodcock, 2011). The Reading Comprehension Cluster also correlates with the Woodcock-Johnson

Tests of Achievement (WJ-III; Woodcock, McGrew, & Mather, 2001) at .86 (WRMT-III; Woodcock, 2011).

Language Comprehension (15 minutes). The Listening Comprehension Scale, Form A, of the Oral and Written Language Scales—2nd Edition (OWLS-II; Carrow-Woolfolk, 2011) was used to measure language comprehension. For this subtest, examinees are required to listen to words, phrases, and brief passages spoken by the experimenter and point to the picture that best depicts the meaning. This test examines vocabulary and grammar skills and requires the examinee to comprehend what they heard. For this subtest raw, standard, and age-equivalent scores were used in data analysis. The internal consistency reliability coefficient of this subtest is .84 and the test-retest reliability coefficient is .73-.80 (OWLS-II; Carrow-Woolfolk, 2011). The OWLS-II Listening Comprehension subtest correlates with the original Oral and Written Language Scales (OWLS; Carrow-Woolfolk, 1996) at .78 (OWLS-II; Carrow-Woolfolk, 2011).

Vocabulary (10-15 minutes). The Peabody Picture Vocabulary Test—4th Edition, Form A, (PPVT-4; Dunn & Dunn, 2007) was used to measure vocabulary. Examinees are required to point to the picture that best depicts an individual word spoken by the examiner. The test increases in difficulty and is organized into sets based on chronological age. Raw, standard, age-equivalent, and GSV scores were used in data analysis. The split-half reliability coefficients for the age norm and grade norm samples are high and average .94-.95 for each form (PPVT-4; Dunn & Dunn, 2007). The PPVT-4 correlates with the Expressive Vocabulary Test—Second Edition (EVT-2; Williams, 2007) with a mean of .82 (PPVT-4; Dunn & Dunn, 2007).

Syntax (10 minutes). The Sentence Comprehension subtest of the Comprehensive Assessment of Spoken Language—2nd Edition (CASL-2; Carrow-Woolfolk 2017) was used to measure syntax. For this test, examinees are required to point to a picture that best describes a sentence spoken by the examiner. Raw, standard, and age-equivalent scores were used in data analyses. The split-half reliability for this subtest is .90- .97 for the age range of the current study. The test re-test reliability is .86 (CASL-2; Carrow-Woolfolk, 2017). The Sentence Comprehension subtest correlates with the OWLS-II Listening Comprehension subtest (OWLS-II; Carrow-Woolfolk, 2011) at .73 (CASL-2; Carrow-Woolfolk, 2017).

Procedure

Testing. This study was approved by the University of Mississippi's Institutional Review Board (IRB). Individuals who wished to participate and who passed the parent reported inclusion/exclusion criteria were scheduled for testing. Testing took place in a quiet room free of distractions in a laboratory setting on campus, at the individual's home, or another location of their choosing (e.g. their local Down syndrome group office). When the participant arrived, the parent/primary caregiver and participant were briefed on the different elements of the study, including the tests, procedures, and purpose. The parent/primary caregiver was then given a consent form to sign. For participants over the age of 18, both parents/primary caregivers and adult participants signed the informed consent. For participants under the age of 18, only parents/primary caregivers signed the informed consent, and participants were asked to give verbal assent.

The parent was then briefed on completing the background questionnaire and SRS-2 while the participant began testing. Testing took approximately 2 hours, and

participants were given breaks as needed. The subtests from the WRMT-III were administered first followed by the KBIT-2 and then remaining tasks were administered in a predetermined, counterbalanced order depending on participant number. For measures requiring a verbal response, testing was audio-recorded to allow for double-scoring and reliability checks. Verbal encouragement from the examiner was used to encourage and motivate participants. Following testing, participants were debriefed and given a $30 gift card as an incentive for participating.

Chapter III

RESULTS

Descriptives

Descriptive statistics (means, standard deviations, and ranges) for all dependent variables for raw, standard, age-equivalent, and GSV scores are shown in Tables 2, 3, 4, and 5. The PPVT-4 scores only include 10 of the 11 participants due to an administration error.

For raw scores, the Passage Comprehension subtest of the WRMT-III had the lowest mean and least amount of variability. Participants also had low scores on the Word Comprehension subtest, with particularly low scores on the Synonyms portion of the subtest. In fact, Synonyms and Antonyms were the only tasks that some participants were not able to score on at all. In contrast, all participants were able to score on all other reading tasks and on all language tasks. See Table 2.

Examining standard scores, the Sentence Comprehension subtest of the WRMT-III had the lowest mean standard score and also had zero variability. All participants had a standard score of 40, despite a relatively large range in raw scores. In contrast, the Word Attack subtest had the highest mean standard score followed by Word Identification. The mean standard score for the Word Comprehension and Passage Comprehension subtests were nearly identical and both had low variability in raw and standard scores. The standard score for the Basics Skills Cluster, which includes the Word Identification and Word Attack subtests, had a higher standard score than the

Reading Comprehension Cluster, which included the Word Comprehension and Passage Comprehension subtests. See Table 3.

Table 2
Raw Score Means, Standard Deviations, and Ranges on Dependent Variables

	M	*SD*	*Range*
Word Comprehension	13.82	6.43	4-25
WC Antonyms	5	2.86	0-9
WC Synonyms	1.64	2.01	0-6
WC Analogies	7.18	3.31	2-12
Passage Comprehension	9.55	3.42	4-15
Word Identification	24.91	4.09	20-32
Word Attack	11.73	6.02	1-22
Listening Comprehension	57.82	14.59	31-74
PPVT-4	129.1	19.64	93-162
Sentence Comprehension	28.45	7.38	16-38

**Note: PPVT-4 scores are out of 10 participants*

Table 3
Standard Score Means, Standard Deviations, and Ranges on Dependent Variables

	M	*SD*	*Range*
Word Comprehension	55.36	1.21	55-59
Passage Comprehension	55.64	1.50	55-60
Reading Comprehension Cluster	55.09	0.30	55-56
Word Identification	59.27	6.42	55-75
Word Attack	64.36	13.35	55-96
Basic Skills Cluster	61	9.04	55-84
Listening Comprehension	42.91	4.83	40-52
PPVT-4	56.1	10.97	35-74
Sentence Comprehension	40	0	40

**Note: PPVT-4 scores are out of 10 participants*

For age-equivalent scores, the Sentence Comprehension subtest had the lowest group mean. With the exception of PPVT-4 scores, participants had higher age-equivalent scores on reading tasks than on language tasks. The highest age-equivalent score was on Word Identification, at 9 years, 2 months. The Word Attack subtest had the widest range in age-equivalent scores, with a 10-year span. The Word Comprehension, Passage Comprehension, and Reading Comprehension age-equivalent scores were almost uniform. Participants also appeared to be at a very similar level across all three measures, indicated by low variability in scores. Due to the fact that the CASL-2 reports age-equivalent score as an age range, we reported the age-equivalent scores as a range of means. The range includes the mean of the first reported age-equivalent scores to the mean of the second age-equivalent scores reported. Also, for any age-equivalent scores that were in written in terms of less than (e.g. "< start-age" or "<6:0"), an age-equivalent score of one month less than the reported age-equivalent was used. See Table 4.

Table 4
Age-Equivalent Means, Standard Deviations, and Ranges on Dependent Variables

	M	*SD*	*Range*
Word Comprehension	7.36	0.81	6:4-9:0
Passage Comprehension	7.24	0.65	6:4-8:6
Reading Comprehension Cluster	7.30	0.71	6:3-8:6
Word Identification	9.18	1.30	7:10-11:9
Word Attack	8.70	2.90	6:1-16:1
Basic Skills Cluster	8.83	1.65	7:1-12:8
Listening Comprehension	5.95	1.13	3:11-7:4
PPVT-4	8.2	1.57	5:9-11:4
Sentence Comprehension	5.93-6.10		

**Note: PPVT-4 Scores are out of 10 participants*

Growth score values were only available for WRMT-III tasks and for the PPVT-4. Across the WRMT-III tasks, Passage Comprehension had the lowest group mean, and Word Identification had the highest. See Table 5.

Table 5
Growth Score Value Means, Standard Deviations, and Ranges on Dependent Variables

	M	*SD*	*Range*
Word Comprehension	475.45	13.34	452-496
Passage Comprehension	465.55	14.97	440-489
Reading Comprehension Cluster	470.91	13.44	449-490
Word Identification	492.45	18.90	469-524
Word Attack	482.18	23.61	430-518
Basic Skills Cluster	487.55	19.78	452-521
PPVT-4	162	13.67	137-185

**Note: PPVT-4 scores are out of 10 participants*

Correlations

Next, Pearson *r* correlations were used to examine the relationship between reading comprehension and reading and linguistic subskills. Raw scores were used for correlations because they were available for all subtests and provided the greatest sensitivity and variability in participant performance. KBIT-2 (IQ, verbal raw, and nonverbal raw) and SRS (raw) scores were also included in correlations. Word Comprehension correlated significantly with Verbal Knowledge, Passage Comprehension, Listening Comprehension, and the PPVT-4. Passage Comprehension correlated significantly with Verbal Knowledge, Word Comprehension, Sentence Comprehension, and the PPVT-4. Correlations between the measures of reading

comprehension and the measures of word identification and phonological decoding were much weaker. Table 6.

Table 6
Correlations Among Key Variables

	SRS	V	NV	IQ	WC	PC	WID	WA	LC	PPVT	SC
SRS	-										
V	-.271	-									
NV	-.209	.423	-								
IQ	-.269	.698*	.813**	-							
WC	-.378	.745**	.383	.564	-						
PC	-.137	.728*	.401	.600	.806**	-					
WID	.339	.398	.108	.376	.266	.176	-				
WA	-.079	.362	.342	.497	.353	.271	.764**	-			
LC	-.034	.662*	.369	.625*	.672*	.528	.523	.631*	-		
PPVT	-.367	.939**	.578	.787**	.691*	.711*	.232	.263	.564	-	
SC	-.062	.684*	.066	.354	.533	.675*	.396	.543	.685*	.645*	-

* $p <$ 0.05. ** $p <$ .01.
Note: V= KBIT-2 Verbal; NV= KBIT-2 Nonverbal; WID= Word Identification; WA= Word Attack; WC= Word Comprehension; PC= Passage Comprehension; LC= Listening Comprehension; SC= Sentence Comprehension

Chapter IV

DISCUSSION

The purpose of this study was to analyze strengths and weaknesses in reading comprehension and its subskills in individuals with Down syndrome. We examined an Expanded Simple View of Reading, including reading comprehension, word identification, decoding, language comprehension, vocabulary, and syntax in eleven adolescents and adults with Down syndrome. We hypothesized that individuals with Down syndrome would display relative strengths in word identification and vocabulary and relative weaknesses in reading comprehension, decoding, language comprehension, and syntax. We chose to examine performance on raw, standard, age-equivalent, and GSV (when available) scores to fully describe participant performance. We also hypothesized that these reading and linguistic subskills would correlate with reading comprehension ability.

Performance across Tasks

The data from this study appears to support both the Simple View of Reading (Hoover & Gough, 1990) and the Expanded Simple View of Reading, while also highlighting phenotypic strengths in individuals with Down syndrome. As we hypothesized, participants scored poorly on measures of reading comprehension in comparison to their scores on measures of word identification and vocabulary when examining standard and age-equivalent scores. The average standard and age-equivalent

scores from the Word Comprehension and Passage Comprehension subtests were higher than scores from the Listening Comprehension and Sentence Comprehension subtests. However, when examining raw scores, the participants had the lowest scores on both the Word Comprehension and Passage Comprehension subtests.

As hypothesized, participants performed well on the Word Identification subtest. The subtest had the highest average raw score from the WRMT-III, as well as the highest average GSV and age-equivalent score. However, unexpectedly, participants also performed well on the phonological decoding task. The Word Attack subtest had the highest average standard score, as well as the second highest average GSV and age-equivalent score in comparison to the other subtests.

In contrast to strong performances in the word identification domain, participants did not perform well on language comprehension. In comparison to standard scores from the Word Identification and Reading Comprehension measures, Listening Comprehension had the lowest average and range of standard scores as well as the lowest average age-equivalent score. Within the language comprehension domain, as hypothesized, participants performed well on the measure of vocabulary, but not as well on the measure of syntax. In comparison to Listening Comprehension and Sentence Comprehension, the PPVT-4 had the highest average standard and age-equivalent score. The Sentence Comprehension subtest had the lowest average standard score and also was the only subtest where every participant received the same standard score.

Results on reading comprehension, language comprehension, and syntax were consistent with previous research documenting these skills to be weaknesses, with syntax being the most impaired (Abbeduto et al., 2007; Chapman et al., 1998). Results on

measures of word identification and vocabulary were also relatively consistent with current research. Word identification was found to be a strength and the age-equivalent scores yielded a range that is slightly older than a typical first-grader which is consistent with many current studies with a reading age matched typically-developing comparison group (Roch & Levorato, 2009; Hulme et al., 2012). Vocabulary skills were also found to be a relative strength in comparison to language comprehension and syntax skills (Chapman et al., 1998; Chapman, Schwartz, & Bird, 1991). The results for phonological decoding, in contrast, were less consistent with previous research that has documented decoding skills to be a weakness in individuals with Down syndrome in comparison to their level of word identification skills (Boudreau, 2002; Loveall & Conners, 2016).

Correlations

The correlations found between the reading comprehension measures used in this study were particularly interesting. Significant correlations were found between the Word Comprehension subtest and the Verbal score from the KBIT-2, the Listening Comprehension subtest, and the PPVT-4. Significant correlations were also found between the Passage Comprehension subtest and the Verbal score from the KBIT-2, the Sentence comprehension subtest, and the PPVT-4. No significant correlations were found between the measures of reading comprehension and measures of word identification or decoding. Ultimately, reading comprehension was found to be more strongly correlated with the language comprehension domain versus with reading subskills. This result makes sense due to the fact that language skills are more important to reading comprehension success at later reading developmental periods (Gough, Hoover, & Peterson, 1996; Vellutino et al., 2007).

Implications

The results of this study show the need for more research on literacy in individuals with Down syndrome. They also suggest that improving language comprehension skills may be beneficial to reading comprehension success for individuals with Down syndrome, at least for adolescents and adults with Down syndrome who have achieved basic levels of word identification. Syntax, in particular, emerged as an area of weakness that should be targeted in therapy.

Limitations and Future Directions

There are several limitations to note in the present study. The small sample size and large age range decrease the ability to generalize these findings to the general population. A future study could analyze a larger sample size with a narrower age range to allow for better generalizability. The short time frame of this study also did not allow for the ability to analyze these skills over time. A longitudinal study examining how these skills develop over time may provide more information on developmental changes in these skills. Further, some of the assessments used were outside of the normative age range of the sample size and/or had little sensitivity at the low end of the task. This shows the need for more sensitive measures for individuals with intellectual disabilities. Finally, we did not have a way to measure the participants' educational histories, including reading instruction. Some participants may have been taught through sight words, while others may have had instruction that emphasized phonics. It is important that future research looks at the impact of how reading is being taught because the results could also provide insight into how to improve these skills from an early age.

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