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The Associations of Reading Prosody Components with Fluency and Comprehension for Typically Developing Students and Students with Autism in Grades 4-6

A Dissertation submitted in partial satisfaction
of the requirements for the degree of

Doctor of Philosophy

in

Education

by

Aya Shhub

June 2023

Dissertation Committee:
Dr. Michael Solis, Chairperson
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2023

The Dissertation Aya Shhub is approved:

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Committee Chairperson

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ABSTRACT OF THE DISSERTATION

The Associations of Reading Prosody Components with Fluency and Comprehension for Typically Developing Students and Students with Autism in Grades 4-6

by

Aya Shhub

Doctor of Philosophy, Graduate Program in Education
University of California, Riverside, 2023
Dr. Michael Solis, Chairperson

A key characteristic of individuals with autism is communicative dysfunction. Specifically identifying the appropriate use of pragmatic skills such as phrasing and syntax. When looking at expressing phrasing (producing of word groups), communication research has highlighted a significant group difference between students with autism and typically developing student in upper elementary grades. Although reading frameworks such as the Reading Systems Framework (adapted) have highlighted the importance of phrasing across reading development, it remains an understudied concept specifically when it relates to upper elementary grade typically developing students and students with autism. The current study investigates the associations of phrasing, reading rate, comprehension, and student group (i.e., typically developing students and autism) in grades 4 through 6 using both spectrographic analysis and the Multidimensional Fluency Scale (adapted). A secondary analysis of three previous data sets was conducted. Standard multiple regression findings indicated that, phrasing was statistically significant for the prediction of reading rate (p<0.05) but not for reading

comprehension. The addition of the independent variables (i.e., phrasing, student group, comprehension) into the regression model explained 28% (MDFS) and 50% (spectrograph) of the variability of rate outcomes. The addition of the independent variables (i.e., phrasing, student group, rate) into the regression model explained 14% (MDFS and spectrograph) of the variability of comprehension outcomes. Overall, findings from the current study indicate a correlation between phrasing, reading rate, and reading comprehension outcomes.

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CHAPTER I

INTRODUCTION

Within research and practice, fluent reading has been described as an essential aspect of overall reading development (Hudson et al., 2020). Although the construct of reading fluency is often defined differently across the literature, there are three key and consistent components included: text reading accuracy, text reading speed, and reading prosody (Hudson et al., 2020). The component of reading prosody is understudied compared to the other two reading fluency components (i.e., accuracy and speed) (Wade-Woolley et al., 2022). Prosody has been investigated within two aspects, (1) reading prosody and (2) speech prosody. Speech prosody has been described as "the music of speech," focusing on intonation, pitch, and expression within communication (Wennerstrom, 2001). Reading prosody has been described as an individual's phrasing (i.e., word groups) and expression at both sentence-level oral reading and passage-level oral reading (Dowher, 1991; Wof & Katzir-Cohen, 2001).

Prosody Dimensions

The definition of prosody as a construct holds constant the contribution of phrasing and expression in overall reading prosody (Hudson et al., 2008; Kuhn, 2005; Rasinski et al., 2011).

Phrasing is the ability to group words into meaningful groups (Dowhower, 1991; Klauda & Guthrie, 2008) and is often linked to pauses within speech and reading. Three types of pauses are described within reading prosody research: (1) breath pauses, (2) hesitation pauses, and (3) syntactic pauses (Bailly & Gouvernayre, 2012; Lalain et al.,

2016, 2014). Breath pauses are when an individual stops to take in air and are associated with audible breathing noises (Bailly & Gouvernayre, 2012). Hesitation pauses are associated with decoding or solving a problem during reading. They are typically a symptom of cognitive activity occurring and are typically referred to as ungrammatical pauses (Bailly & Gouvernayre, 2012). Syntactic pauses are associated with emphasizing syntactic units to support comprehension (Lalain et al., 2016).

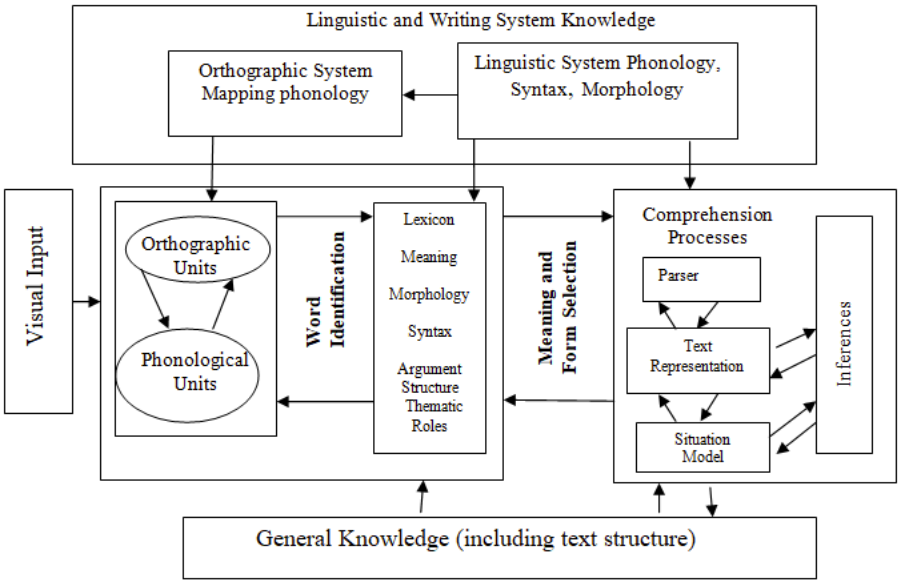
Expression is described as the melodic variation of an individual's voice (Schwanenflugel et al., 2004) and as consisting of two aspects, (1) intonation and (2) pitch. Intonation describes melodic variations linked to punctuation (e.g., declarative versus interrogative sentences) (Godde et al., 2020). Pitch describes variations in intensity across words/sentences and is often measured through F0 (intensity amplitude or slope) (Alvarez-Canizo et al., 2017; Cowie et al., 2002).

Many of the critical attributes of phrasing and expression overlap with reading outcomes, which may be one reason why reading research has begun to investigate the relationship between phrasing, expression, and reading components (i.e., rate, accuracy, and comprehension) (Wade-Woolley et al., 2022). This will allow researchers and practitioners to better understand how reading prosody fits into pre-established reading frameworks such as the Reading Systems Framework, RSF (Perfetti, Landi, & Oakhill, 2014) to strengthen further the importance of reading prosody across reading development.

Reading System Framework

Perfetti, Landi, & Oakhill (2014) derived a reading framework (i.e., Reading Systems Framework, RSF) that includes key components of reading (i.e., visual processing through higher-level comprehension). RSF includes three knowledge sources, (1) linguistic knowledge (i.e., phonology, syntax, morphology), (2) orthographic knowledge (i.e., mapping to phonology/morphology), and (3) general knowledge (i.e., knowledge about the world, text genres). The RSF model emphasis how the three knowledge sources and the relationship among them play an integral role in reading comprehension. RSF prioritizes the mental lexicon (i.e., mental storage of words and definitions) because of its role in the connection between word identification and comprehension system (Perfetti & Stafura, 2014). Figure 1 shows all processes within RSF and how they are involved in reading comprehension development (i.e., decoding, word identification, retrieval of meaning, building of components, inferencing, and using different sources of knowledge in different ways). RSF describes how these reading processes work together in both constrained ways (i.e., orthographic and phonological knowledge is needed for decoding, but general knowledge is not) and in interactive ways (i.e., meaning and general knowledge are needed for inferencing skills). Although RSF has been used to support the development of new hypotheses for explaining reading weaknesses, it leaves out one integral aspect of fluent reading, specifically reading prosody. Wade-Woolley et al. (2022) adapted the RSF framework to take into consideration reading prosody.

Figure 1. Reading System Framework (Perfetti et al., 2014)



Reading Systems Framework Adapted

Wade-Woolley et al. (2022) state that reading prosody is complex as it informs many aspects of reading development (i.e., multisyllabic decoding and reading comprehension) and one way to justify this argument is by including reading prosody within RSF. Figure 2 shows the adapted version of RSF that takes into consideration reading prosody (Wade-Woolley et al., 2022). Within the adapted RSF, reading prosody (i.e., prosodic competence) is situated within the linguistic system (i.e., phonology), word identification process (WIP) (i.e., lexicon & orthographic process), and the comprehension process (i.e., expression). This next section will summarize the role of reading prosody within each dimension of the RSF.

Linguistic System

Wade-Woolley et al. (2022) state that suprasegmental information (i.e., pitch, duration, amplitude) plays a vital role in phonology within the linguistic system. More specifically, the reading prosody component within metalinguistic awareness of word stress is an essential skill that impacts various domains within reading (i.e., decoding and word reading). Research of these various relationships has reported a strong significant relationship between lexical stress and decoding (Clin, Wade-Woolley, & Heggie, 2009) and that the reading prosody component of expression strongly predicts word reading (Lin et al., 2018).

Fluency Process

Orthographic Process. Wade-Woolley et al. (2022) suggest that within the orthographic system (i.e., print-sound mapping), the suprasegmental information within multisyllabic words depends on reading prosody components (i.e., stress). Specifically, when considering English language, which does not explicit mark word stress placement making reading prosody (i.e., stress) more crucial. In one study looking at phonological abilities for 3rd-7th grader English speaking students, a significant difference was found between student ability to form words with phonological changes and stress changes (i.e., atom – atomic) compared to words with only phonological changes (i.e., correct – correction) (Clin et al., 2009). Findings also indicated that words with phonological and stress changes were the most difficult.

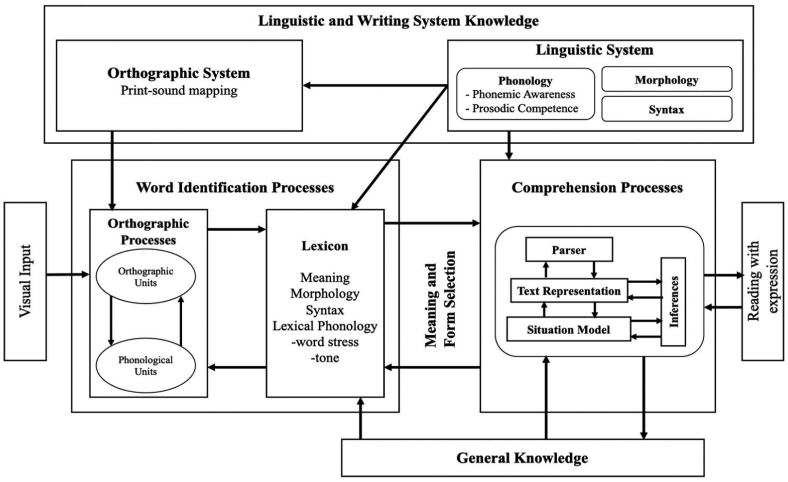
Lexicon. Wade-Woolley et al. (2022) suggest that suprasegmental phonology (i.e., phonological representation, word stress) should also be featured within the lexicon.

Research investigating the role of reading prosody at the lexical level has indicated that words with two or more stressed syllables (i.e., preposterous) take longer to read than words with one stressed syllable (i.e., ostentatious) independent of reading rate (i.e., Ashby & Clifton, 2005).

Comprehension Process

Recent research on reading prosody (i.e., expression) has begun investigating its relationship with reading comprehension (i.e., Kim, Quinn, & Petscher, 2021). In one meta-analysis of 35 studies, an overall relation of $r = 0.51$ was found between reading prosody (i.e., expression) and comprehension (Wolters et al., 2022). Findings from other studies show that phrasing and word stress (Groen, Veenendaal, & Verhoeven, 2019; Lochrin, Arciuli, & Sharama, 2015) are strong predictors of reading comprehension. Wade-Woolley et al. (2022) suggest that regardless of the type (i.e., correlational and causational) or limited amount of research on reading prosody and comprehension, given the theoretical rationale from the adapted RSF described above, it is possible that reading prosody could drive reading comprehension growth.

Figure 2. Reading System Framework Adapted (Wade-Woolley et al., 2022)



Future Directions

Reading prosody plays an essential role across reading developmental components, as Wade-Woolley et al. (2022) have indicated. When considering the adapted RSF, reading prosody is a key aspect of phonology within the linguistic system and may be crucial for fluency and reading comprehension. Given the importance of reading prosody within the adapted RSF, Wade-Woolley et al. (2022) recommend that future research should continue to investigate the relationship between reading prosody components (i.e., phrasing, expression) and other components of reading (i.e., rate, accuracy, comprehension) across different student groups (i.e., typically developing and students with disabilities).

Empirical Rationale

Although reading frameworks like the adapted RSF have established prosody within reading development, reading research remains limited (Godde et al., 2020). This bulk of research becomes even more limited when student group and age/grade are

considered (Wade-Woolley, 2022). Most reading prosody research focuses mainly on typically developing student's 1st through 4th grade and has indicated a significant relationship between prosody and reading components (Kim et al., 2021; Paige et al., 2017; Tsui et al., 2016; Sabatini et al., 2019).

Sabatini et al. (2019) investigated the relationship between overall reading prosody, reading rate, and reading comprehension for 1,713 typically developing 4th-grade students. Findings indicated a significant relationship between overall prosody, rate ($r=0.87$), and comprehension ($r= 0.59$). Findings also indicated that overall prosody was a significant predictor of comprehension ($p=0.06$). While these findings are important, they do not provide sufficient information on if similar findings are true for upper elementary-grade students and students with autism. In fact, after an extensive search of the literature, it was found that for upper elementary grade typically developing students and students with autism reading prosody research is extremely limited.

One example is Klauda & Guthrie (2008), who investigated the relationship between phrasing and comprehension for 278 5th-grade typically developing and at-risk readers and found that phrasing was a significant predictor of comprehension outcomes. While important, this study again does not provide information on if similar findings are true for students with autism. Given that impairment in pragmatic language skills is a common characteristic of students with autism (Friedman & Sterling, 2019), it is concerning that there is such a limited focus on this population of students within reading prosody research.

Speech and communication research indicates that many students with autism significantly struggle with pragmatic language skills closely associated with prosody (i.e., expression and phrasing) (Veenendaal et al., 2014). Specifically, this body of research suggests that students with autism struggle with expressive phrasing skills (i.e., production of phrasing) (Veenendaal et al., 2014). Expressive phrasing is the ability for students to speak using appropriate word groups. Communication research has also highlighted that when looking at expressive phrasing for upper elementary-grade students with autism and typically developing students, a significant group difference is found (Diehl et al., 2012; Gargan, 2020). Furthermore, no significant group difference was found when looking at receptive phrasing (i.e., the ability to identify appropriate phrasing) for the same group of students (Diehl et al., 2013; Filipe et al., 2018; Gargan, 2020).

Diehl et al. (2013) investigated expressive phrasing (i.e., production of phrasing) within speech prosody for 62 students with autism (n= 24) and typically developing students (n= 38) ages 8 to 16. Findings indicated a significant group difference in expressive phrasing ($p< 0.01$). Findings from a study by Gargan (2020) converged with the findings of Diehl et al. (2013). Gargan (2020) found a significant group difference in expressive phrasing ($p=0.015$) for a sample of 34 students with autism (n= 17) and typically developing students (n= 17) ages 7-19. Findings from Diehl et al., 2013 and Gargan (2020) suggest that students with autism show significant differences in speech with expressive phrasing compared to their typically developing peers.

Given these findings and the similarities between key attributes of expressive phrasing and reading prosody, the question remains as to how these significant group differences would impact reading outcomes for upper elementary-grade students with autism and typically developing students.

Research Questions

This study addresses the following research questions:

1. Utilizing the Multidimension Fluency Scale (adapted) and Spectrographic Analysis:
    a. Are phrasing, comprehension, and student group (i.e., autism, typically developing) significant predictors of reading rate (i.e., WRPM) for students in 4th through 6th grade?
    b. Are phrasing, rate (i.e., WRPM), and student group (i.e., autism, typically developing) significant predictors of comprehension for students in 4th through 6th grade?

CHAPTER II

LITERATURE REVIEW

The purpose of this chapter is to review the literature of descriptive studies focused on reading prosody (e.g., phrasing, syntax, expression). Due to the limited number of studies focused on reading prosody for students with autism, the literature summarized in this chapter will include other populations of students. These populations will include at-risk-readers (ARR), learning disabilities (LD), reading disabilities (RD), language impairment (IL), and typically developing (TD) students. The literature search identified a total of 20 studies.

The following sections will provide a deeper understanding of the relationship between reading prosody and various reading components (i.e., rate, accuracy, comprehension) along with a better understanding of group differences (i.e., autism and typically developing) in prosody outcomes. This will be achieved by first describing research on the relationship between reading prosody and reading rate/accuracy. Second, research on the relationship between reading prosody and reading comprehension will be summarized. Third, literature on speech prosody and group differences (i.e., autism, typically developing) will be summarized. Although the focus of this study is not on speech prosody, understanding this relationship will strengthen the argument for why reading prosody research and group differences is essential. Fourth, the quality of the identified studies will be described using the quality indicators for evaluating correlational research suggested by Thompson et al. (2005). Finally, a summary of

limitations in the field will be provided to emphasize a gap in the literature that the proposed study will fill.

Reading Prosody and Reading Rate/Accuracy

The literature search identified seven studies that looked at the relationship between reading prosody components and reading rate/accuracy. The following section will describe findings from each study organized by early elementary graders (i.e., 1st – 3rd) and upper elementary graders (i.e., 4th and above) (see Table 1) followed by a summarization of overall findings. Given that prosody remains an understudied area of the literature and the construct itself is somewhat abstract, a summary of the measures used across the identified studies are described in Table 4 to further contextualize the findings from the corpus of studies.

Early Elementary Grades

Schwanenflugel et al., (2004) conducted a descriptive study on the relationship between prosody dimensions (i.e., expression, phrasing) and reading accuracy through a one-way ANOVA. Participants included 120 typically developing 2nd-3rd graders. Participant age ranged from 7 to 10 years old. Phrasing (i.e., intersentential & intrasentential) was measured using spectrographic analysis. No interrater reliability information was provided for use of spectrographic analysis. Findings indicated a significant positive relationship between phrasing and reading accuracy ($p < 0.001$).

Schwanenflugel et al., (2015) further investigated the relationship between phrasing and reading rate/accuracy. Participants included 120 typically developing 3rd graders. Phrasing was measured using spectrographic analysis. No interrater reliability

information was provided for use of spectrographic analysis. Findings indicated strong negative relationship between rate/accuracy and phrasing (r= -0.99).

Nash & Arciuli (2016) investigated the relationship between phrasing and accuracy through a bivariate parametric correlation. Participants included 29 students with autism. Participant age ranged from five to 11 years old. Autism was described in accordance with DSM-IV (American Psychiatric Association, 1994). Phrasing was measured using the Mispronunciation Task (Holliman et al., 2010) and the Compound Noun Task (Whalley & Hansen, 2006). Inter-rater reliability was not reported. Findings indicated that phrasing had no significant correlation with reading accuracy (p>0.05).

Paige et al., (2017) investigated the relationship between phrasing and various reading dimensions (i.e., accuracy and rate) through a hierarchical regression analysis. Participants included 250 typically developing 2nd – 3rd grade students. Phrasing was measured using the MDFS. Inter-rater reliability of 50 recordings was reported. Inter-rater reliability for the MDFS was 90%. Findings indicated that accuracy and rate accounted for 70.8% unique variance in phrasing.

Kim et al., (2021) investigated the relationship between overall prosody and reading rate/accuracy through a longitudinal confirmatory factor analysis study. Participants included 371 students in 1st – 3rd grade. Participant age ranged from 6 to 8 years old. Participants included typically developing students, students with learning disabilities, and students with autism. No information was reported on how students with learning disabilities or autism were defined. Overall prosody was scored using the Multidimensional Fluency Scale (Rasinski, 2004). Overall inter-rater reliability was not

reported but researchers indicated a minimum of 80% inter-rater reliability was needed prior to the conclusion of training sessions. Findings indicated a strong significant relationship between overall prosody and rate/accuracy ($0.70 < r < 0.86$). Furthermore, researchers reported that when the prosody components were analyzed separately, the findings indicated a negative relationship between rate/accuracy and phrasing ($-0.59 < r < -0.77$) and a negative relationship between rate/accuracy and expression ($-0.26 < r < -0.17$).

Upper Elementary Graders and Above

Sabatini et al., (2019) conducted a descriptive study on the relationship between overall prosody and rate. Participants were randomly selected from the pool of students who completed that 2002 NAEP reading assessment. The sample of participants included 1,713 typically developing students in fourth grade. Overall prosody was scored using the NAEP ORF scale. Inter-rater reliability was reported for a random selection of 25% of recordings. Inter-rater reliability for NAEP ORF scale was 81%. Findings indicated a significant relationship between overall prosody and rate ($r= 0.87$).

Nomvete & Easterbrooks (2020) investigated the relationship between phrasing and reading rate through hierarchical linear modeling and mediation regression modeling. Participants included 65 typically developing students and students with learning disabilities. Participant age ranged from 13 to 21 years old. Students with learning disabilities were defined as students whose school data reported a label of a learning disability under special education guidelines. Phrasing was measured using the NAEP ORF scale. Inter-rater reliability was 100% over three sets of recordings. Findings

indicated a positive correlation between phrasing and reading rate (p<0.01). Furthermore, findings indicated reading rate was a strong predictor of phrasing (p<0.01).

Summary of reading prosody and reading rate/accuracy

Across the 7 identified studies, two utilized the Multidimensional Fluency Scale (Rasinski, 2004), two utilized the NAEP ORF scale, three utilized spectrographic analysis, one utilized the mispronunciation task (Holliman eta l., 2010) and the compound noun task (Whalley & Hansen, 2006). See table 4 for a description of these measures. A majority of studies included all typically developing students in first through third grade. Across studies which measured prosody outcomes using rubrics and scales (i.e., MDFS and NAEP ORF) consistencies included a strong significant relationship between overall prosody and rate/accuracy. Furthermore, across studies which utilized spectrographic analysis consistencies included a strong negative relationship between the specific component of phrasing and rate/accuracy (Kim et al., 2021; Schwanenflugel et al., 2004; 2015). Consistencies across both early elementary and upper elementary grades indicated a significant relationship between prosody and reading rate/accuracy.

Reading Prosody and Reading Comprehension

The literature search identified 8 studies that looked at the relationship between reading prosody components and reading comprehension. The following section will describe findings from each study organized by early elementary graders (i.e., 1st – 3rd) and upper elementary graders (i.e., 4th and above) (see Table 2) followed by a summarization of overall findings. Given that prosody remains an understudied area of the literature and the construct itself is somewhat abstract, a summary of the measures

used across the identified studies are described in Table 4 to further contextualize the findings from the corpus of studies.

Early Elementary Graders

Lochrin, Arciuli, & Sharama (2015) investigated the relationship between prosody dimensions (i.e., phrasing, expression) and comprehension through a simultaneous regression analysis. Participants included 63 typically developing students. Participant age ranged from 7 to 12 years old. Phrasing was measured using the PEPS-C scale. Inter-rater reliability was reported for 10% of recordings. Inter-rater reliability was 90%. Findings indicated that phrasing accounted for 15.44% unique variance in comprehension. Furthermore, expression accounted for no unique variance in comprehension.

Tsui et al., (2016) investigated the relationship between expression and reading comprehension through a three-step hierarchical regression. Participants included 36 typically developing 2nd graders. Expression was measured using spectrographic analysis (i.e., fundamental frequency). Inter-rater reliability was not reported for spectrographic analysis. Findings indicated that expression accounted for 12.4% unique variance in comprehension.

Paige et al., (2017) investigated the relationship between phrasing and comprehension through a hierarchical regression analysis. Participants included 250 typically developing 2nd – 3rd grade students. Phrasing was measured using the MDFS. Inter-rater reliability of 50 recordings was reported. Inter-rater reliability for the MDFS

was 90%. Findings indicated that phrasing accounted for 2.5% unique variance in comprehension.

Kim et al., (2021) investigated the relationship between overall prosody and comprehension through a longitudinal confirmatory factor analysis study. Participants included 371 students in 1st – 3rd grade. Participant age ranged from 6 to 8 years old. Participants included typically developing, students with learning disabilities, and autism. No information was reported on how students with learning disabilities or autism were defined. Overall prosody was scored using the Multidimensional Fluency Scale (Rasinski, 2004). Overall inter-rater reliability was not reported but researchers indicated a minimum of 80% inter-rater reliability was needed prior to the conclusion of training sessions. Findings indicated overall prosody had a significant relationship with comprehension ($0.03 < r < 0.74$).

Upper Elementary Graders and Above

Klauda & Guthrie (2008) investigated the relationship between phrasing and reading comprehension through a hierarchical regression analysis. Participants included 278 5th graders. Participants included typically developing students and at-risk readers. At risk readers were defined as students reading several years below grade level. A three-point scale to measure phrasing was developed using the NAEP ORF scale as a model. Overall inter-rater reliability was reported for 16 audio recordings. Inter-rater reliability for the researcher developed scale was 70-79%. Findings indicated that phrasing accounted for 10% unique variance in comprehension.

Sabatini et al., (2019) conducted a descriptive study on the relationship between overall prosody and comprehension. Participants were randomly selected from the pool of students who completed that 2002 NAEP reading assessment. The sample of participants included 1,713 typically developing students in fourth grade. Overall prosody was scored using the NAEP ORF scale. Inter-rater reliability was reported for a random selection of 25% of recording. Inter-rater reliability for NAEP ORF scale was 81%. Findings indicated a significant relationship between overall prosody, and comprehension ($r = 0.59$). Findings also indicated that overall prosody was a marginally significant predictor of comprehension ($p = 0.062$).

Nomvete & Easterbrooks (2020) investigated the relationship between phrasing and reading comprehension. Participants (N=65) included typically developing students (n= 51) and students with learning disabilities (n= 19). Five participants did not complete the study due to parents not approving of student being audio taped. Participant age ranged from 13 to 21 years old. Students with learning disabilities was defined as students whose school data reported a label of a learning disability under special education guidelines. Phrasing was measured using the NAEP ORF scale. Inter-rater reliability was 100% over three sets of recordings. Findings indicated a positive correlation between phrasing and comprehension ($p<0.01$). Furthermore, findings indicated phrasing was a strong predictor of comprehension ($p<0.01$).

Chan et al., (2020) investigated the relationship between expression and comprehension through a multiple regression. Participants included 110 typically developing 4th through 5th graders. Expression was measured using a researcher

developed measure (Wade-Woolley, 2016). Internal reliability of the researcher developed measure was $\alpha = 0.64$. Findings indicated expression had no direct effect on comprehension and was not a significant predictor of comprehension ($p = 0.003$).

Summary of reading prosody and reading comprehension

Across the 8 identified studies, two utilized the Multidimensional Fluency Scale (Rasinski, 2004), two utilized the NAEP ORF scale, one utilized spectrographic analysis, one utilized the PEPS-C (Peppe & McCann, 2003), one utilized the ORF (Pinnell et al., 1995), and one utilized the PrA (Wade-Woolley, 2016). See table 4 for a description of each of these measures. A majority of studies included all typically developing students. When looking at consistencies for early elementary age students' findings indicate a significant relationship between overall prosody and comprehension as well as phrasing and expression being significant predictors of comprehension outcomes. However, when looking for consistencies across findings for upper elementary age students it becomes difficult. One reason is some studies look at just expression outcomes while others look at phrasing outcomes and their relationship with comprehension outcomes. One consistency that is noted is that overall prosody and phrasing were both found to be significant predictors of comprehension outcomes while expression was found to have no significant direct effect on comprehension outcomes. Overall, consistencies across grade/age included a strong significant relationship between overall prosody and comprehension.

Speech Prosody and Group Differences

To gain a better understanding of differences in phrasing outcomes between students with autism and typically developing students and due to the dearth in research within reading prosody literature, a literature search was conducted to identify studies which investigate expressive (i.e., the ability for students to produce phrasing during communication) and receptive (i.e., the ability for students to identify appropriate phrasing within speech prosody). The goal of this literature search was to gain a better understanding of the difference in phrasing ability between students with autism and typically developing students. The literature search identified six studies. All six studies utilized the PEPS-C program to measure phrasing within speech prosody. See table 4 for a description of the measure. The following section will describe findings from each study (See Table 3) followed by a summarization of overall findings.

Peppe et al., (2011) investigated group difference in phrasing outcomes for students with autism and typically developing students. Participants included 143 students. Participant age ranged from six to 9 years old. Students with autism were defined as students whose school reporting's adhered to the ICD-10 (World Health Organization, 1993). Phrasing was measured using the PEPS-C program. Inter-rater reliability for 10% of recordings was provided. Inter-rater reliability was 82%. Findings indicated a significant group difference in expressive phrasing with the autism group scoring significantly less than the typically developing group ($p = 0.011$).

Diehl et al., (2012) investigated group difference in phrasing outcomes for students with autism, LD, and typically developing students. Participants included 62

students. Participants age ranged from 8 to 16 years old. Participants with autism were defined as students who met the DSM-C-TR (APA, 2000) criteria for one of the three autism groups (i.e., Autistic Disorder, Asperger's Disorder, or Pervasive Developmental Disorder). Students with learning disabilities were defined as students who were clinically diagnosed by a speech language pathologist and who were found to not exhibit autism. Phrasing was measured using the PEPS-C program. Inter-rater reliability of PEPS-C was reported for a random 10% of recordings. Inter-rater reliability ranged from 84-96% with an average inter-rater reliability of 88%. Findings indicated no significant group difference was found ($p = 0.43$).

Diehl et al., (2013) further investigated group difference in phrasing outcomes for the same sample of students in the Diehl et al., 2012 study. The aim was to identify if a significant group difference would be found when looking at receptive vs expressive phrasing. Receptive phrasing is defined as perception of phrasing. Expressive phrasing is defined as production of phrasing. Phrasing was measured using PEPS-C. Inter-rater reliability for a random 10% of the sample was reported. Inter-rater reliability ranged from 0.84 to 0.96 with an average of 0.88 inter-rater reliability. Findings indicated no significant group difference for receptive phrasing ($p = 0.21$). However, findings for expressive phrasing indicate a significant group difference ($p < 0.01$).

Filipe et al., (2018) investigated group difference in receptive and expressive phrasing between student with autism and typically developing students. Participants included 30 students. Participant age ranged from 6 to 9 years old. Participants with autism were defined as students who met the DSM-5 criteria for autism (American

Psychiatric Association, 2013). Phrasing was measured using the PEPS-C program. Inter-rater reliability was not reported. Findings indicated no significant group difference in receptive or expressive phrasing ($p > 0.05$). Furthermore, finings indicated a significant group difference in overall speech prosody (i.e., phrasing and expression) ($p < 0.05$).

Gargan (2020) investigated group difference in phrasing outcomes for students with autism and typically developing students. Participants included 34 students. Participant age ranged from 7 to 19 years old. Participants with autism were defined as students who met the DSM-4 criteria (APA, 1994). Phrasing was measured using the PEPS-C program. Inter-rater reliability was reported using Cohen's kappa coefficient (Landis & Koch, 1997). Inter-rater reliability ranged from 0.61 to 1.00. Findings indicated no significant group difference in receptive phrasing ($p = 0.322$). However, findings indicate significant group difference for expressive phrasing ($p = 0.015$).

Summary of speech prosody and group difference.

Across findings from the six identified studies one consistency across grade/age is no significant group differences in receptive phrasing (i.e., the ability for students to identify appropriate phrasing) outcomes between students with autism and typically developing students. However, findings across grade/age indicate a significant group difference in expressive phrasing (i.e., the ability for students to produce phrasing during communication) between students with autism and typically developing students. These findings provide important information for research because they indicate that students with autism struggle to produce phrasing (i.e., expressive phrasing) within speech. Given that many of the key attributes of expressive phrasing overlap with phrasing attributes

with reading the question remains if similar results would be present within reading prosody. The proposed study seeks to identify if group difference between upper elementary age students with autism and typically developing students exists when looking at expressive phrasing within reading tasks.

Quality Indicators

The literature search identified 20 studies which focused on prosody within the context of reading and/or speech. The literature search findings support previous research which indicated that a majority of research on prosody (i.e., speech and reading) focuses on typically developing students, and students in K-4th grade (i.e., Godde et al., 2020; Wade-Woolley et al., 2022). While the findings from the literature search provide important information for both research and practice the review also highlighted many areas of concern regarding quality of the identified studies. Preliminary analysis revealed an absence in studies that reported inter-rater reliability of prosody measurement, and there were many inconsistencies in prosody measurement tools specifically within reading prosody research. These findings support previous findings from a systaltic review focused on reading prosody intervention research which also highlighted inconsistencies in prosody measurement tools and a majority of literature not reporting inter-rater reliability of prosody measurement (Shhub et al., 2023).

To address these concerns all studies were coded using the quality indicators for evaluating correlational research suggested by Thompson et al., (2005). These next sections will provide a description of the proposed quality indicators followed by findings from quality indicator coding of the 20 identified studies.

Description of Quality Indicators

Thompson et al., (2005) proposed four sets of quality indicators when evaluating correlational research studies: (a) measurement; (b) practical and clinical significance; (c) avoidance of some common analytic mistakes; and (d) confidence intervals for score reliability coefficients, statics, and effect sizes.

The first subset "measurement" focuses on score reliability and validity of measures. Thompson et al., (2005) stresses the importance of researchers not reporting score reliability coefficients from prior studies unless they also provide explicit evidence that the sample compositions and standard deviations of both the current study and prior studies are reasonably comparable.

The second subset "practical and clinical significance" focuses on two forms of evaluation (i.e., practical, and clinical). For the purpose of the proposed study only practical significance will be described. Practical significance focuses on statistical significance of results from a study sample diverging from the null hypothesis. Thompson et al., (2005) states that practical significance is often referred to as "effect sizes." Three categories of effect size statistics were provided: (a) standardized differences (i.e., Cohen's *d*), (b) uncorrected variance-accounted-for (i.e., η^2, R^2), and (c) corrected variance-accounted-for (i.e., adjusted R^2, ω^2). Thompson et al., (2005) also stresses the importance of researchers describing both how they are calculating effect size and how they are interpreting effect size. Without both of these descriptions a clear interpretation of results is not possible.

The third subset "avoidance of some common analytic mistakes" focuses on four analytic errors seen across literature. The first analytic mistake discussed is failure to interpret structure coefficients either explicitly (i.e., regression, descriptive, discriminant analysis) or implicitly (i.e., *t*-tests, ANOVA). The second analytic mistake focuses on converting independent variables such as intervalley scaled variables to nominal scales (i.e., IQ scores, achievement scores). Thompson et al., (2005) claims that this conversion "throws information away" (i.e., discards score variability), weakens the power of the reliability of scores being analyzed, and distorts variable distribution/relationship. The third analytic mistake focuses on inappropriate univariate methods used in the presence of multiple outcome variables. Thompson et al., (2005) states that the use of univariate methods when several outcome variables are present inflates the probability of a Type I error. Thompson et al., (2005) further suggests that the use of a univariate method post hoc to a multivariate test is also inappropriate. The fourth analytic mistake focuses on failure to test statistical assumptions. Thompson et al., (2005) stresses that empirical studies on published articles have shown that assumptions are rarely tested by researchers. Although methodological assumptions are never perfectly met, Thompson et al., (2005) claims that researchers must ensure that they are at least approximately met in order for findings to be approximately correct.

The fourth and final subset of "confidence intervals for score reliability coefficients, statics, and effect sizes" focuses on the importance of confidence intervals informing researchers ability to evaluate consistencies of evidence across studies. Thompson et al., (2005) suggests that confidence intervals can be calculated for (a)

reliability coefficients; (b) sample statistics; and (c) effect sizes. Together Thompson et al., (2005) states that these confidence intervals across studies can lead researchers to the correct population values.

Quality of Identified Studies

Quality indicator analysis revealed that average quality indicator score across the 20 identified studies was 11.3 points (18 total points possible) with a range of 8 to 17 points. When identifying the largest areas of missing data two findings stick out: (1) approximately 65% of the identified studies did not report reliability and/or validity information about used measures, and (2) 80% of the identified studies did not report confidence interval information resulting in difficulty with making strong predictions of population values (Thompson et al., 2005). These findings are concerning given that many reliable and valid measures have been developed and used for targeting accuracy and rate within reading. These include Curriculum-Based Measures (Pearson Education Inc., 2012) and Dynamic Indicators of Basic Early Literacy Skills (University of Oregon, Center on Teaching and Learning, 2022). Furthermore, research has emphasized the importance of scores from a measure being stable, consistent, and approximately the same when administered multiple times (Chiang et al., 2015). While alarming these findings are supported by previous findings from a systematic review which found that a majority of reading prosody intervention studies consistently did not report inter-rater reliability data (Shhub et al., 2023). The literature search indicates a gap in the literature specifically related to study quality (i.e., reliability, validity, and statistical reporting).

Future high-quality research is of importance. The proposed study seeks to fill this gap in the literature by ensuring that quality indicators are addressed.

Conclusion

This literature search revealed 20 studies that focused on prosody within the context of reading and/or speech. Overall findings indicated that most research on reading prosody focuses on typically developing students in early elementary grades. These findings are consistent with previous meta-analyses and systematic reviews on prosody (Godde et al., 2020; Wade-Woolley et al., 2022). Findings from this literature review support previous findings stating that a majority of prosody research has not investigated reading prosody as an isolated skill; instead, a majority of research has investigated reading prosody within the context of fluency skills, often making it difficult to fully understand the relationship it plays in overall reading development (Godde et al., 2020; Wade-Woolley et al., 2022).

The literature search also indicated that phrasing significantly predicts reading rate/accuracy. Although not completely clear, studies have indicated that reading prosody correlates significantly with reading comprehension outcomes. These findings again support previous research findings indicating a significant relationship between phrasing and various reading outcomes (Godde et al., 2020). Although these findings are important for practice and research, they are mainly based on typically developing populations of students in early elementary grades. Of the 20 identified studies, one study looked at the relationship between reading prosody and reading dimensions within the population of students with autism. Furthermore, communication research has highlighted a significant

group difference in expressive phrasing outcomes between typically developing students and students with autism in upper elementary grades. This, along with researchers highlighting the importance of reading prosody components within the reading systems framework (adapted) (Wade-Woolley, 2022), findings from this literature search highlight a gap in the literature that the proposed study seeks to investigate.

Table 1. Reading Prosody and Reading Rate/Accuracy

Study	Grade/Age	N	Student Group	Measure	Outcome
1. Kim et al., 2021	1-3rd/6-8 years	371	TD, LD, ASD	MDFS, SP	Strong significant relationship between overall prosody and rate/accuracy ($0.70 < r < 0.86$) Negative relationship between rate/accuracy and phrasing ($-0.59 < r < -0.77$) Negative relationship between rate/accuracy and Expression ($-0.26 < r < -0.17$)
2. Nash & Arciuli, 2016	NR/5-11 years	29	ASD	MT, CNT	Phrasing has no significant correlation with reading accuracy ($p>0.05$)
3. Nomvete & Easterbrooks 2020	NR/13-21 years	65	TD, LD	NAEP-ORF Scale	Positive correlation between reading rate and phrasing ($p<0.01$) Reading rate strong predictor of phrasing ($p<0.01$)
4. Paige et al., 2017	2nd-3rd/NR	250	TD	MDFS	Accuracy and rate accounted for 70.8% unique variance in phrasing
5. Sabatini et al., 2019	4th/NR	1,713	TD	NAEP-ORF Scale	Strong significant relationship between rate and overall prosody ($r = .87$)
6. Schwanenflugel et al., 2004	2nd-3rd/ 7-10 years	120	TD	SP	Stronger accuracy indicated shorter intersentential & intrasentential phrasing compared to lower accuracy ($p<0.001$)
7. Schwanenflugel et al., 2015	3rd/NR	120	TD	SP	Negative relationship between rate/accuracy and phrasing ($r = -0.99$

Note: LD= Learning disability, TD= Typically developing, ASD= Autism Spectrum Disorder, MDFS= Multidimensional Fluency Scale, NAEP ORF= National Assessment of Educational Progress- Oral Reading Fluency (Pinnell et al., 1995), SP= Spectrographic Analysis, MT= Mispronunciation Task (Holliman et al., 2010), CNT= Compound Noun Task (Whalley & Hansen, 2006)

Table 2. Reading Prosody and Comprehension

Study	Grade/Age	N	Student Group	Measure	Outcome
1. Chan et al., 2020	4th-5th/NR	110	TD	PrA	Expression had no direct effect and was not a significant predictor of comprehension (p=0.76)
2. Kim et al., 2021	1-3rd/6-8 years	371	TD, LD, ASD	MDFS	Overall prosody strong relationship with comprehension ($0.03 < r < 0.74$)
3. Klauda & Guthrie 2008	5th/NR	278	TD, ARR	ORF	Phrasing accounted for 10% unique variance in comprehension
4. Lochrin, Arciuli, & Sharama, 2015	NR/7-12 years	63	TD	PEPS-C	Phrasing accounted for 15.44% unique variance in comprehension Expression had no unique variance in comprehension
5. Nomvete & Easterbrooks 2020	NR/13-21 years	65	TD, LD	NAEP-ORF Scale	Positive correlation between comprehension and phrasing (p<0.01) Phrasing strong predictor of comprehension (p<0.01)
6. Paige et al., 2017	2nd-3rd/NR	250	TD	MDFS	Phrasing accounted for 2.5% unique variance in comprehension
7. Tsui et al., 2016	2nd/NR	36	TD	SP	Expression accounted for 12.4% unique variance in comprehension
8. Sabatini et al., 2019	4th/NR	1,713	TD	NAEP-ORF Scale	Medium significant relationship between overall prosody and comprehension (r = 0.59) Overall prosody marginally significant predictor for comprehension (p=0.062)

Note: LD= Learning disability, TD= Typically developing, ASD= Autism Spectrum Disorder, MDFS= Multidimensional Fluency Scale, NAEP ORF= National Assessment of Educational Progress- Oral Reading Fluency (Pinnell et al., 1995), SP= Spectrographic Analysis, MT= Mispronunciation Task (Holliman et al., 2010), CNT= Compound Noun Task (Whalley & Hansen, 2006), PrA Task= PrA Task (Wade-Woolley, 2016), ORF= Oral Reading Fluency Rubric (Klauda & Guthrie, 2008), PEPS-C= PEPS-C Program (Peppe & McCann, 2003)

Table 3. Phrasing in Speech Prosody

Study	Grade/Age	N	Student Group	Measure	Outcome
1. Diehl et al., 2012	NR/8-16 years	62	ASD, LD, TD	PEPS-C	No significant group difference in phrasing (p=0.43)
2. Diehl et al., 2013	NR/8-16 years	62	ASD, LD, TD	PEPS-C	No significant group difference in receptive phrasing (p=0.21) Significant group difference in expressive phrasing (p<0.01)
3. Filipe et al., 2018	NR/6-9 years	30	ASD, TD	PEPS-C	No significant group difference in receptive phrasing (p>0.05) and expressive phrasing (p>0.05).
4. Gargan, 2020	NR/7-19 years	34	ASD, TD	PEPS-C	Significant group difference in expressive phrasing (p=0.015) No significant difference is receptive phrasing (p=0.322)
5. Peppe et al., 2011	NR/6-9 years	143	ASD, TD	PEPS-C	Significant group difference in expressive phrasing (p=0.011)

Note: NR= Not reported, ASD= Autism spectrum disorder; TD= Typically developing; LD= Learning disability, RD= Reading disability Receptive phrasing= perception of phrasing, Expressive phrasing= production of phrasing

Table 4. Prosody Measures Description

Measure	Abbreviation	Prosody Skill/s Assessed	Description
Multidimensional Fluency Scale (Rasinski, 2004)	MDFS	Phrasing Expression Syntax Pace	Each domain is scored on a scale of 1 (word-by-word reader with no expression) to 4 (3 or more words groups for majority of reading with consistent expression)
National Assessment of Educational Progress- Oral Reading Fluency (Pinnell et al., 1995)	NAEP-ORF	Phrasing Expression Syntax Pace	Rating scale: Overall fluency scored on a 4-level scale. 1 for word-by-word reader with infrequent expression. 4 for primarily larger meaningful phrases, preserves syntax, expression throughout.
Oral Reading Fluency Rubric (Klauda & Guthrie, 2008)	ORF	Expression (passage & word) Phrasing Pace Smoothness	Each domain is scored on a scale of 1 (very weak) to 4 (very strong)
PEPS-C Program (Peppe & McCann, 2003)	PEPS-C	Expressive phrasing Receptive phrasing Expression	Computer program designed to assess prosody performance in children ages 4-16.
PRATT Software (Boersma & Weenink, 2015)	SP	Phrasing Expression	Speech language pathology spectrograph computer software used to measure language domains.
Mispronunciation Task (Holliman et al., 2010)	MT	Phrasing	Using audio recordings participants are asked to identify various prosodic features at the word level.

Table 4. Continued

Measure	Abbreviation	Prosody Skill/s Assessed	Description
Compound Noun Task (Whalley & Hansen, 2006)	CNT	Phrasing	Using audio recordings participants asked to identify various prosodic features at the phrase level.
Brenda's Animal Park Task (Holliman, 2010)	BAP	Expression	Microsoft PowerPoint Presentation with audio files. Participants are asked to help the character overcome challenges related to a range of prosodic expressive features.
DEEdee Task (Whalley & Hansen, 2006)	DD	Expression	Prerecorded phrases from a children's book. Participants are asked to identify various prosodic expressive features.
PrA Task (Wade-Woolley, 2016)	PrA	Expression	Participants are asked to identify various prosodic expressive features within multisyllabic words.

CHAPTER III

METHODS

Overview

In this chapter, the following components will be discussed: research questions, participants, measures, procedures, and data analytic plan. This study was be based on secondary analyses of data collected from three studies. Two data sets consisted of pre-test scores from intervention studies (Solis et al., 2022), (Solis et al., in development). One data set came from a reader profile study (Solis et al., in development). Given, that the original data sets focused on various domains of reading (i.e., fluency, comprehension), the collected research allowed for an analysis of phrasing and its relation to various domains of reading development. Secondary analysis allows researchers to utilize preexisting data sets to test new hypotheses or answer new research questions (Cheng & Phillips, 2014).

Research Questions

This study seeks to address the following research questions:

1. Are phrasing, comprehension, and student group (i.e., autism, typically developing) significant predictors of reading rate (i.e., WRPM) for students in 4th through 6th grade?
2. Are phrasing, rate (i.e., WRPM), and student group (i.e., autism, typically developing) significant predictors of comprehension for students in 4th through 6th grade?

Setting

This study included participant data from three preexisting data sets. Two data sets (i.e., study A, study B) came from pretesting data of intervention studies. The third data set (i.e., study C) came from a reader profile study. This next section will go into detail about each of the studies which the preexisting data was pulled from.

Study A

The first data set came from pretest data from an intervention pilot study (Solis et al., 2022). The focus of this study was to investigate the effects of a multicomponent reading intervention (i.e., vocabulary, fluency, and reading comprehension) on students with autism in grades three to 8. The study consisted of 28 participants and came from two school sites (i.e., south midwestern site and southwestern site). As a result of school closure, the south midwestern school site was not able to provide demographic information (Solis et al., 2022). The overall student sample consisted of 18% White, 21% Hispanic, 4% Asian, and 57% undisclosed.

Study B

The second data set came from an intervention replication study. This study was a replication of study A; however, it took place completely remote (i.e., Zoom). Pre and post testing occurred via zoom. This study consisted of 13 participants with autism in grades 5 to 9. Participants in this study came from two urban school sites surrounding Los Angeles, CA (i.e., Sherman Oaks and Westside). Both school sites serve only students with autism and specialize in working with students with mild cognitive delays and challenges with social communication and/or language development. The overall

student sample consisted of 54% White, 14% Hispanic, 23% Asian, 8% African American.

Study C

The third data set came from a reader profile study. This study consisted of participants undergoing a battery of reading assessments. This study consisted of 26 typically developing students in grades 4 to 6. Participants in this study came from one college preparatory charter school site in urban Riverside, CA. The overall student sample consisted of 27% White, 35% Black/African American, 19% Asian, 4% Other, 15% Undisclosed.

Participants

The data set used for secondary analysis in the current study (N=45) consisted of students in 4th through 6th grade who are typically developing (n= 27) or students with autism (n=18). Participant ages ranged from 9 to 12 years old, with an average age of 10 ½ years old. Table 5 provides demographics of this data set. Variation in participant grade is not a concern for this study given recent findings from a meta-analysis which indicated that the relationship between reading prosody and comprehension remained insignificant even after grade level was added as a covariate to the model (p = .11) (Wade-Woolley et al., 2022). Furthermore, the magnitude of this relationship did not show significant difference by grade level (p= .40) (Wade-Woolley et al., 2022).

Students with autism were identified by school admin through preexisting individualized education plans. To descriptively conceptualize the sample of participants with autism each data set administered the Gilliam Autism (ASD) Rating Scale, Third

Edition (GARS; Gilliam, 2013). The GARS is used to provide information regarding the classification of ASD severity (Level 1, 2, 3) and autism index. Level 1 indicates less symptom severity and Level 3 indicates most symptom severity. The GARS is a standardized assessment of communication skills and social skills for individuals. The measure is completed by a student's teacher or case manager. All persons who completed the GARS were individuals with teaching credentials and/or held degrees required to work with this population of students. See Table 5 for a description of the autism severity level distribution by level and sample.

Table 5. Demographics

	Sample #1 – ASD	**Sample #2 – ASD**	**Sample #3 – typically developing**	**Total sample**
ASD severity (GARS)				
Level 1 (minimal)	n=3	n= 2		n= 5
Level 2 (substantial)	n= 9	n= 3		n= 12
Level 3 (very substantial)	n= 2	n= 0		n= 2
Grade				
4th	n= 8	n= 0	n= 15	n= 23
5th	n= 2	n= 3	n= 4	n= 9
6th	n= 4	n= 2	n= 7	n= 13
Gender				
Male	n= 13	n= 5	n= 14	n= 32
Female	n= 1	n= 0	n= 12	n= 13
Race/Ethnicity				
White	n= 2	n= 3	n= 7	n= 12
Hispanic	n= 0	n= 1	n= 0	n= 1
Asian	n= 0	n= 1	n= 5	n= 6
Black/African American	n= 0	n= 0	n= 9	n= 9
Other	n= 3	n= 0	n= 1	n= 4
Undisclosed	n= 9	n= 0	n= 4	n= 13

Measures

Preexisting data from the Passage Comprehension subtest from the *Woodcock-Johnson Tests of Achievement* (WJ ACH) and Aimsweb Oral Reading Fluency were used for this study. Multi-Dimensional Fluency Scale (adapted) and spectrographic analysis were used for secondary analysis of reading passage audio recordings.

Woodcock-Johnson Test of Achievement (WJ ACH)

The WJ Passage Comprehension subtest (WJ-PC) is an untimed, individually administered reading comprehension assessment. The items on the subtest require the student to read a given passage/sentence and orally provide the appropriate missing word. The subtest consists of 52 items which increase in length and language complexity. Internal reliability for WJ ACH untimed subtests is .84 to .94 (Schrank, McGrew, Mather 2014).

Aimsweb Oral Reading Fluency (ORF)

ORF is a 60 second timed, individually administer reading fluency assessment. The test requires students to orally read a given grade level passage for one minute. As the student reads the passage the assessor marks any mispronunciations, skipped words, repeated words, and the final word read. A final score for words read and words read correct per minute is calculated. See figure 3 for a sample of the Aimsweb ORF passage. Average alternate form's reliability for timed reading measures is .86 to .96 (Pearson, 2018).

Prosody Measurement

Two forms of prosody measurement were implemented (i.e., scale and spectrographic analysis). This decision is based on inconsistencies in recent findings

suggesting that when prosody dimensions are measured using rubrics/scales findings indicated a stronger significant relationship between prosody and comprehension compared to studies which used spectrographic analysis (Wade-Woolley et al., 2022). Furthermore, recent findings indicated that when using spectrographic analysis for prosody measurement it is found that the component of phrasing is a significant predictor of comprehension and the other components of prosody (i.e., expression) are not significant predictors (i.e., Kim et al., 2020; Schwanenflugel et al., 2004; Schwanenflugel, 2008). Given these findings the current study seeks to investigate the relationship between phrasing and reading dimensions (rate, comprehension) using both scale measurement (i.e., MDFS) and spectrographic measurement (i.e., PRAAT).

Multi-Dimensional Fluency Scale (MDFS)

The MDFS (adapted) scores phrasing on a 4-point rubric. A score of 1 on the rubric describes a student as reading word-by-word or in large phrase groups with no meaningful word groups 90% or more of the passage, and 20% or more of the passage consists of mispronunciations and/or omissions. A score of 4 on the rubric describes a student as reading in longer than 3 meaningful word groups for 90% or more of the passage, and 5% or less of the passage consists of mispronunciations and/or omissions. See figure 4 for a sample of the rubric. The Aimsweb passage (see figure 3) was used as the content for scoring phrasing outcomes. Sentences 2 through 7 from the passage will be used for this analysis based on previous literature and given the resources-intensive nature of coding (Kim et al., 2020; Miller & Schwanenflugel, 2006; Schwanenflugel et al., 2004).

PRAAT Spectrograph

Spectrographic analysis PRAAT Software (Version 5.4; Boersma & Weenink, 2015) was used to measure pause frequency within target sentences. Pauses are defined as 100ms to 3000ms (Miller & Schwanenflugel, 2010). The same text described above was used for phrasing outcomes.

Procedures

The lead researcher identified participants which the preexisting data sets included the following items: Woodcock Johnson Passage Comprehension subtest scores, Aimsweb Oral Reading Fluency scores, and Aimsweb audio recording. Once the initial data set was identified the lead researcher went through and identified any corrupted audio files and any participants who were unable to complete an oral reading of the first 8 sentences of the reading passage. Participants who were unable to read through the first 8 sentences of the reading passage were removed from the data set given previous research emphasizing a minimum of 7 sentences of oral reading for prosody measurement (Hasbrouck & Tindal, 2006; Miller & Schwanenflugel, 2010; Rasinski, 2004). Of the 48 original participants, three were removed from the data set. Two files were corrupted, and one was removed due to the participant not reading the 8 target sentences. Once the final data set (N=45) was identified coder training began.

ORF and WJ-PC Coder Training

Scores for reading rate (i.e., ORF) and comprehension (i.e., WJ-PC) were collected from each of the preexisting data sets. Assessors in intervention study A underwent extensive in person training and reliability checks to a gold standard (Solis et

al., 2022). Assessors in intervention study B underwent two 4-hour long extensive virtual training sessions with a researcher and reliability checks to a gold standard (Solis et al., in development). Lastly, assessors in reader profile study C underwent 2 virtual (i.e., zoom) 1-hour long weekly training sessions for a total of 10 weeks with a researcher and reliability checks to a gold standard (Solis et al., in development).

Phrasing Coder Training

Four coders were recruited for prosody coding. Each prosody measure was assigned two coders. All coders participated in eight 30-minute training sessions via Zoom. Once training was completed inter-rater reliability was collected utilizing audio from students not included in this studies data set. Inter-rater reliability for spectrographic analysis was 98%. Initial inter-rater reliability of the Multi-Dimensional Fluency Scale (adapted) (MDFS) was 85%. A second one-hour virtual training was conducted for the MDFS, and new inter-rater reliability was collected. Final MDFS inter-reliability was 95%.

To ensure consistent reliability of coders, weekly check ins and refresher trainings were conducted by the lead researcher. A second round of inter-rater reliability was also conduct halfway through scoring. Spectrographic analysis and MDFS inter-rater reliability were 95%. Furthermore, to strengthen the rigor of this study and given previous literature indicating an absence of inter-rater reliability of prosody measures (Shhub et al., 2023) all participant audio files were double coded. Inter-rater reliability of double coding was 98%. Any disagreements in scores were addressed in a team meeting with the lead researcher and a final score was agreed upon.

Lastly to further strength the rigor of this study the first author served as the gold standard and coded all participants using both prosody measures. Scores were matched with the blind coders. Inter-rater reliability of the MDFS was 95% and for spectrographic analysis was 98%.

Data Analysis

The aim of this study is to identify the predictors of reading outcomes (i.e., rate, comprehension) when phrasing is measured using two measurement techniques (i.e., spectrograph, MDFS) for students with autism and typically developing students grades 4 through 6. This study used multiple regression analysis to identify if the independent variables (i.e., predictor variables) are statistically significant to the dependent variable. Table 6 describes the independent variables and dependent variables within each research question. The best analysis for this study was a multiple regression. The reason for this was that multiple regressions allowed for the researcher to determine which if any of the independent variables have a statistically significant effect on the dependent variables and how much of the variation in the dependent variable is explained by the independent variable.

Table 6. Research Questions and Variables

Research Questions	Independent Variable (Predictor)	Dependent Variable
1. Are phrasing, comprehension, and student group (i.e., autism, typically developing) significant predictors of reading rate (i.e., WRPM) for students in 4th through 6th grade?	Phrasing (MDFS & Spectrograph) Student group Comprehension	Reading rate (i.e., WRPM)
2. Are phrasing, reading rate (i.e., WRPM), and student group (i.e., autism, typically developing) significant predictors of comprehension for students in 4th through 6th grade?	Phrasing (MDFS & Spectrograph) Student group Rate (i.e., WRPM)	Comprehension

Multiple Regression Assumptions.

There are eight assumptions that must be met before running a multiple regression. Assumptions can be checked using SPSS. The first assumption of multiple regression is that the dependent variable is measured on a continuous level (i.e., interval). In this study the dependent variables (i.e., reading rate, comprehension) are measured on continuous levels meeting the first assumption of multiple regression.

The second assumption of multiple regression is that it requires two or more independent variables that are continuous or nominal. Continuous variables are measured at the interval or ratio level. Nominal variables are measured as categorical or group. This study includes three continuous independent variables (i.e., phrasing, rate, comprehension) and one nominal categorical independent variable (i.e., student group).

The third assumption of multiple regression is independence of observations. This assumption can be tested by running the Durbin-Watson test looking for a value approximately close to 2 but not higher then 3.

The fourth assumption of multiple regression is linearity. This assumption states two requirements, (1) there needs to be a linear relationship between the dependent variable and each of the independent variables, and (2) there needs to be a linear relationship between the dependent variable and the independent variables collectively. To test for the first requirement partial regression plots between each independent variable and the dependent variable will be created. For categorical independent variables the plot will be ignored. The plots should resemble an approximately straight line to meet this requirement. For the second requirement, a scatterplot will be created from the standardized residuals against the unstandardized predicted values. Again, the plots should resemble an approximately straight line. If this assumption is violated the data can be transformed, and the analysis can be rerun.

The fifth assumption of multiple regression is homogeneity of variance (i.e., homoscedasticity). This assumptions states that the variance is equal for all values of the predicted dependent variables. This assumption can be checked by creating a scatterplot of the studentized residuals against the unstandardized predicted values. This assumption is met if the residuals in the scatterplot are randomly scattered and do not follow any pattern. If they follow a pattern (i.e., funnel shape) this assumption will be violated. If this assumption is violated three possible solutions exist, (1) running the regression with

robust standard errors, (2) transforming the dependent variable and/or independent variables, and (3) using weighted least squares regression equation.

The sixth assumption of multiple regression is no multicollinearity. Multicollinearity occurs when two or more independent variables are highly correlated (Alin, 2010). This assumption can be checked by inspecting correlation coefficients and Tolerance and Variable Inflation Factors (VIF). Running the analysis through SPSS will provide a correlation table of all variables in the model along with Tolerance and VIF scores. To meet this assumption all independent variables should not have correlations greater than 0.7. Tolerance scores should be smaller than 0.1 and VIF scores should be smaller than 10 (Hair et al., 2014). If this assumption is violated then one solution is dropping the independent variable that is highly correlated and re-running the multiple regression.

The seventh assumption of multiple regression is no outliers, leverage, or influential points. Outliers include data points that do not follow the usual pattern of points (Hawkins, 1980). SPSS creates a column of studentized deleted residuals. This column can be inspected for studentized residuals greater than $\pm$ three standard deviations. If outliers are present then they would need to be removed and the multiple regression would need to be rerun. To check for leverage point, SPSS will also provide a column with leverage values for each case. Leverage values that are less then 0.2 are considered safe, 0.2 to 0.5 are considered risky, and values above 0.5 are considered dangerous (Huber, 1981). If risky or dangerous leverage points exist then two solutions exist, (1) remove them from the data set and rerun the multiple regression, and (2) take

note of them and check for influential points. To check for influential points SPSS will provide Cook's Distance values for each case (Cook, 1977). Values above 1 are considered influential points and two solutions exist, (1) remove them from data set and rerun the multiple regression, and (2) transform the data.

The eighth and final assumption of multiple regression is normality. This assumption is met if the residuals are normally distributed. This assumption can be checked by using a histogram and P-Plot of standardized residuals. The histogram should indicate that the residuals are approximately normally distributed. The P-P plot should also show that the residual points are approximately following a diagonal line. Another way to check this assumption is by using Normal Q-Q Plot of the studentized residuals. This plot should show that the studentized residual points are approximately following a diagonal line. If this assumption is violated the data can be transformed or the researchers can choose not to rely on the normally distributed errors and continue to analyze the data set.

Overall Model Fit

Once all assumptions have been met the results can be interpreted. The first step would be to check the overall model fit. SPSS can provide a model summary table that includes the multiple correlation coefficient *R,* R^2, and adjusted R^2 which provide information on the overall model fit. *R* provides information on the scores between the regression (i.e., predicted scores) and the dependent variable actual scores (Miles, 2005). *R* also measures the strength of the linear associations between the variables and provides a goodness of fit for the model. Values for *R* will range from 0 to 1. Values closer to 1 are

considered a stronger linear relationship (Cohen, 1988). R^2 measures the proportion of variance in the dependent variable that is explained by the independent variable (Miles, 2005). R^2 is considered a positively biased estimate of the proportion of dependent variable that is accounted for by the regression model, however, it is still important to report it. To correct for this the adjusted R^2 should be reported. Adjusted R^2 provides a value that is usually smaller than R but is preferred because it provides a value that would be expected in the general population. Adjusted R^2 also provides an effect size. Effect sizes at 0.2 are considered small, 0.5 are considered medium, and 0.8 are considered larger (Cohen, 1988).

It is also important to look at the statistical significance of the model. SPSS provides this through an ANOVA table. If the ANOVA indicates a statistically significant result (i.e., $p<0.05$) this would indicate that the addition of the independent variables leads to a statistically significantly better model predicting the dependent variables then the mean model. It also indicates a statistically significant better fit to the data than the mean model.

Interpreting the Coefficients

Lastly, interpreting the slope coefficients for each independent variable provides information on the change to the dependent variable for every one-unit change in the independent variable. SPSS provides a coefficients table that contains unstandardized and standardized coefficients, confidence intervals, and statistical significance of each slope coefficient. If the slope coefficient is statistically significant, then this means that the coefficient is statistically significantly different from zero. If one or more of the

independent variables are not statistically significant two considerations exist when considering whether to keep or remove the independent variable, (1) data-driven (i.e., magnitude of the IV and precision), theory based (i.e., theoretical importance of IV and relationship with DV).

Figure 3. Aimsweb Reading Passage

"Charlie Clark had"

Charlie Clark had been a mailman for thirty years. He was used to 13
delivering mail in all types of weather. He'd delivered letters on 24
delightful days, and he's delivered letters on dreadful days. 33

Charlie was proud of his work and happy with his job. Never, in all 47
his years as a mailman, had Charlie ever had a problem with a mailbox. 61
Other mailmen complained about mailboxes on their routes, but not Charlie. 72

He didn't have any worries until one day when he noticed there was 85
a new box on his route. The mailbox was nailed to a branch of a dead tree. 102
It was battered, dented, and badly rusted. The flag at its side was crooked and bent. 118

Charlie felt bad about it. "People should treat their mailboxes with 129
more respect," he muttered as he dug through his bag. 139

He had letters addressed to the box, so he pulled it open and set 153
them inside. He was about to pull his hand out when the box bit him. It 169
had a grip on his hand and wouldn't let go. 179

Charlie looked up and down the street for someone to help him, but 193
there was no one in sight. He wrestled with the box for an hour, until the 208
box spit out his hand. 213

The next day he had more letters addressed to that box. With the 226
letters in his hand, he stopped in front of it. He waited for something to 241
happen, but the box was quiet today. 248

Charlie quickly slipped the letters inside and almost got his hand out 260
before the box latched onto him again. 267

This time Charlie and the mailbox had a fierce battle. Charlie hit 279
and kicked the box, but still the box wouldn't let go. Finally, Charlie was 293
out of breath, and he had to stop. He rested his head on the mailbox. 308

Suddenly, he had an idea. "There, there," he told the mailbox, 319
patting it gently. "Why don't you let me go so I can deliver the rest of my mail?" 337

The mailbox began to purr and let him go nicely. 347

Charlie Clark had
Grade 4, Passage 2

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Figure 4. Multidimensional Fluency Scale (Adapted)

	Multi-Dimensional Fluency Scale (Adapted)			
	Participant ID:			
	Rater:			
	Level 1 **Non-Fluent Reader**	**Level 2** **Non-Fluent Reader**	**Level 3** **Fluent Reader**	**Level 4** **Fluent Reader**
Phrasing	Reads word-by-word **OR** in large phrase groups without meaningful punctuation. 90% of the passage is read primarily word-by-word OR in large phrase groups without meaningful punctuation. This includes 16 (20% or more) total or more mispronunciations and omissions	Reads primarily word-by-word, but two and/or three-word phrasing is present. 90% of the passage is read primarily word-by-word, but 2- OR 3-word phrasing is present at 2 or more occurrences. This includes no more than 12 (15%) total mispronunciations and omissions	Several three-word or longer word phrases. 90% of the passage is read with several 3- word OR longer word phrases. This includes no more than 8 (10%) total mispronunciations and omissions	Longer than three-word phrases throughout the **entire** reading. 90% of the passage is read with longer than 3-word phrases. This includes no more than 4 (5%) total mispronunciations and omissions
Score	1 ☐	2 ☐	3 ☐	4 ☐

CHAPTER IV

RESULTS

This chapter reports the findings of reading prosody regarding predictors for reading rate and reading comprehension. Each section will include the following: (1) description of variables, (2) assumptions for multiple regression, (3) multiple regression findings, and (4) interpretation of coefficients.

Are phrasing, comprehension, and student group (i.e., autism, typically developing) significant predictors of reading rate (i.e., WRPM) for students in 4th through 6th grade?

Findings for the Multidimensional Fluency Scale

Variables. The independent variables in this model include phrasing (i.e., MDFS), comprehension (i.e., WJIV-PC), student group (i.e., autism, typically developing). The dependent variable in this model is rate (i.e., AIMSweb).

Multiple Regression Assumptions. There was independence of residuals, as assessed by a Durbin-Watson statistic of 1.910. The assumption of homoscedasticity was met, as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values (see figure 5). No evidence of multicollinearity was present, as assessed by tolerance and variable inflation factors (VIF) values greater than 0.1. There was also no studentized deleted residuals greater than ±3 standard deviations, no leverage values larger than 0.2, and no values for Cook's distance above 1. Furthermore, the assumption of normality was met, as assessed by a Q-Q Plot (see figure 5).

Multiple Regression Findings. A multiple regression was run to predict rate from phrasing (i.e., MDFS), comprehension, and group. The multiple regression model was statistically significant for the prediction of rate, $F(3,41)=6.573$, $p < 0.001$, adj. $R^2 = 0.28$. The addition of the independent variables into the regression model explained 28% of the variability of the dependent variable rate. Phrasing outcomes from the MDFS and comprehension were statistically significant ($p<0.05$) to the prediction. Regression coefficients and standard errors can be found in table 7 (below).

Coefficient Interpretation. For every one unit increase in phrasing we expect a 15.118 increase in rate assuming comprehension and group are held constant ($p=0.003$). For every one unit increase in comprehension we expect a 0.659 increase in rate assuming phrasing, and group are held constant.

Table 7. Multiple Regression Results for MDFS & Rate Outcome

	B	95% CI for *B*		SE *B*	β	R^2	ΔR^2
		LL	UL				
Constant	10.876	-47.926	69.677	29.116	-	0.325	0.275***
Group	-7.923	-28.712	12.867	10.294	-0.105		
Phrasing	15.118	5.330	24.907	4.847	0.406 **		
Comp	0.659	0.089	1.229	0.282	0.314 *		

Note. B=unstandardized regression coefficient; CI=confidence interval; *SE B*=standard error of the coefficient; β = standardized coefficient; *LL*= lower limit; *UL*: upper limit; Comp= comprehension; R^2: coefficient of determination; ΔR^2: adjusted R^2.
*p<.05. **p<.01. ***p<.001

Findings from the Spectrographic Analysis

Variables. The independent variables in this model included phrasing (i.e., spectrograph), comprehension (i.e., WJIV-PC), student group (i.e., autism, typically developing). The dependent variable in this model was rate (i.e., AIMSweb-ORF).

Multiple Regression Assumptions. There was independence of residuals, as assessed by a Durbin-Watson statistic of 2.25. The assumption of homoscedasticity was met, as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values (see figure 6). No evidence of multicollinearity was present, as assessed by tolerance and variable inflation factors (VIF) values greater than 0.1. There was also no studentized deleted residuals greater than ±3 standard deviations, no leverage values larger than 0.2, and no values for Cook's distance above 1. Furthermore, the assumption of normality was met, as assessed by a Q-Q Plot (see figure 6).

Multiple Regression Findings. A multiple regression was run to predict rate from phrasing (i.e., spectrograph), comprehension, and group. The multiple regression model was statistically significant for the prediction of rate, $F(3,41) = 15.424$, $p < 0.001$, adj. $R^2 = 0.496$. The addition of the independent variables into the regression model explained 50% of the variability of the dependent variable rate. Phrasing outcomes from spectrographic analysis and comprehension were statistically significant ($p<0.05$) to the prediction. Regression coefficients and standard errors can be found in tabled 8 (below).

Coefficient Interpretation. For every one unit increase in phrasing we expect a 1.031 decrease in rate assuming comprehension and group are held constant ($p<0.001$).

For every one unit increase in comprehension we expect a 0.520 increase in rate assuming phrasing, and group are held constant ($p<0.05$). Regression coefficients and standard errors can be found in table 8 (below).

Table 8. Multiple Regression Results for Spectrograph & Rate Outcome

	B	95% CI for *B*		SE *B*	β	R^2	ΔR^2
		LL	UL				
Constant	111.023	66.227	155.819	22.181	-	0.530	0.496***
Group	-5.822	-23.134	11.490	8.572	-0.077		
Phrasing	-1.031	-1.399	-0.662	0.182	-0.620 **		
Comp	0.520	0.041	0.998	0.237	0.248 *		

Note. B=unstandardized regression coefficient; CI=confidence interval; *SE B*=standard error of the coefficient; β = standardized coefficient; *LL*= lower limit; *UL*: upper limit; Comp= comprehension; R^2: coefficient of determination; ΔR^2: adjusted R^2.
*p<.05. **p<.01. ***p<.001

Are phrasing, rate (i.e., WRPM) and student group (i.e., autism, typically developing) significant predictors of comprehension for students in 4th through 6th grade?

Findings from the Multidimensional Fluency Scale

Variables. The independent variables in this model included phrasing (i.e., MDFS), rate (i.e., Aimsweb ORF), and student group (i.e., autism, typically developing). The dependent variable in this model was comprehension (i.e., WJIV-PC).

Multiple Regression Assumptions. There was independence of residuals, as assessed by a Durbin-Watson statistic of 1.223. The assumption of homoscedasticity was met, as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values (see figure 7). No evidence of multicollinearity was

present, as assessed by tolerance and variable inflation factors (VIF) values greater than 0.1. There was also no studentized deleted residuals greater than ±3 standard deviations, no leverage values larger than 0.2, and no values for Cook's distance above 1. Furthermore, the assumption of normality was met, as assessed by a Q-Q Plot (see figure 7).

Multiple Regression Findings. A multiple regression was run to predict comprehension from phrasing (i.e., MDFS), rate, and group. The multiple regression model was statistically significant for the prediction of comprehension, $F(3,41) = 3.359$, $p < 0.05$, adj. $R^2 = 0.139$. The addition of the independent variables into the regression model explained 14% of the variability of the dependent variable comprehension. Rate was statistically significant ($p<0.05$) to the prediction. Although phrasing and group were not statistically significant, the decision was made to keep these variables in the model because when they were removed the overall model was no longer statistically significant. Regression coefficients and standard errors can be found in table 9 (below).

Coefficient Interpretation. For every one unit increase in rate we expect a 0.178 increase in comprehension assuming rate, phrasing, and group are held constant (p=0.05).

Table 9. Multiple Regression Results for MDFS & Comprehension Outcome

	B	95% CI for *B*		SE *B*	β	R^2	ΔR^2
		LL	UL				
Constant	71.056	50.208	91.903	10.323	-	0.197	0.139*
Group	-8.098	-18.675	2.480	5.237	-0.225		
Phrasing	-2.524	-8.126	3.078	2.774	-0.142		
Rate	0.178	0.024	0.332	0.076	0.373 *		

Note. B=unstandardized regression coefficient; CI=confidence interval; *SE B*=standard error of the coefficient; β = standardized coefficient; *LL*= lower limit; *UL*: upper limit; Comp= comprehension; R^2*:* coefficient of determination; ΔR^2: adjusted R^2.
*p<.05. **p<.01. ***p<.001

Findings from the Spectrographic Analysis

Variables. The independent variables in this model included phrasing (i.e., spectrograph), rate (i.e., AIMSweb-ORF), student group (i.e., autism, typically developing). The dependent variable in this model was comprehension (i.e., WJIV-PC).

Multiple Regression Assumptions. There was independence of residuals, as assessed by a Durbin-Watson statistic of 1.296. The assumption of homoscedasticity was met, as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values (see figure 8). No evidence of multicollinearity was present, as assessed by tolerance and variable inflation factors (VIF) values greater than 0.1. There was also no studentized deleted residuals greater than ±3 standard deviations, no leverage values larger than 0.2, and no values for Cook's distance above 1. Furthermore, the assumption of normality was met, as assessed by a Q-Q Plot (see figure 8).

Multiple Regression Findings. A multiple regression was run to predict comprehension from phrasing (i.e., spectrograph), rate, and group. The multiple regression model was statistically significant for the prediction of comprehension, $F(3,41)=3.335$, $p < 0.05$, adj. $R^2 = 0.137$. The addition of the independent variables into the regression model explained 14% of the variability of the dependent variable comprehension. Rate was statistically significant ($p<0.05$) to the prediction. Although phrasing and group were not statistically significant, the decision was made to keep these variables in the model because when they were removed the overall model was no longer statistically significant. Regression coefficients and standard errors can be found in table 10 (below).

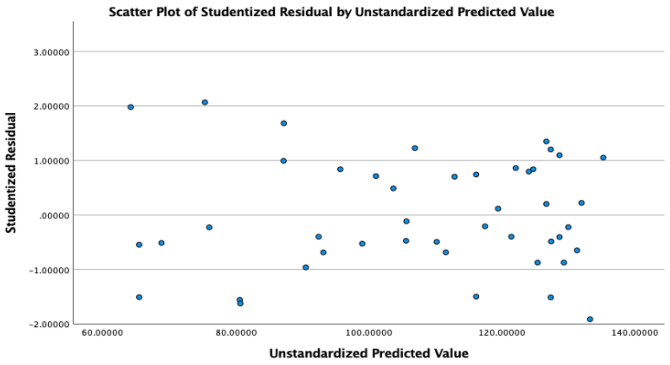
Coefficient Interpretation. For every one unit increase in rate we expect a 0.202 increase in comprehension assuming rate, phrasing, and group are held constant ($p<0.05$).

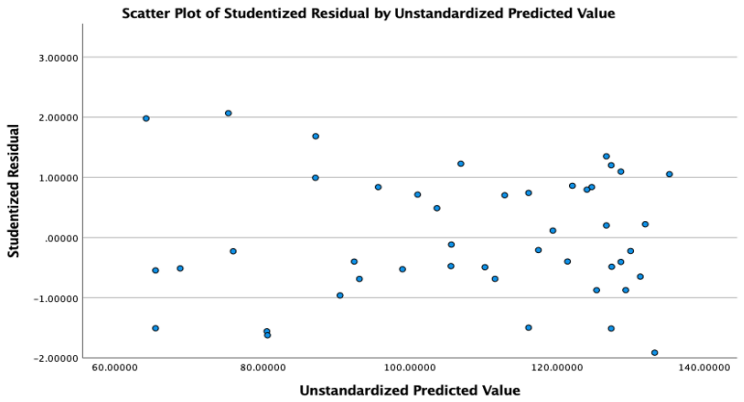
Table 10. Multiple Regression Results for Spectrograph & Comprehension Outcome

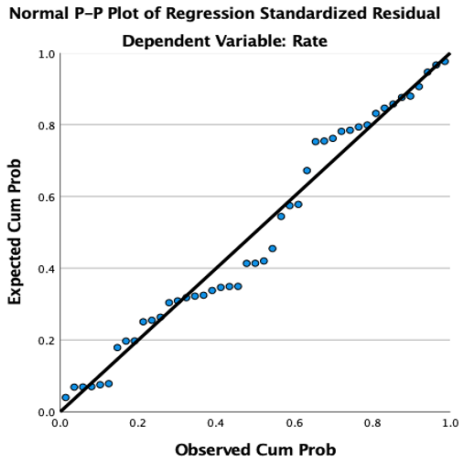
	B	95% CI for *B*		SE *B*	β	R^2	ΔR^2
		LL	UL				
Constant	54.943	24.019	85.866	15.312	-	0.196	0.137*
Group	-7.864	-18.430	2.702	5.232	-0.219		
Phrasing	0.132	-0.172	0.435	0.150	0.166		
Rate	0.202	0.016	0.388	0.202	0.424*		

Note. B=unstandardized regression coefficient; CI=confidence interval; *SE B*=standard error of the coefficient; β = standardized coefficient; *LL*= lower limit; *UL*: upper limit; Comp= comprehension; R^2: coefficient of determination; ΔR^2: adjusted R^2.
*p<.05. **p<.01. ***p<.001

Figure 5. Assumptions MDFS & Rate







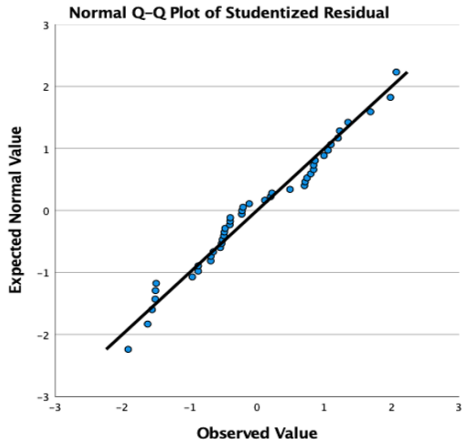
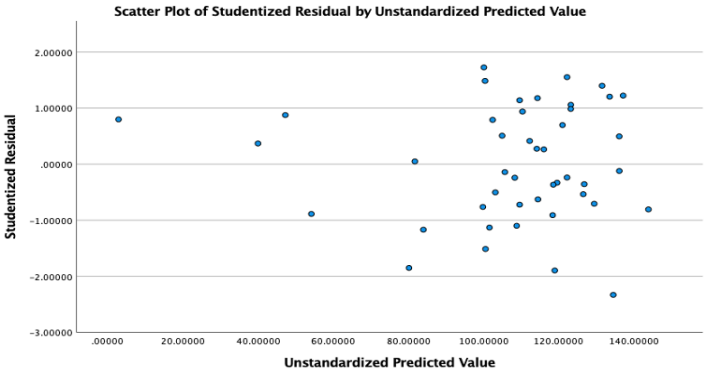
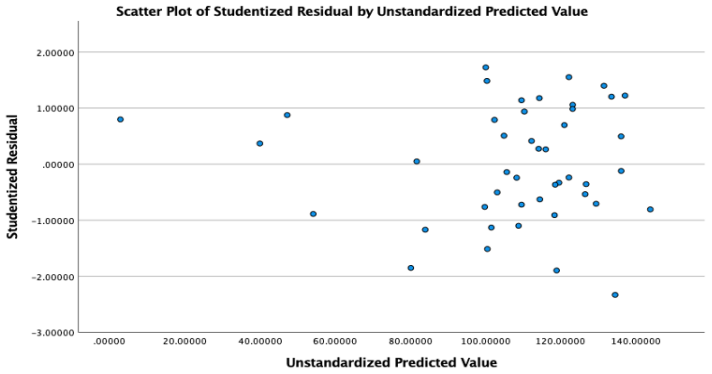
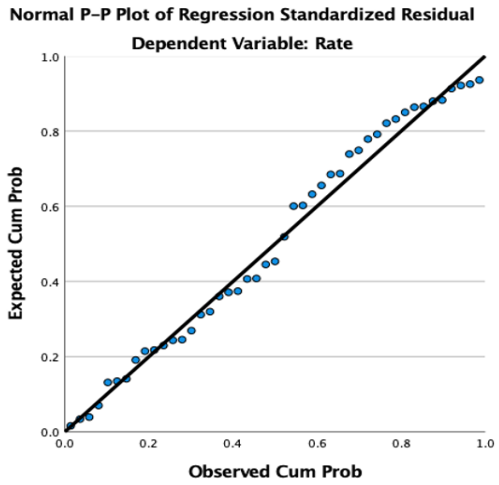


Figure 6. Assumptions Spectrograph & Rate







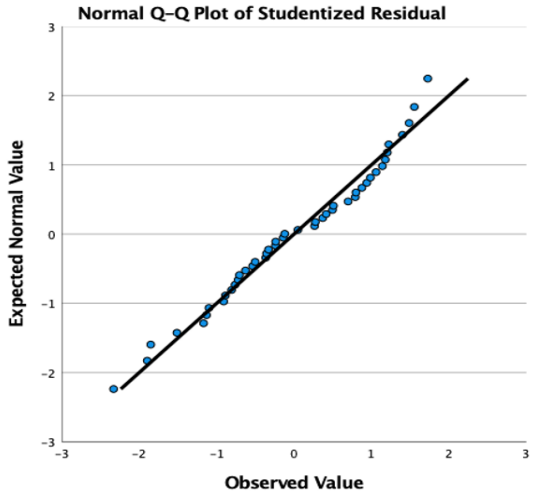
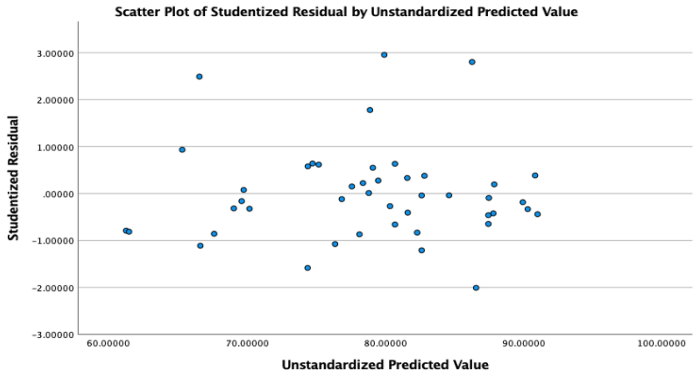
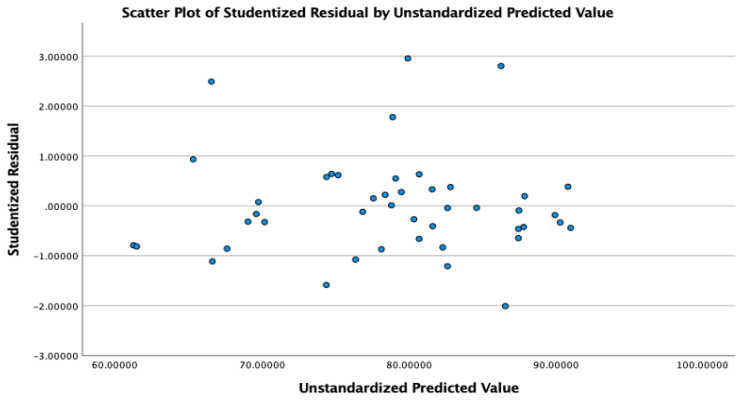
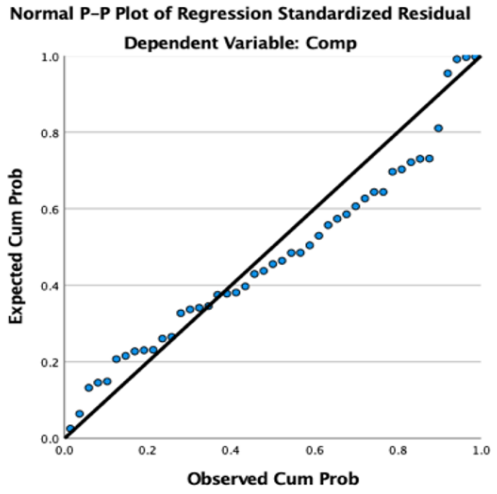


Figure 7. Assumptions MDFS & Comprehension







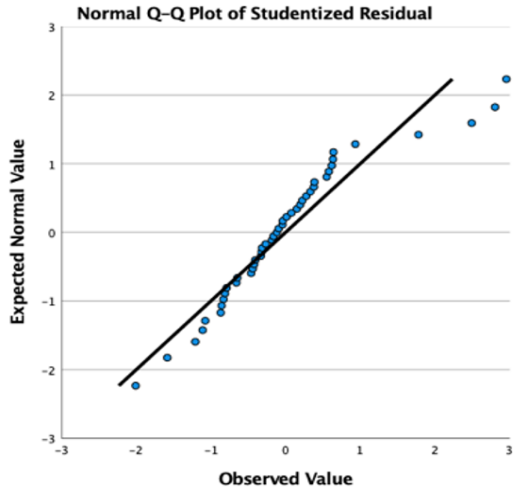
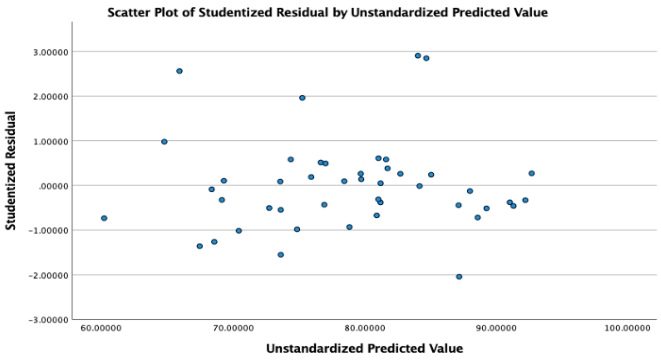
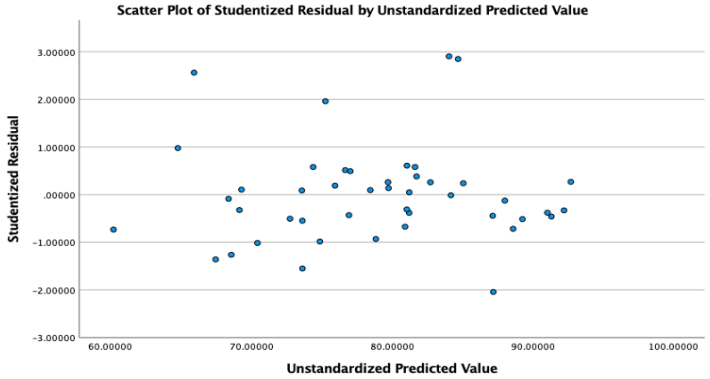
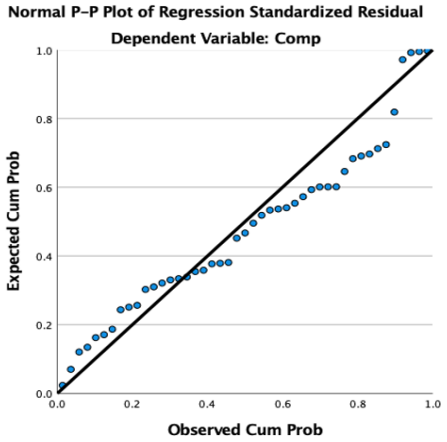
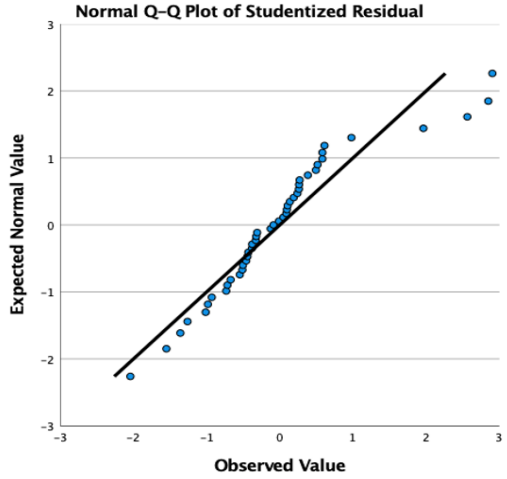


Figure 8. Assumptions Spectrograph & Comprehension









CHAPTER V

DISCUSSION

This study aimed to contribute to the literature on the relationship between phrasing and reading components (i.e., rate and comprehension) by running a standard multiple regression analysis aimed at identifying predictors (i.e., rate, comprehension, student group) of reading outcomes (i.e., rate, comprehension) when phrasing was measured using two measurement techniques (i.e., spectrograph, MDFS) for students with autism and typically developing students in grades 4 through 6.

The current study focused specifically on phrasing within prosody, given that a critical characteristic of students with autism is difficulty identifying the appropriate use of pragmatic skills such as phrasing and syntax when conveying ideas (Friedman & Sterlin, 2019). More specifically, communication research has indicated a significant group difference in expressive phrasing outcomes between students with autism and typically developing students in upper elementary grades (Diehl et al., 2013; Filipe et al., 2018; Gargan, 2020). Given these concerns, along with theoretical frameworks like the Reading Systems Framework highlighting the importance of prosody across reading development (Wade-Woolley et al., 2022), the current study contributes to understanding these associations.

The results from this study indicated that phrasing was statistically significant for the prediction of reading rate ($p<0.05$) but not for reading comprehension. The addition of the independent variables (i.e., phrasing, student group, comprehension) into the regression model explained 28% (MDFS) and 50% (spectrograph) of the variability of

rate outcomes. The addition of the independent variables (i.e., phrasing, student group, rate) into the regression model explained 14% (MDFS) and 14% (spectrograph) of the variability of comprehension outcomes.

Prosody and Reading Components

Previous literature has highlighted a moderate to strong significant relationship between prosody and reading rate (Kim et al., 2021; Sabatini et al., 2019) and a significant relationship between prosody and comprehension (Wolters et al., 2022). One emerging concern is that a majority of this research focuses mainly on overall prosody and typically developing students in early elementary grades (K-3rd grade). An aspect of this concern stems from key differences between early elementary grades (i.e., K-3rd) and upper elementary grades (i.e., 4th-6th grade) in the progression of becoming a proficient reader.

Students in early elementary grades (i.e., K-3rd grade) first learn to recognize individual letters, then letter groups, followed by word recognition (Nation et al., 2006). When considering the progression of becoming a fluent reader for upper elementary grades (i.e., 4th and above), the focus shifts to fluent reading with an emphasis on words read correct per minute and comprehension (Nation et al., 2006). Although researchers have highlighted the importance of not linking reading components to one grade level alone, given their overlap (Chall, 1983; Atamain, 2021), the apparent differences in focus across grade level make the importance of the current investigation of the relationship between prosody and reading components for upper elementary grades clearer. Especially given that the current study includes students with autism who are a group of students

that previous research has highlighted show significant weakness in reading comprehension outcomes when compared to their typically developing peers (Nation et al., 2006).

The differences in focus across grade levels also highlights another fundamental importance when looking at upper elementary grades and prosody. As previously mentioned, research has highlighted that becoming a proficient reader is more than just being able to read words quickly and accurately but also the ability to understand text (Kuhn & Stahl, 2003; Mokhtari et al., 2006). One aspect of this is phrasing, or the ability to understand syntactic structures of text by chunking groups of words into phrases and meaningful syntactic units signaled by grammatical pauses during oral reading (Kuhn & Stahl, 2003). When fluency is defined as only the number of words read correct per minute without any account for comprehension, one could assume that reading rate would decrease when phrasing increases, given that the number of pauses would increase. Yet again highlighting the importance of the current study investigating this relationship in upper elementary grades.

Predictors of Reading Rate

Phrasing. Findings from the current study indicated that phrasing accounted for 20% (MDFS) and 44% (spectrograph) unique variance in reading rate. These findings support Chung & Bidelman's (2021) findings, which indicated that phrasing accounted for 35% (spectrograph) unique variance in reading rate outcomes for a sample of 109 typically developing 3rd and 4th-grade students. Furthermore, findings support outcomes from Lochrin, Arciuli, & Sharama (2015), which indicated that phrasing accounted for

6.60% unique variance in reading rate for a sample of 63 typically developing 7 through 12-year-old students.

One potential reason the current study and Chung & Bidelman (2021) had a large difference in reported unique variance when compared to Lochrin, Arciuli, & Sharama (2015) may be due to how reading rate was measured. Chung & Bidelman (2021) and the current study, measured reading rate at the passage level, scoring the number of words a student read during a one-minute timed oral reading assessment. However, Lochrin, Arciuli, & Sharama (2015) measured reading rate using the Weschler Individual Achievement Test (WIAT-II; Weschler, 2007). This assessment does not measure passage-level reading rate; instead, it measures word-level reading rate (i.e., automaticity). Previous research has indicated that word level reading rate outcomes are not always consistent with passage level reading rate outcomes (Eason et al., 2013). More specifically Eason et al., (2013) indicated that for 88 typically developing participants ages 10 to 14 passage level reading rate outcomes were significantly higher than word level reading rate outcomes.

Another potential reason for differences in outcomes may be due to student group. Descriptive statistics from the current study indicated that 53% of overall participants scored below average on reading rate outcomes. Lochrin, Arciuli, & Sharama (2015) did not provide descriptive statistics for their sample but reported that preliminary inclusion criteria utilized outcomes from the Test of Nonverbal Intelligence (Brown, Sherbenou, & Johnson, 1997) with a standard score of 83 (mid-low average) serving as the lower cut off point. Chun & Bidelman (2021) did not report descriptive for their sample, so a

comparison was not possible. However, it is important to note that a majority of the current study sample scored below average in reading rate outcomes which may be a vital contributor to differences in outcomes.

Student Group. Findings also indicated that student group was not statistically significant to the prediction of rate for both models (i.e., MDFS and spectrograph). These findings diverge from previous findings, which have indicated that when compared to their typically developing peers, students with autism have slower speech rates (Patel et al., 2020) and longer phrase durations (Hubbard et al., 2017), which have been shown to impact various pragmatic functions (i.e., reading rate) (Lau, Losh, Speights, 2023). Descriptive statistics for reading rate outcomes indicated that 52.6% of students with autism scored two standard deviations below the mean compared to 26.9% of typically developing students who scored one standard deviation below the mean, and 23% of typically developing students who scored two standard deviations below the mean. These findings highlight that a majority of participants in both groups were scoring one or more standard deviations below the mean, which could be a reason why student group was not a significant predictor. However, it is important to note that the overall models were not significant when student group was removed. This may be due to the sample of typically developing students scoring slightly better in reading rate outcomes impacting the overall model.

While findings from the current study are not identical to previous study findings, they indicate that phrasing is a significant predictor that holds some percentage of unique variance in reading rate outcomes. Given that research has established a strong

relationship between reading rate and comprehension, along with the current study indicating that phrasing is a significant predictor of reading rate, the next question would be how phrasing relates to comprehension outcomes.

Predictors of Comprehension

Reading Rate. The current study indicated that rate accounted for 12% unique variance (MDFS and spectrograph) in comprehension outcomes. While these findings cannot be directly related to previous findings given that the variables of student group (i.e., autism and typically developing) and phrasing were held constant, which has not been investigated in a prior study. Reading research has consistently reported a strong relationship between reading rate and reading comprehension outcomes (Kim & Wagner, 2015; Kim et al., 2021; Sabatini, Wang, & O'Reilly, 2019).

Klauda and Guthrie (2008) indicated that some unexplained variance in comprehension outcomes is attributed to additional variables outside of just reading rate. The researchers investigated the relationship between three types of fluency (i.e., word, syntactic, and passage level) with reading comprehension in a sample of 278 fifth-grade typically developing students. Their findings indicated that fluency and comprehension are linked not only through reading rate but also through the processing of syntactic units (i.e., phrasing). These findings are supported by the current study, given that the overall model for reading comprehension outcomes was found to be most significant when phrasing was controlled, indicating that it played a unique role in the link between reading rate and comprehension outcomes.

Phrasing and Student Group. The current study indicated that phrasing and student group (i.e., MDFS and spectrograph) were not significant predictors of reading comprehension outcomes. Although phrasing and student group were not statistically significant for the prediction of comprehension, the decision was made it keep it in each model because when removed, the models were no longer statistically significant. Highlighting the need for further investigation of this relationship to better identify the specific role that phrasing plays in its relationship with reading comprehension outcomes. Previous studies have also highlighted that more work is needed to better understand the relationship between phrasing and comprehension (Wade-Woolley et al., 2022).

Furthermore, the findings from the current study diverge from previous findings, which have indicated that phrasing accounted for 10% (Klauda & Guthrie, 2008), 15.4% (Lochrin, Arciuli, & Sharama 2015), 5.3% (Chun & Bidelman, 2021), and 7.1% (Chun & Bidelman, 2021) unique variance in comprehension outcomes. One potential reason for this may be due to student group. Klauda & Guthrie (2008) comprised a sample of 5th-grade typically developing at-risk readers (N= 278). Lochrin, Arciuli, & Sharama (2015) comprised a sample of 7–12-year-old typically developing students (N= 63). The current study included a sample of N=45, 4th-6th grade students with autism and typically developing students.

Descriptive statistics of the current study indicated that 84% of overall participants scored below average on reading comprehension (i., WJIV-PC). Klauda & Guthrie (2008) indicated that their sample included students reading several years above grade level and several years below grade level; however, outcomes on the Gates-

MacGinite Reading Test indicated a mean grade equivalency of 5.87 suggesting a majority of students were reading at or above grade level. As previously mentioned, Lochrin, Arciuli, & Sharama (2015) did not provide descriptive statistics for their sample but reported that preliminary inclusion criteria utilized outcomes from the Test of Nonverbal Intelligence (Brown, Sherbenou, & Johnson, 1997) with a standard score of 83 (mid-low average) serving as the lower cut off point. Given that participants in the current study included a majority of participants with already below-average reading comprehension abilities compared to studies investigating similar relationships, it may be one justification for differences in outcomes for predictors of reading comprehension.

Another aspect of consideration is why student group was not a significant predictor, even when communication research has highlighted a significant group difference in expressive phrasing outcomes that overlap with reading phrasing attributes between typically developing students and students with autism (Friedman & Sterlin, 2019). When breaking down descriptive statistics for reading comprehension outcomes by group findings indicated that 84.2% of students with autism and 84.6% of typically developing students scored one to three standard deviations below the mean. Of this percentage 52.6% of students with autism scored three standard deviations below the mean and 53.8% of typically developing students scored one standard deviation below the mean. This is an important observation because it highlights a potential contribution for why student group was not a significant predictor of reading comprehension outcomes, given that both groups were already scoring below average. Furthermore, the

difference in deviation from the mean between the two groups also highlights a potential justification for why the models were not significant when student group was removed.

Overall, findings indicated that reading rate alone significantly predicted reading comprehension outcomes, assuming that phrasing and student group were held constant. However, findings from this study support previous findings, which indicated that fluency and comprehension are linked not only through reading rate but also through the processing of syntactic units (i.e., phrasing) (Klauda & Guthrie 2008) and further research is still needed to better understand the relationship between phrasing, student group, and comprehension (Wade-Woolley et al., 2022).

Differences Across Phrasing Measure

Another aspect of this study was whether findings would be similar across two phrasing measurement techniques (i.e., MDFS and spectrograph). Overall findings across both measures indicated that phrasing was a statistically significant predictor of reading rate outcomes but not reading comprehension outcomes. However, when looking at the unique variance of phrasing for both measures, findings for MDFS outcomes indicated that phrasing accounted for 20% unique variance, and findings for spectrographic analysis indicated that phrasing accounted for 44% unique variance. These findings support previous literature which has indicated that phrasing outcomes from spectrographic analysis provide more specific information and emphasize that phrasing is a significant predictor of reading rate outcomes (Kim et al., 2020; Schwanenflugel et al., 2004; Schwanenflugel, 2008), while the research which has utilized the MDFS provides a

broader understanding by reporting overall prosody outcomes instead of focusing on phrasing specifically.

Furthermore, the current study expands on the bulk of previous literature, which has utilized the MDFS in two ways, (1) it has adapted the measure to support inter-rater reliability, and (2) it focuses on the specific components of phrasing instead of overall prosody outcomes. As previously mentioned, the bulk of reading research which has utilized the MDFS has reported that overall prosody has a moderate to strong significant relationship with reading rate (Wade-Woolley et al., 2022); however, the current study expands on these findings by highlighting that the specific component of phrasing from the MDFS is a statistically significant predictor of reading rate outcomes and accounted for 20% unique variance in reading rate outcomes.

Limitations

One limitation of this study is the small sample size. This study utilized previous data sets to run a secondary analysis. Secondary analysis allowed for the use of preexisting data sets to test a new hypothesis or answer new research questions (Cheng & Phillips, 2014). A power analysis was run prior to running the investigation, and it indicated that a sample size of 100 (50 students with autism, 50 typically developing) would be best to obtain strong power. Given that the current study was not fully powered since it only included a sample size of N= 45, it only had a small chance of detecting a true effect and was also at risk of making a type 2 error (Farrokhyar et al., 2013). However, findings from this study provide considerations for future investigations, which can be run with larger sample sizes to meet power analysis requirements.

Implications for Research

One aspect of this study was adapting the Multi-Dimensional Fluency Scale (from Haskins & Aleccia, 2014). The scale was adapted to include more concrete measurement techniques to support reliability (see figure 3). This decision was made in light of the fact that previous studies had an absence of MDFS inter-rater reliability reported across studies of intervention research on prosody (Shhub et al., 2023). Although reliability above 95% was obtained and multiple steps were implemented to ensure inter-rater reliability remained consistent throughout coding, future research should focus on prosody measurement work using a larger sample to ensure that this scale can be used across coders (i.e., researchers and teachers) and student group (i.e., disability, grade, race, ELL). Furthermore, future measurement research is still needed to better understand differences in phrasing outcomes between the MDFS (adapted) and spectrographic analysis. Identifying the best approach for prosody measurement will allow future integration of prosody components within current reading instruction and classroom testing.

Descriptive statistics from the current study highlighted that 54% of the sample scored below average on reading rate outcomes, and 83% scored below average on reading comprehension outcomes. When breaking this down by student group, findings for reading rate indicated that 52.6% of students with autism and 49.9% of typically developing students scored one or more standard deviations below the mean. Findings for reading comprehension indicated that 84.2% of students with autism and 84.6% of typically developing students scored one to three standard deviations below the mean.

Although not a primary focus of the current study, given the alarming percentage of typically developing participants who scored below average in both reading rate and comprehension it is important to note that the data for the typically developing sample in the current study was collected post-pandemic. Although not much is known about the effects of distance learning it could be one potential reason for the high percentage of typically developing students in this group that scored below average. Future research should investigate group differences related to reading outcomes to understand the impact of distance learning better.

Lastly, while findings from this study provide essential contributions to research concerning reading prosody for upper elementary grades and group differences, future replication research is needed to identify if similar findings are true for larger sample sizes.

Implication for Instruction

Findings from this study still need to be more conclusive in regard to recommendations for reading instructions, and further investigation is still needed to better understand the role that prosody may contribute to instructional practices. However, the Reading Systems Framework (adapted) has highlighted the importance of phrasing across reading development (Wade-Woolley et al., 2022), supporting its integration within reading instruction.

Furthermore, recent findings from a systematic review showed potential promise with instruction targeting phrasing (Shhub et al., 2023) in addition to the more common approach to reading fluency instruction that emphasizes the use of repeated reading,

modeling, and immediate feedback to support improvements in phrasing outcomes of students in K-8th grade (Lee & Yoon, 2017). These features align with the commonly used instructional strategy of explicit instruction, which includes modeling, feedback, and multiple opportunities for practice (Hughes et al., 2017). Another recommendation is to dedicate some fluency (i.e., repeated reading) instructional time for prosody work (Vaughn et al., 2022; WWC grades 4-9 practice guide). Vaughn et al. (2022) recommend that students are taught what prosody is (i.e., reading with expression, appropriate pitch, and temp, and pauses at the right places) and why prosody is important to support better reading outcomes. Continued use of these features would support better overall reading outcomes for students.

Conclusion

Overall, findings from this study highlight that when looking at phrasing outcomes from both spectrographic analysis and MDFS, phrasing is a statistically significant predictor of reading rate outcomes for typically developing students and students with autism in grades 4 through 6. Questions remain about how much variance is explained, and findings across this body of research still needs to be more conclusive. Future investigation is still needed to better understand the relationship between phrasing, comprehension, and student group, given that no significant relationship was found; however, it should be noted that the overall model was most significant when phrasing and student group remained.

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