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The Influence of Reading Intervention on Language and Narrative Development in Children with Mild Intellectual Disability

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by

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Under the Direction of Rose A. Sevcik, PhD

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ABSTRACT

Narrative language provides unique information about the use of language above and beyond other component language skill measures (e.g., Clinical Evaluation of Language Fundamentals, CELF). The use of language as described by Bates (1976) requires integration of social, linguistic, and cognitive abilities. Prior research has theorized that narrative language may influence the relationship between language and reading skills (Snow, 1991, 1993; Westby et al., 1989), but few studies have tested this theory directly. To better understand this relationship, we evaluated the relationship between component language, narrative language, and reading among elementary school children with mild intellectual disability (MID) who participated in a reading intervention. This study aimed to: (1) examine the nature of the constructs narrative and component language skills and determine if they are best defined at a single or two-factor model; (2a) determine if latent factors of reading and/or component language predicted narrative language at post-intervention; (2b) explore if narrative language moderated the relationship between component language and reading abilities at baseline and post-intervention; (3) examine the growth of narrative comprehension, reading, and component language skills over time; and (4) examine the relationship between reading and component language with narrative language comprehension across the intervention. Overall, narrative language was a separate but related skill to component language. No significant effects for narrative language as a moderator between component language and reading were found. However, the models supported that narrative language was significantly correlated with reading across the three time points of the intervention.

INDEX WORDS: Narrative, Language, Reading, Intellectual and developmental disabilities

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DEDICATION

This dissertation is dedicated to my energetic family, and their unwavering support of my aspiration to achieve my PhD. Mark, you have always been a champion of my work and made me feel like a rock star no matter the stage. Coleman, your excitement about mommy becoming "Dr. Walters" has pushed me to the finish line. Eve, you have been physically present with me for most of my dissertation journey. I am so thankful to have had you as my research assistant to snuggle while I typed, to laugh when I felt overwhelmed, and to cry when mommy needed a break. Becoming a mother during my tenure as a PhD student was a constant reminder of why I love the work that we do: to support the language development of children, celebrate their unique qualities, and cultivate an environment where they can excel. Although it has been extremely difficult at times, I would not have had it any other way.

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1 INTRODUCTION

1.1 Narrative Language development

Narratives can be defined as “containing decontextualized language, organized temporally, causally linked, and structurally patterned around a goal-oriented action” and are the most common way we share information about the human experience (Bruner, 1991; Petersen et al., 2010). They are often accounts of real or fictional events that have already occurred, thus they are usually told in the past tense (McCabe & Rollins, 1994). For children, narrative language skills also have been shown to positively correlate with academic performance, specifically reading skills among children who are typically developing (Piasta et al., 2018; Suggate et al., 2018) and children with developmental disabilities (Barton-Hulsey et al., 2017; Fang, 2001; Feagans & Appelbaum, 1986; Fey et al., 2004; Heath, 1986; Paul & Smith, 1993; Snow, 1991; Westby, 1991). Typically developing children begin to understand and use narrative forms at a very young age (Applebaum, 1978; Bruner, 1991; Hudson & Shapiro, 1991; Nelson, 1989; Paul, 1993). Hudson and Shapiro (1991) describe that the earliest narrative form, scripts, emerge around two years of age. Other narrative forms such as personal and fictional narratives, emerge as young as three and four years of age. Personal and fictional narratives are most closely linked and studied in relationship to other cognitive abilities and academic outcomes (Snow, 1991). Applebee (1978) offers the earliest description of personal and fictional narrative development by outlining six stages of narrative skills that develop gradually throughout childhood including: heaps, sequences, primitive narratives, unfocused chains, focused chains, and true narratives. The first of these stages begins around two years of age, at which time children’s narratives are presented in “heaps”, or unrelated utterances and switch topics without any apparent connections. By three years of age, children’s narratives are typically “sequenced” appropriately, include central characters and setting, but are loosely connected and without any causal links. Between three and four years of age, “primitive narratives” are usually mastered. Applebee describes primitive narratives as including some of the basic macrostructural elements: central character, topic, and setting. These story elements are usually loosely related to a central, often concrete idea. At this stage, children also may begin to use cohesive ties (e.g., then, next, last). The fourth stage, “unfocused chains” generally occur between four and four and a half years of age and include linked events with logical cause and effect relationships but lack consistency of characters and theme. Children quickly begin to evolve their narratives to include a prominent theme acted on by a central character by five years of age. Applebee refers to these narratives as “focused chains” and adds that they include a logical sequence of events, but they rarely lead to the character attaining a goal or conclude with a logical ending. The last stage of narrative development, “true narratives,” occurs between six and seven years of age. True narratives provide a consistent perspective, true plot, character development, and sequenced events. Problems introduced at the beginning of the narrative are logically resolved by the end.

Applebee’s description of narrative development was driven by the larger structural elements of narratives, also known as macrostructures. Macrostructures include story elements such as characters, setting, actions, conflict resolution, and mental states (Heilman et al., 2010; Stein & Glen, 1978). Although macrostructures are the backbone of narrative content, microstructures, or the linguistic and syntactical features, are necessary to coherently connect the larger narrative elements together. Specifically, microstructure often refers to the use of conjunctions and complex/causal sentence structure (Justice et al., 2006). Until recently, there has not been a “gold standard” measure for narrative production, examining macro- and microstructures to assess narrative language is widely practiced across all populations. Conversely, there also are several standardized measures/subtests of narrative comprehension including Woodcock Language Proficiency Battery, Passage Comprehension subtest and Clinical Evaluation of Language Fundamentals, Passage Comprehension subtest. Comprehension of narratives usually includes reading a short passage or short story to an individual and asking them to answer questions about the story's content. Together, narrative production and comprehension are indicative of more complex and functional language use and understanding when compared to component measures of language such as expressive and receptive vocabulary.

1.1.1 Language and learning disorders

Children with language and learning disorders overall demonstrate weaker and less complex oral narratives than children who are typically developing (TD) (Fey et al., 2004; Klecan-Aker & Kelty, 1990; Roth & Spekman, 1986; Ukrainetz & Gillam, 2009). Klecan-Aker and Kelty (1990) note that children with language and learning disorders in the fourth grade produced primitive narratives at best, or narratives that have a central, concrete theme with loosely connected characters, settings, and actions. Children who are typically developing (TD) in the same grade produced true narratives, or narratives with complete episodes and causal relationships. Ukrainetz and Gillam (2009) identified lower mean length of utterance (MLU) in the narratives of children with specific language impairment (SLI) at ages six and eight than participants who are TD.

Fey et al. (2004) examined narrative abilities among different profiles of language and cognitive impairment. Their large-scale, longitudinal study included more than 500 children whose language and narrative abilities were assessed at kindergarten, second, and fourth grade.

Children in this study represented four groups: SLI, non-specific language impairment (NSLI), low non-verbal IQ (LNVIQ), and TD. Across time there were overall effects of age and gender; such that children's narrative abilities improved over time across the different groups. Girls outperformed boys especially at younger ages, but boys were observed to catch up by 4^{th} grade. Analysis of the four language/cognitive profiles revealed that children with SLI, NSLI, and LNVIQ demonstrated weaker narrative skills than children with TD. However, children with SLI and LNVIQ consistently performed better than children with NSLI across time points. This was an important finding that suggested that having gross language impairments made narrative tasks even more challenging than children who presented with low nonverbal IQ.

Children with comorbid language and reading disorders may demonstrate even more difficulty with narrative language. Vandewalle and colleagues (2012) longitudinally examined the relationship between language impairment and reading disorders from kindergarten to third grade in children with SLI. Ten children in the study were diagnosed with SLI and presented with "normal literacy skills" and a comparison group (n =8) were diagnosed with SLI and reading disorder. Although all children with SLI demonstrated persistent difficulties with language across both component and narrative language tasks, the narratives of children with SLI were better than children with SLI and reading disorders. This finding supports that both component language and reading skills may contribute uniquely to narrative abilities.

Narrative language provides unique information about the "use" of language above and beyond other component language skill measures (e.g., Clinical Evaluation of Language Fundamentals, CELF). The use of language as described by Bates (1976) requires integration of social, linguistic, and cognitive abilities. Narrative language research has highlighted that related skills such as working memory, attention, meta-cognition, and receptive language skills are important for skilled language use. In a study that included elementary aged children with dyslexia, Fisher and colleagues (2019) found that working memory explained variance in narrative language skills above and beyond contributions of component language skills as measured by the CELF. Children with attention deficit hyperactivity disorder (ADHD) also have been shown to have difficulties with narrative production but not with narrative comprehension (Tannock et al., 1993). Children with language impairment also may have weaknesses in attention and memory recall on narrative tasks. Bishop and Dolan (2003) suggested that although children with SLI overall remembered fewer story details, the children with specific weaknesses in receptive language demonstrated more difficulty than children with specific weaknesses in expressive language. Meta-cognitive skills also are important for narrative language to share a story coherently. Kaderavek and colleagues (2004) examined meta-cognitive skills during oral narrative tasks with a self-awareness assessment. Elementary aged children were asked to rate their narrative productions. They found that there was an overall age, gender, and disability effect. Boys, younger children, and children with language disorders often over-evaluated their narrative abilities. As children matured and meta-cognitive skills improved, their self-evaluations more often matched the ratings of the experimenter. Ripich and Griffith (1988) examined self-awareness on narrative language tasks in a similar population. Their results suggested that although children with language disorders improved with age, their increased self-awareness may have resulted in increased disfluencies (e.g., mazes, false starts, abandoned utterances). Together, these findings suggest that narrative language is an important skill to elucidate broader cognitive and language abilities that may have implications for general language use.

1.1.2 Intellectual Disability

The narrative skills of children with language and learning disorders have been studied extensively compared to children with intellectual and developmental disability (IDD). Among the available literature, similar themes emerge when examining the narrative development of children with IDD, such as improved ability over time and the reliance on skills other than expressive language when producing narratives. Additionally, the relationship between narrative language and academic outcomes is observed in this population. Barton-Hulsey et al. (2017) identified that among children with IDD, overall narrative skills as measured by the Narrative Scoring Scheme (Heilmann et al., 2010) explained unique variance in reading comprehension above and beyond the effect of basic word attack skills and mean length of utterance (MLU) on the narrative task. Additionally, these children were observed to have relative strengths in macrostructures. Specifically, they demonstrated higher inclusion of characters and plot elements compared to other components of the narrative (e.g., mental states). This study, however, is one of the few studies that examined narrative abilities in a heterogeneous population of children with IDD. These findings however are consistent with other narrative research that primarily included individuals with Down syndrome (DS) and other developmental disabilities (Finestack, 2012).

Abbeduto and colleagues' research on narrative language have focused on the micro-structural skills of children with Fragile X (FX) and DS. Keller-Bell and Abbeduto (2007) concluded that children with DS were less grammatical when compared with children with FX. However, several years later this lab examined MLU as a control variable when examining narrative abilities using wordless picture books among DS, FX, and TD mental age (MA) matched peers (Channell et al., 2015). The results of this study suggested that when controlling for MLU, there were no significant differences between the FX and DS groups. Overall, MLU minimized group differences across all groups including the TD, MA matched peers as well. Additionally, the DS group was observed to improve over a two-year period on macrostructures but not microstructures. Other studies have highlighted the relative strength in macrostructure, or global elements of stories, in the IDD population over time. Cleave et al. (2012) demonstrated that among children and adolescents with DS they exhibited relative strengths in macrostructures that improved with age across two years. Increased exposure to narrative language as children and adolescents mature may be one cause of this increase in macro, but not micro structure over time (Boudreau & Chapman, 2000).

1.2 Reading Development

Unlike language development, learning to read is not a natural process even for children who are TD. Learning to read requires specific and explicit instruction. Despite the challenge that learning to read presents, it is a highly important and necessary skill for children, regardless of disability, to succeed both in school and in their broader lives. Seidenberg (2017) noted that even school subjects that do not seem to be academic in nature may require reading skills to gain background knowledge and to understand and produce course projects.

Although learning to read may be thought as a separate process from learning language, the skills are intricately related. The National Reading Panel (NRP, 2000) identified that phonemic awareness, phonics, fluency, and language skills including vocabulary and language comprehension are all crucial components of reading development for children.

1.2.1 Reading in children with IDD

Much of the literature on reading disorders focus on children with developmental dyslexia or other definitions of reading disorders that exclude children with intellectual disability. Research on reading development and interventions among children with IDD is relatively recent (Sevcik et al., 2019). Much of the work that has occurred in this population has focused on teaching narrow skills such as memorizing sight words and letter-sound correspondences (Allor et al., 2014; Browder et al., 2006; Sevcik et al., 2019). More recently, there have been several studies focused on providing intervention to children with a range of IDD that have examined the relationship among pre-reading skills and reading outcomes (Barker et al., 2013; Wise et al., 2010) and efficacy of instructional practices (Allor et al., 2010, 2014; Browder et al., 2008; O'Connor et al., 2010)

Although much of the research on reading in this population focuses on response to intervention, there is evidence that the relationships between pre-reading skills (e.g., phonological awareness and vocabulary) and reading abilities is similar to that of children who are TD. Wise and colleagues (2010) examined the relationships between variables known to be supportive and predictive of reading development (i.e., phonological awareness, word/nonword identification, vocabulary knowledge) among 80 elementary aged children with mild IDD. Results supported that phonological awareness was significantly related to measures of reading achievement and vocabulary. This important finding justified providing children with IDD instruction in phonological skills as a foundation for their later reading skills instead of focusing on sight word memorization only. Further explorations of the relationship between phonological processing and language among children with mild IDD also have supported this finding. Barker and colleagues (2013) examined the phonological processing and language skills among 294 elementary aged children with mild IDD. The authors used confirmatory factor analysis to model phonological processing skills. Two factors, phonological awareness and naming speed, fit the data best. They demonstrated that the latent factor of phonological awareness had stronger positive correlations with language and reading variables when compared to naming speed.

Evidence from research that examines the efficacy of instructional programs targeting reading for children with IDD support many of the same findings articulated by the National Reading Panel (NRP, 2000), including teaching phonemic awareness and letter sound knowledge to improve decoding skills, as well as targeting vocabulary and other language skills to improve fluency, background knowledge, and reading comprehension. Allor and colleagues (2014) examined the efficacy of a reading intervention in a four-year longitudinal study that targeted word level skills (e.g., phonological awareness letter-sound knowledge), fluency, and comprehension in elementary aged children with IQs ranging from 40 - 80. Children in the reading intervention group received daily instruction for 40 to 50 minutes of instruction in small groups, one to four children. Children in the intervention group were compared with children randomly assigned to a business as usual group in which the children received whatever reading instruction their district/school specified. Results from longitudinal hierarchical linear modeling (HLM) suggested the intervention group responded significantly better than the control group on almost every measure including blending real/nonwords, segmenting words, expressive and receptive vocabulary, non-word reading and oral reading fluency. The authors found statistically significant differences in reading comprehension at the end of intervention but this significant difference between the intervention and control group was not observed in listening comprehension. Additional analyses on the impact of IQ on rate of change revealed that IQ significantly affected response to instruction as measured by vocabulary, phonemic decoding, and fluency but not phonological processing. These results support the work by Wise et al., (2010) and Barker el al., (2013) that phonological processing among children with mild IDD is not necessarily impacted by IQ and thus should be an important area of focus when beginning reading instruction in this population. The findings from Allor's lab also reported that IQ was negatively correlated with the time it took to respond to the intervention. The lower the IQ, the longer it took to respond to intervention.

Although it is generally accepted that children with IDD may take longer to achieve the same skills in reading as children who are TD or with reading disorders without the presence of IDD, there is some research that supports children with some baseline knowledge of pre-reading skills may show results in decoding and sight word recognition more quickly than others skills (e.g., fluency). In a single-subject research design, Lemons et al. (2012) examined the effects of reading intervention for 15 children (ages 5 – 13) with Down syndrome. Children were assigned to three different interventions depending on their abilities to identify letter sounds and copy a model of segmenting words. Instruction was conducted by trained school staff and ranged for approximately 30 to 40 minutes 4 days per week for 12 weeks. Overall, children made gains in reading phonetically regular words and high frequency words, but they did not see generalization to reading fluency. Additionally, children with very little letter knowledge at the baseline did not demonstrate improvements that could be attributed to the intervention. In another study, Browder and colleagues (2008) also reported positive effects of direct reading intervention for children with significant developmental disabilities who may communicate using augmentative and alternative communication (AAC). The intervention, Early Literacy Skills Builder (Browder et al., 2008), targeted sight word identification, letter-sound correspondences, identifying initial/final sounds, and vocabulary during one school year. Children were included in the study if they were in kindergarten through 4th grade, with an IQ below 55, and reading below the first-grade level. The 93 children in the study were randomly assigned to either the intervention condition or a comparison group which focused on sight word instruction. At the conclusion of the intervention, children in the treatment condition had significantly better literacy scores and receptive vocabulary than children in the comparison group.

The effects of reading intervention on language skills can also be observed in this population on functional measures of language. Barton-Hulsey and colleagues (2017) examined the relationship between narrative language, decoding, and reading comprehension among third and fourth grade children with mild IDD. Narrative measures included measures of microstructure (e.g., mean length of utterance, number of different words) and macrostructure (i.e., Narrative Scoring Scheme composite score) from a story retell. Performance on measures of narrative language and reading were examined after the children participated in 120 hours of reading intervention, which targeted phonological skills, decoding, and word retrieval. Significant positive relationships were observed between decoding skills, reading comprehension, and both micro and macro-structural elements of narrative language. These correlational results support further study of the potential causal and directional links between narrative language and reading intervention in children with mild IDD.

1.3 Relationship between narrative language and reading skills

Several researchers have hypothesized the connections between narrative language and reading skills (Snow, 1991, 1993; Westby et al., 1989). Westby and colleagues (1989) described that this relationship may exist because narrative language connects oral and written language. Westby proposed that narratives lie at the intersection of the context (shared experience vs. decontextualized), function (sharing past events vs. teaching/sharing new information), and method (phonemes vs graphemes) of oral vs written language. Snow (1991) hypothesized that the decontextualized nature of narrative language may be why narratives serve as a bridge between oral and literacy skills. Because the context of a story being shared is usually unknown (or decontextualized) the narrator is required to create a "reality" for the listener by using story grammars (Stein & Glen, 1979) and high points (Labov, 1972) cohesively pieced together. Later, Snow (1993) noted that while vocabulary may be predictive of later reading skills, it is in narrative tasks that children integrate vocabulary knowledge into complex grammars while self-monitoring to convey a message. These rich modes of expression also support the idea that narrative language helps children move successfully from decontextualized language skills to reading and comprehending contextualized written stories. Although no studies to date have specifically examined if narrative language acts as a moderator between component language and reading outcomes, there is evidence supporting positive relationships between component language, narrative, and reading skills.

Several studies have noted that narrative language skills are related to reading skills across age groups (Allor et al., 2009; Storch & Whitehurst, 2002), ability level (Catts, 2001; Feagans & Appelbaum, 1986) , and language status (Miller et al., 2006). However, the majority of the work examines preschool and kindergarten narrative language skills to relate to current reading skills or future reading abilities. Piasta and authors (2018) identified that narrative language and emergent reading skills (e.g., conventions of print, phonological awareness) were significantly and positively correlated among three to five-year-old children. They also found that emergent literacy fully mediated the relationship between narrative language and word reading. The authors hypothesized that in addition to narrative language's relationship to emergent literacy skills, narratives may increase exposure to print, improve metalinguistic awareness, and support reading comprehension. In a longitudinal study, Griffin and colleagues (2004) assessed whether oral discourse skills in preschoolers predicted later reading comprehension after accounting for the contribution of the component language skill, morphosyntax. The authors found that among 32 preschoolers (range = 5;2 to 5;7 years), their macrostructure and elaboration of a narrative task significantly predicted reading comprehension at age 8, after controlling for morphosyntax skills. In a study that examined narrative retell and narrative generation tasks in preschoolers, Hipfner-Boucher and colleagues (2014) hypothesized that narrative discourse would be related to phonological awareness skill. This hypothesis was supported by previous research.

Comprehension of narratives also has demonstrated some correlation with early reading skills among pre-school aged children (Kendeou et al., 2009; Lynch et al., 2017). Among 4-year olds, overall recall and answering comprehension questions correlated with letter identification and phonological awareness respectively. Six-year old's word identification abilities also was correlated with answering narrative comprehension questions accurately (Lynch et al., 2017).

Children with language disorders also show a correlation between narrative language and reading skills. In a study that examined different subtypes of language disability among 63 children (*M*age = 7.19) with learning disorders, Feagans and Appelbaum (1986) identified six clusters of language skill that were defined by their relative strengths: syntax, semantics, narrative, superior narrative, and superior syntax and semantics. In the syntax, semantics, and superior syntax and semantics groups the children demonstrated strengths in either or both component skills of language but were not able to generalize these skills to generate quality narratives. Conversely, children in the narrative and superior narrative groups demonstrated higher narrative ability relative to their component language skills. Children with profiles higher in narrative abilities also were more likely to have higher academic achievement as measured by their performance on reading recognition, reading comprehension, and math skills. This study identified significant relationships between narrative skills and reading, distinguishing component language skills and narrative abilities for children with language and learning disorders. It is important to note that children were excluded from this study if they had “low-IQ”.

Catts and colleagues (1999) longitudinally assessed children at kindergarten and second grade, based on their oral language abilities, reading abilities, and IQ. In this study, oral language was measured by the *Test of Language Development*, Second Edition-Preschool (Newcomer & Hammill, 1988) and a narrative task that required children to comprehend and retell a story. Reading was measured by phonological processing at kindergarten and reading comprehension and word identification in second grade. IQ was measured by the Wechsler Intelligence Scale for Children-111 (WISC-111; Wechsler, 1991) and children were divided into two groups normal and low IQ (>1 SD below mean). The majority of poor readers had oral language deficits or oral-language and phonological deficits. The authors compared the children’s language abilities among groups of good and poor readers separated by different reading measures. When children were grouped based on reading comprehension, narrative language was more impaired among the poor readers than when the children were grouped based on decoding skills. When children were grouped based on normal and low IQ, the difference in narrative language was significant but the effect was not as strong as when the groups were defined by reading skill. These results support that reading abilities, more than IQ, may be important when predicting narrative language as an outcome. Although we have begun to understand much more about the relationship between narrative language and reading outcomes among children with language and learning disorders.

Although no research study has examined if reading intervention specifically improves narrative skills, there is modest evidence that narrative language intervention may improve literacy skills via direct or indirect relationships with reading skills over time. In a cross-sectional study, Kendeou and authors (2009) examined the relationship between oral language, decoding, and reading comprehension in two cohorts of children: Pre-kindergarten and kindergarten (cohort 1) and kindergarten and second grade (cohort 2). Oral language was measured by vocabulary, auditory narrative comprehension, and a visual narrative comprehension task. Decoding was measured by letter and word identification and fluency from the Woodcock Reading Master Test-Revised (Woodcock, 1987) and the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Good & Kaminski, 2002). The authors measured reading comprehension only at second grade with *The Barber's Wife,* an age appropriate Indian folk tale. Structural equation models (SEM) were fit examining the relationships between pre-kindergarten to kindergarten (cohort 1) and kindergarten and second grade (cohort 2). The best fitting model in Cohort 1 illustrated that pre-kindergarten decoding skills mediated the relationship between pre-kindergarten oral language skills and kindergarten decoding skills. Alternative models that included cross-lagged paths between the constructs and time points did not significantly improve the model fit. In cohort 2, kindergarten oral language skills no longer significantly predicted kindergarten decoding skills but rather was indirectly related to second grade reading comprehension via second grade oral language skills. Together these findings support that oral language skills, as measured by narrative comprehension and receptive vocabulary, are differentially related to reading skills over time. Additionally, they introduce many unanswered questions about how specific aspects of language (e.g., vocabulary and narrative) relate to reading skills over time.

Similarly, Storch and Whitehurst (2002) conducted a large scale (n = 626), longitudinal study that examined the relationship between oral language and reading skills from preschool to fourth grade. This study found that oral language skills in pre-school indirectly related to kindergarten decoding, first and second grade reading ability, and third and fourth grade reading accuracy and comprehension. Kindergarten oral language skills were significantly, but weakly related to later reading skills. Notably, the latent construct of oral language in pre-kindergarten included a narrative retell task (i.e., Renfrew Bus Story; Glasgow & Cowley, 1994), whereas later oral-language constructs did not include this task (note: the narrative task was only administered in pre-kindergarten). It is possible that the addition of a narrative task to the oral language construct added predictive abilities to the later reading skills compared to other constructs of oral language that only included component language skills.

Although all of the studies to date have tested the assumption that narrative language precedes and predicts reading skills, there also is evidence that reading interventions that incorporate instruction on vocabulary and semantics may improve not only reading skills but also component language skills (Allor et al., 2010; Barton-Hulsey et al., 2017; Browder et al., 2008). It is important to more fully understand the relationship between reading intervention and language skills, including narrative language, over time to support our theoretical understanding of these skills and to shape instructional practices for children with comorbid reading and language deficits who have IDD.

1.4 Aims

This study evaluated the relationship between component language, narrative language, and reading among elementary school children with mild intellectual disability (MID) who participated in a reading intervention. This study aimed to: (1) examine the nature of the constructs narrative and component language skills and determine if they are best defined as a single or two-factor model; (2a) determine if latent factors of reading and/or component language predicted narrative language at post-intervention; (2b) explore if narrative language moderated the relationship between component language and reading abilities at baseline and post-intervention; (3) examine the growth of narrative comprehension , reading, and component language skills over time; (4) examine the relationship between reading and component language with narrative language comprehension across the intervention.

We hypothesized that both the one and two-factor measurement models of narrative and component language skills would fit well, but the two-factor model would demonstrate better fit. Based on previous research linking reading and component language skills with narrative language, we hypothesized that these measures would predict narrative language outcomes at post intervention and reading skills would explain unique variance in narrative language above and beyond the contribution of component language skills. Although most research examines reading and component language skills as predictors of narrative outcomes, also we hypothesized that narrative language would moderate the relationship between these predictors at post-intervention based on theoretical evidence that narrative language ability may influence the relationship between these two skills (Snow, 1991). Lastly, we hypothesized that when examined longitudinally, narrative language comprehension and reading skills would be positively related at all three time points: pre-intervention, after 60 hours of intervention, and post-intervention.

2 METHODS

2.1 Participants

The current study examines 95 participants 2nd through 5th graders (Mage = 9.39 years) who were originally recruited to participate in a larger study investigating the outcomes of two reading interventions among elementary school children with mild intellectual disability (MID). Children were determined to have intellectual disability based on the school's classification. However, not all student's individualized education plans (IEPs) reported standardized assessment for cognitive ability. Seventy-six of the 95 students' IEPs (80%) reported IQ assessment data (M = 63.74, range 44 – 90). This sample includes 43 girls and 52 boys who represent diverse backgrounds: African American (n = 52), Caucasian (n = 21), Hispanic (n = 13), Asian (n = 2), and Mixed (n = 7). The students were randomly assigned to one of three groups: (1) PHAB intervention which targeted phonological skills (n = 49) or (2) PHAB + RAVE-O intervention which targeted vocabulary, fluency, and retrieval in addition to phonological skills (n = 46). Children were eligible to participate in the study if they were identified by their home school as having a MID and presented with difficulty in developing reading skills or were not yet reading. Children who spoke English as a second language, demonstrated hearing impairments, uncorrected vision impairment, or disorder of serious emotion and/or psychiatric disturbance based on parental report or school record were excluded from the larger study. Children presented with a variety of etiologies including Down syndrome, fragile X syndrome, and unspecified.

Children in this study were recruited in years three through five of the larger study who completed 120 hours of intervention. The larger study included 228 participants 2nd through 5th graders (Mage = 9.50 years; 81 girls and 147 boys) who met the inclusionary criteria mentioned above. This larger group of children were used for the multivariate models.

2.2 Measures

Both formal and informal measures were used to examine children's language, processing, and reading skills. The full battery of assessments was given before intervention (time 0), immediately following 60 hours of intervention (time 60), and at the end of 120 hours of intervention (time 120). Narrative assessment was added in years three through five of the larger study at time 0 and 120.

The following standardized language measures were used to examine language abilities across all time points. Peabody Picture Vocabulary Test, Third edition (PPVT-3; Dunn, 1997) assesses single word receptive vocabulary by having an individual identify which of four pictures corresponds with a give spoken word. Expressive Vocabulary Test (EVT, Williams, 1997) assesses an individual's single word expressive vocabulary by providing a single picture stimulus and asking the participant to generate a label for the picture. Test of Word Finding-2 (TWF-2; German, 2000) assesses an individual's ability to find words based on accuracy and speed. Woodcock Language Proficiency Battery (WLPB; Woodcock, 1991) intends to provide a comprehensive assessment of English language ability and achievement in oral language, reading, and writing. Five subtests from the WLPB were administered: memory for sentences, listening comprehension, letter word ID, passage comprehension, and word attack.

The Clinical Evaluation of Language Fundamentals (CELF-4; Semel, Wiig, & Secord, 2003) is a comprehensive assessment of component receptive and expressive language at the word, phrase, and sentence level. Six subtests from the CELF-4 were administered: concepts and following directions, word structure, recalling sentences, formulated sentences, sentence structure, and word classes.

An unstandardized language sample also was collected from the children at all time points. In years three through five of the study, narrative language samples were collected at baseline (Time 0) and the end of intervention (Time 120). Narrative language samples were elicited using Frog Goes to Dinner (Meyer, 1969), a wordless picture book. The examiner first asked the child to look at each page of the book then tell the story to the examiner. A set of standardized prompts (e.g., "tell me more" and "I'd like to hear more about that") were used to encourage the child to continue telling the story if necessary. Each narrative was videotaped and transcribed using the Systematic Analysis of Language Transcript (SALT) software (Miller & Iglesias, 2012). Transcripts were created by a trained graduate research assistant. A second transcriber independently reviewed and corrected the original transcript according to SALT conventions. After the transcripts were complete, they also were scored based on an adapted version of the Narrative Scoring Scheme (NSS, Heilmann et al., 2010) by Finestack et al. (2012). The NSS examined and scored (0-5) the macrostructure of the student's narratives on the following elements: introduction, character development, mental states, referencing, conflict resolution, cohesion, and conclusion. Together these scores were summed to create a NSS composite score. Reliability of both the SALT transcripts and the NSS scores were achieved (see Barton-Hulsey et al., 2017).

The following standardized reading measures were collected across all time points. Comprehensive Test of Phonological Processing (CTOPP; Wagner et al., 2013). Four subtests from the CTOPP were administered: elision, rapid color naming, rapid letter naming, and blended words. These subtests assess a child's ability to manipulate phonemes through phoneme combination and removal as well as phonological processing speed. Test of Word Reading Efficiency (TOWRE; Torgeson et al., 1999) was administered to assess sight word reading and phonemic decoding efficiency. Three subtests from the Woodcock Reading Mastery Test, Revised- Normative Updated (WRMT-R/NU; Woodcock, 1998) were administered: word identification, word attack, and passage comprehension. These subtests examined a child's ability to read and pronounce words in isolation they may have never seen before, decode and read aloud increasingly complex nonsense words, and complete a cloze task based on the meaning of a series of sentences respectively. The nonsense word fluency (NWF) subtest of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Good et al., 2001) was administered. This subtest is a timed assessment of a child's ability to decode and read aloud vowel-consonant and consonant-vowel-consonant nonsense words.

2.3 Intervention

Children were randomly assigned to one of two reading intervention programs or a comparison program that focused on math skills. Both reading interventions included a core component, Phonological Analysis and Blending/Direct Instruction component (PHAB), which provided direct instruction of basic phonological and blending skills to remediate core phonological deficits of children with reading disabilities (Lovett et al., 1994). This program created a foundation for other multidimensional interventions by directly instructing sound analysis, blending skills, letter-sound and letter-sound cluster correspondences. Each phase of the intervention was introduced systematically with many opportunities to revisit previously targeted lessons to reach mastery. The program used components of the instructional materials developed by Englemann and colleagues, Reading Mastery Fast Cycle I/II Program (Englemann & Brunner, 1988). The second intervention group received PHAB plus an additional instruction, Retrieval, Automaticity, Vocabulary, Engagement with language, and Orthography (RAVE-O; Wolf, Miller, & Donnelly, 2000), that targeted language and fluency deficits that often co-occur with reading deficits. The RAVE-O program extended PHAB by targeting orthography, semantics, syntax, and morphology to ultimately improve fluency and automaticity. The program engages children in fun games to provide them with many opportunities to practice orthographic and phonological pattern analysis, word finding strategies, and semantic analysis. As children acquire phonological knowledge through PHAB, RAVE-O then teaches children to pair orthographic “chunks” with sounds in core words that are targeted throughout the program to expand semantic knowledge and practice quick-retrieval skills.

Intervention occurred over the course of one academic school year and generally included 60-minute sessions, five days per week (Sevcik et al., 2019). Children were instructed in small groups of four and received interventions from highly experienced and trained teachers from the research study in the child’s home school.

2.4 Analysis Plan

First, we examined measurement models of narrative and component language skills to determine if these are best explained by a two-factor (Figure 1) or one factor (Figure 2) model at baseline and after 120 hours of intervention. The latent factor narrative language was defined by scores from the SALT transcripts on number of different words (NDW), mean length of utterance (MLU), and NSS, and Passage Comprehension from the WLPB. Component language was defined by PPVT, EVT, TWF, and CELF. Previous CFAs of language in this population have demonstrated significant, positive correlations (.97) between expressive and receptive domains on these measures (Barker et al., 2013), therefore we examined expressive and receptive subtests together in one factor. We compared relative and absolute fit indices of the models to determine which model describes the data best.

To explore the relationship of component language and reading skills over time to narrative language at baseline and post-intervention, we constructed a longitudinal panel model between component language skills and reading across all three time points (i.e., after 0, 60, and 120 hours of intervention; Figure 5). This model allowed us to examine “individual difference expressed as changes over time” (Little, 2013). Cross lagged paths and residual correlations between the constructs at each time point illustrated the directionality of this relationship over the course of the intervention. We used this model to explore the within- and cross-occasion relations, as well as the means and variances among the constructs and determine if they were stable or change systematically over time (Little & Preacher, 2007). This model required systematic testing of invariance to determine the most parsimonious model prior to our interpretation of the results. We tested whether the loadings, covariance matrices, and mean structure are equal across waves of measurement (Little, 2013; Little & Preacher 2007). This informed what constraints should be applied to each construct. We used change in χ^2 to determine which model was the best reflection of the variance in the sample (Little & Preacher, 2007). The most parsimonious of these models was used to examine if component language and/or reading skills over time predicted narrative language skills at the end of intervention.

To explore further the relationship between narrative language and reading skills, we conducted a simple cross-sectional moderation analysis to determine if different levels of narrative language moderated the relationship between component language and reading outcome at baseline and time 120 (Figure 6). In this type of model, there are four constructs examined: predictor, moderator, outcome, and “effect of moderator”. The effect of the moderator construct is defined by orthogonal interaction terms between the measures of the predictor and moderator constructs (see Figure 6). To determine if there is a significant effect of the moderator, we first examined the fit of component language predicting reading skills. Then we added in the moderation terms, narrative language and effect of the moderator and examined the relative change in model fit of structural paths when the moderator variable is added (Little, 2013). If the paths from the predictor to the outcome variable were reduced significantly with the addition of the moderation terms, our findings would have supported a moderation effect.

To examine the relationship between narrative comprehension, language, and reading over time, we estimated response to intervention via growth curve models for narrative comprehension, decoding, reading comprehension, and component language (Figures 7-9). We examined the relationship between the intra-person rate of change on these three measures using two separate multivariate growth curve models (Figures 10 and 11). We conducted our descriptive analyses using IBM SPSS Statistics, Version 27 (IBMCorp, 2020), and our measurement and structural models of narrative, language, and reading were conducted using Mplus8 (Muthén & Muthén, 2021). Prior to proceeding with our analyses we examined the distribution of the data. None of the measures were significantly skewed or kurtotic. Of the 95 participants, there were six participants (6%) with missing data. Of the 228 participants, 18 participants (8%) were missing data. We used maximum likelihood estimation in Mplus8 to handle the missing at random data.

3 RESULTS

Table1 reports descriptive statistics for the study variables across the three timepoints, Time 0, 60, and 120. All measures demonstrated growth in mean raw scores over time. Zero-order correlations are reported for each time point in Tables 2 and 3. At Time 0 and 120, all measures were significantly corelated (r = .26 - .90). However, Student IQ was not significantly correlated with NSS composite, SALT measures, Word Attack, Word ID, or Nonword Reading Fluency at Time 0. Similarly, at Time 120 Student IQ was not significantly corelated with NSS composite, SALT measures, Word ID, or Nonword Reading Fluency.

Table 1 *Descriptive statistics at T0, T60 and T120*

	T0	T60	T120
	Mean (SD)		
Age at T0	112.76 (15.75)	-	-
Student IQ at T0	63.74 (10.24)	-	-
NSS Comp	11.66 (5.64)	*	14.18 (6.53)
Number Dif Wds	66.67 (31.75)	*	72.06 (32.46)
MLU morphemes	5.70 (2.28)	*	6.70 (2.50)
PassComp WLPB	6.79 (4.75)	8.55 (4.58)	10.13 (4.70)
PPVT	70.46 (23.39)	74.66 (23.39)	77.89 (22.12)
EVT	52.38 (11.62)	56.43 (12.57)	58.97 (13.10)
Con & FD, CELF	12.58 (9.30)	15.26 (9.34)	17.03 (10.46)
Wd Struct, CELF	11.06 (6.73)	13.76 (7.10)	15.85 (7.40)
Recall. Sent., CELF	17.33 (13.51)	20.95 (13.97)	22.73 (15.36)
Fom. Sent, CELF	12.33 (10.50)	15.20 (11.83)	15.31 (11.44)
Wd. Class, CELF	20.92 (11.09)	25.38 (9.67)	27.26 (9.23)
Sent. Struct., CELF	14.55 (5.40)	16.42 (5.40)	17.28 (5.49)
Word Attack, WRMT	4.13 (5.59)	6.91 (6.80)	9.37 (8.03)
Word Attack, WLPB	2.43 (3.39)	3.78 (3.85)	5.17 (5.00)
Word ID	22.64 (16.00)	27.39 (16.31)	33.53 (15.25)
PhonDecod, TOWRE	4.22 (6.10)	6.07 (7.02)	8.87 (7.82)
NWF, DIBLES	29.73 (26.92)	35.87 (29.86)	41.72 (30.00)

Note. n = 95, Raw scores used for all measures. *measure not provided at T60. NSS = Narrative Scoring Scheme; MLU = mean length of utterance; WLPB = Woodcock Language Proficiency Battery; PPVT = Peabody Picture Vocabulary Test; EVT = Expressive Vocabulary Test; CELF = Clinical Evaluation of Language Fundamentals; Con & FD = Concepts and Following Directions; WRMT = Woodcock Reading Mastery Test; TOWRE = Test of Word Reading Efficiency; NWF = Non-word reading fluency; DIBELS = Dynamic Indicators of Basic Early Literacy Skills.

Table 2 *Correlation Matrix of all study variables at Time 0*

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*
1. Age at T0 (months)	1.00																		
2. Student IQ*	.04	1.00																	
3.NSS Comp T0	.42**	.20	1.00																
4. Num. Dif Wds., SALT	.37**	.12	.76**	1.00															
5. MLUmorphemes, SALT	.41**	.12	.75**	.75**	1.00														
6. Pass Comp, WLPB	.59**	.31**	.56**	.40**	.43**	1.00													
7. PPVT	.49**	.31**	.55**	.39**	.42**	.52**	1.00												
8. EVT	.46**	.32**	.58**	.49**	.50**	.53**	.72**	1.00											
9. Con & FD, CELF	.44**	.46**	.49**	.42**	.41**	.52**	.67**	.67**	1.00										
10. Word Struc., CELF	.48**	.27*	.67**	.55**	.52**	.51**	.72**	.76**	.71**	1.00									
11. Recal. Sent, CELF	.40**	.32**	.65**	.51**	.56**	.51**	.57**	.61**	.70**	.73**	1.00								
12. Form. Sentenes, CELF	.57**	.41**	.60**	.44**	.51**	.63**	.75**	.69**	.72**	.74**	.70**	1.00							
13. Word Classes, CELF	.52**	.50**	.60**	.43**	.41**	.61**	.67**	.66**	.77**	.68**	.64**	.74**	1.00						
14. Sent Structure, CELF	.52**	.39**	.61**	.39**	.41**	.49**	.74**	.64**	.73**	.69**	.62**	.73**	.78**	1.00					
15. Word Attack, WRMT	.32**	.32**	.30**	.32**	.31**	.71**	.31**	.32**	.32**	.33**	.29**	.45**	.35**	.26*	1.00				
16. Word Attack, WLPB	.43**	.21	.30**	.30**	.30**	.73**	.28**	.25*	.31**	.27**	.29**	.39**	.36**	.22*	.81**	1.00			
17. Word ID, WRMT	.48**	.13	.36**	.26*	.29**	.86**	.36**	.36**	.32**	.36**	.29**	.39**	.41**	.28**	.70**	.73**	1.00		
18. PhonDecod, TOWRE	.39**	.25*	.30**	.35**	.30**	.70**	.29**	.30**	.28**	.31**	.31**	.41**	.33**	.23*	.90**	.87**	.71**	1.00	
19. NWF., DIBELS	.46**	.20	.42**	.36**	.36**	.70**	.36**	.36**	.36**	.32**	.39**	.43**	.40**	.35**	.74**	.74**	.70**	.79**	1.0

Note. ** < .001, * < .01. *n* = 95. NSS = Narrative Scoring Scheme; SALT = Systematic Analysis of Language Transcripts; MLU = mean length of utterance in morphemes; WLPB = Woodcock Language Proficiency Battery; PPVT = Peabody Picture Vocabulary Test; EVT = Expressive Vocabulary Test; CELF = Clinical Evaluation of Language Fundamentals; Con & FD = Concepts and Following Directions; WRMT = Woodcock Reading Mastery Test; TOWRE = Test of Word Reading Efficiency; NWF = Non-word reading fluency; DIBELS = Dynamic Indicators of Basic Early Literacy Skills.

Table 3 *Correlation Matrix of all study variables at Time 120*

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*
1. Age at T0 (months)	1.00																		
2. Student IQ*	.04	1.00																	
3.NSS Comp T0	.49**	.16	1.00																
4. Num. Dif Wds., SALT	.33**	.05	.90**	1.00															
5. MLUmorphemes, SALT	.42**	.16	.84**	.78**	1.00														
6. Pass Comp, WLPB	.44**	.28*	.50**	.35**	.42**	1.00													
7. PPVT	.49**	.30**	.61**	.46**	.49**	.45**	1.00												
8. EVT	.51**	.36**	.66**	.49**	.52**	.54**	.74**	1.00											
9. Con & FD., CELF	.49**	.51**	.65**	.53**	.55**	.49**	.71**	.80**	1.00										
10. Word Struc., CELF	.38**	.35	.62**	.47**	.57**	.49**	.73**	.74**	.70**	1.00									
11. Recal. Sent, CELF	.33**	.28*	.61**	.57**	.57**	.34**	.62**	.66**	.72**	.69**	1.00								
12. Form. Sentenes, CELF	.44**	.33*	.64**	.54**	.54**	.53**	.61**	.67**	.64**	.69**	.62**	1.00							
13. Word Classes, CELF	.41**	.38**	.66**	.52**	.56**	.54**	.60**	.68**	.71**	.68**	.57**	.65**	1.00						
14. Sent Structure, CELF	.50**	.36**	.63**	.50**	.51**	.39**	.71**	.74**	.78**	.67**	.65**	.58**	.72**	1.00					
15. Word Attack, WRMT	.31**	.36**	.37**	.34**	.33**	.73**	.31**	.39**	.42**	.39**	.28**	.39**	.40**	.29**	1.00				
16. Word Attack, WLPB	.32**	.26*	.39**	.34**	.30**	.72**	.30**	.33**	.29**	.32**	.18	.40**	.34**	.21*	.87**	1.00			
17. Word ID, WRMT	.42**	.20	.38**	.23*	.28**	.90**	.33**	.43**	.35**	.34**	.19	.36**	.41**	.29**	.73**	.75**	1.00		
18. PhonDecod, TOWRE	.33**	.24*	.34**	.23**	.28**	.65**	.24**	.35**	.30**	.25**	.24*	.34**	.31**	.24*	.78**	.78**	.73**	1.00	
19. NWF, DIBELS	.30**	.20	.41**	.36**	.35**	.68**	.23**	.31**	.28**	.27**	.28**	.33**	.34**	.25**	.73**	.73**	.72**	.76**	1.0

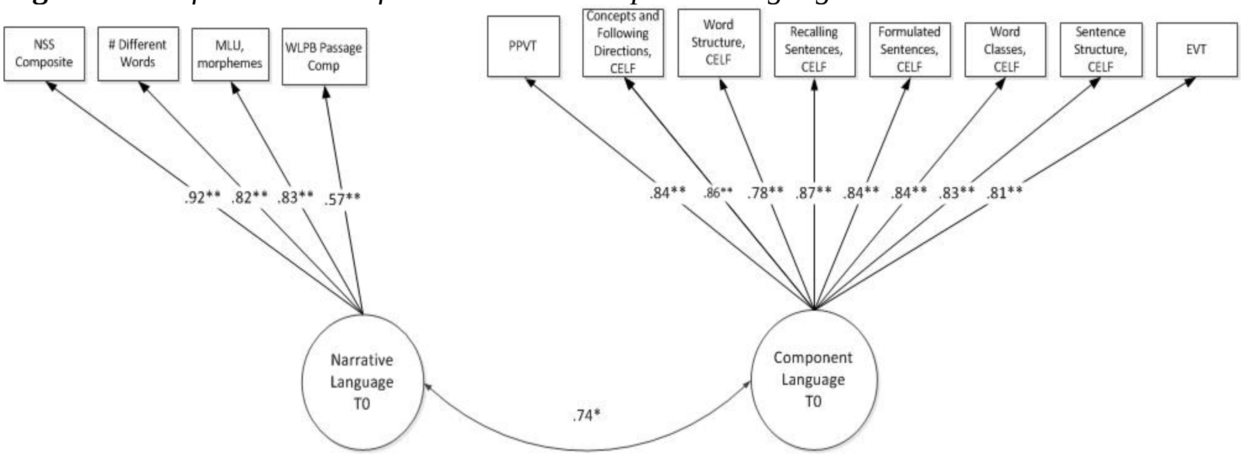
Note ** < .001, * < .01. *n* = 95. NSS = Narrative Scoring Scheme; SALT = Systematic Analysis of Language Transcripts; MLU = mean length of utterance in morphemes; WLPB = Woodcock Language Proficiency Battery; PPVT = Peabody Picture Vocabulary Test; EVT = Expressive Vocabulary Test; CELF = Clinical Evaluation of Language Fundamentals; Con & FD = Concepts and Following Directions; WRMT = Woodcock Reading Mastery Test; TOWRE = Test of Word Reading Efficiency; NWF = Non-word reading fluency; DIBELS = Dynamic Indicators of Basic Early Literacy Skills

3.1 Measurement models

First, we examined the measurement of the constructs of narrative and component language skills by examining the fit of a two-factor model and an alternative, one-factor model. The two-factor model that included separate latent factors for narrative and component language fit reasonably χ^2 (64, *n* = 95) = 129.141, p < .001, RMSEA = .10, CFI = .93, TLI =.92 , SRMR = .07 (Figure 1). We compared this model with an alternative, one-factor model that combined the narrative and component language measures together. The one factor model did not fit as well as the two-factor model, χ^2 (65) = 208.26, p < .001, RMSEA = .15, CFI = .85, TLI = .83, SRMR = .07 (Figure 2). Chi- square difference testing confirmed that the two factor model fit significantly better, $\Delta\chi^{2\,(}$1, *n* =95)= 79.12, p <.001, so we proceeded with the two-factor model of language and narrative skills.

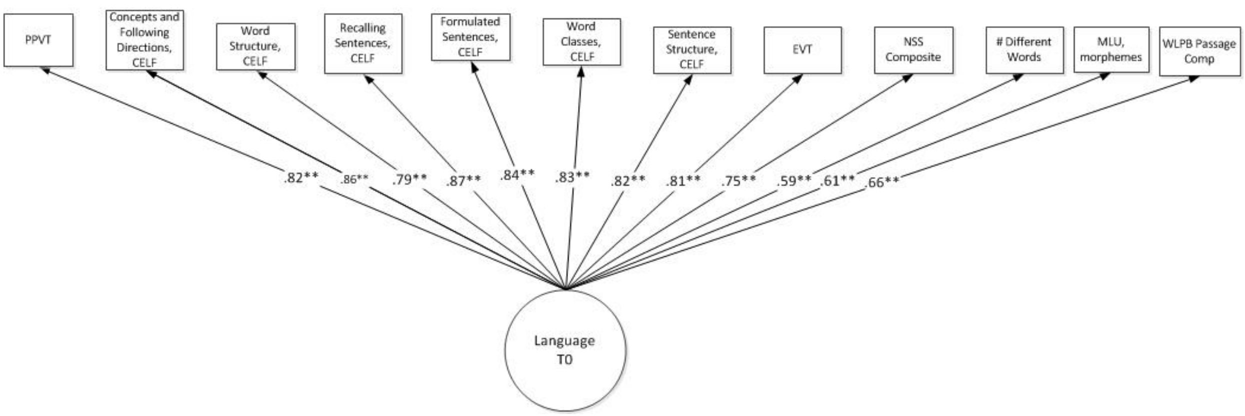
In addition to the measurement of narrative and language, we explored several different models for reading skills. First, we explored a single factor model that included all of the reading measures: Word Attack, Word ID, and Passage Comprehension subtests from the WRMT, Letter Sound ID and Sound Combination subtests from the Sound-Symbol test, Phonemic Decoding and Sight Word subtests from the TOWRE, and Oral Reading Fluency from DIBLES. Although the loadings for these measures were all significant, this model had relatively poor fit, χ^2 (20, *n* = 95) = 160.09, p < .001, RMSEA = .27, CFI = .84, TLI = .77, SRMR = .07(Figure 3).

Figure 1 *Two-factor model of narrative and component language at Time 0*



Note. Factor loadings are standardized estimates; * < .01, ** < .001, n = 95.

Figure 2 One-factor model of language at Time 0.



Note. Factor loadings are standardized estimates; ** < .001, n = 95.

Table 4 *Parameter estimates for two-factor model of narrative and component language*

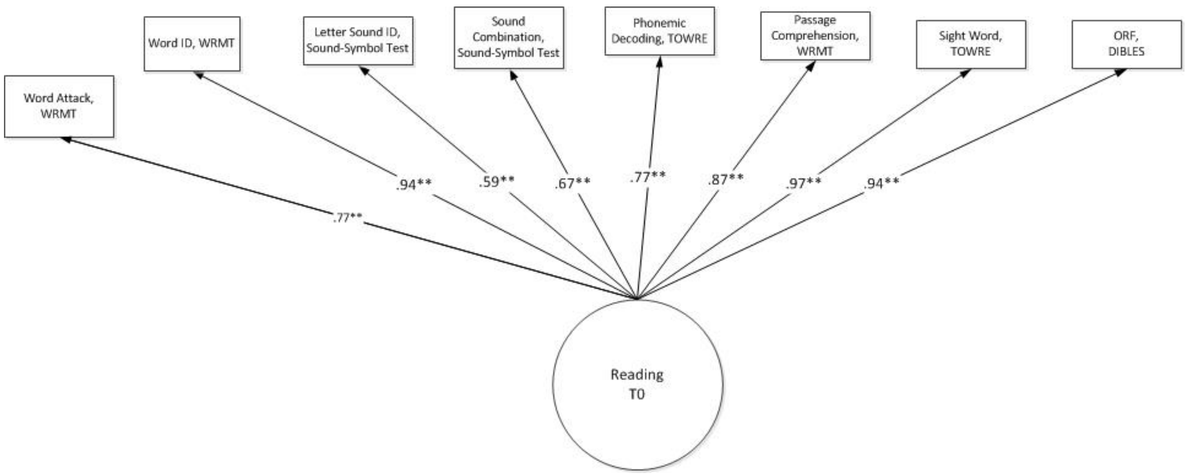
Relation/Variable	Estimate	SE	Ratio	*p*	Std
Factor Loadings					
Component Language by					
PPVT	1.00	__[a]	__	__	.84
Concepts and Foll. Direc,CELF	.75	.07	10.86	<.001	.86
Word Struc, CELF	1.37	.15	9.24	<.001	.78
Recal Sent., CELF	1.17	.11	10.81	<.001	.86
Formulated Sentence, CELF	1.21	.12	10.41	<.001	.84
Word Classes, CELF	.59	.06	10.38	<.001	.84
Sentence Structure, CELF	2.52	.25	9.66	<.001	.83
EVT	1.21	.13	9.66	<.001	.81
TWF	.16	.03	5.90	<.001	.57
Narrative by					
NSS Composite	1.00	__[a]	__	__	.92
Num. Dif. Words, SALT	5.02	4.74	10.61	<.001	.82
MLU morphemes	.36	.03	10.53	<.001	.83
Passage Comp, WLPB	.53	.08	6.23	<.001	.58
Observed/Error Variances					
PPVT	25.54	4.22	6.06	<.001	.32
Con & FD, ,CELF	11.46	1.96	5.83	<.001	.32
Word Struc, CELF	69.56	11.02	6.31	<.001	.15
Recal Sent., CELF	27.14	4.63	5.86	<.001	.67
Formulated Sentence, CELF	35.21	5.88	6.00	<.001	.30
Word Classes, CELF	8.31	1.40	6.00	<.001	.26
Sentence Structure, CELF	164.71	27.15	6.07	<.001	.39
EVT	3.3	1.62	2.04	<.05	.25
TWF	3.20	.47	6.72	<.001	29
NSS Composite	4.61	1.50	3.14	<.001	.28
Num. Dif. Words, SALT	320.61	60.20	5.32	<.001	.30
MLU morphemes	1.65	.31	5.25	<.001	.34
Passage Comp, WLPB	14.80	2.27	6.52	<.001	.68
Covariances					
Component Language with Narrative	29.67	5.81	5.11	<.01	.74
Factor Variance					
Component Language	59.52	11.94	4.98	<.001	__
Narrative Language	26.81	4.70	5.71	<.001	__

Note. *n* = 95. NSS = Narrative Scoring Scheme; SALT = Systematic Analysis of Language Transcripts; MLU = mean length of utterance in morphemes; WLPB = Woodcock Language Proficiency Battery; PPVT = Peabody Picture Vocabulary Test; EVT = Expressive Vocabulary Test; CELF = Clinical Evaluation of Language Fundamentals; Con & FD = Concepts and Following Directions; WRMT = Woodcock Reading Mastery Test; TOWRE = Test of Word Reading Efficiency; NWF = Non-word reading fluency; DIBLES = Dynamic Indicators of Basic Early Literacy Skills

Table 5 *Fit of reading models tested.*

Model Name	AIC	BIC
Model 1	5029.26	5090.55
Model 2	11195.27	11340.84
Model 3	11655.71	11773.19
Model 4	2959.22	2997.53

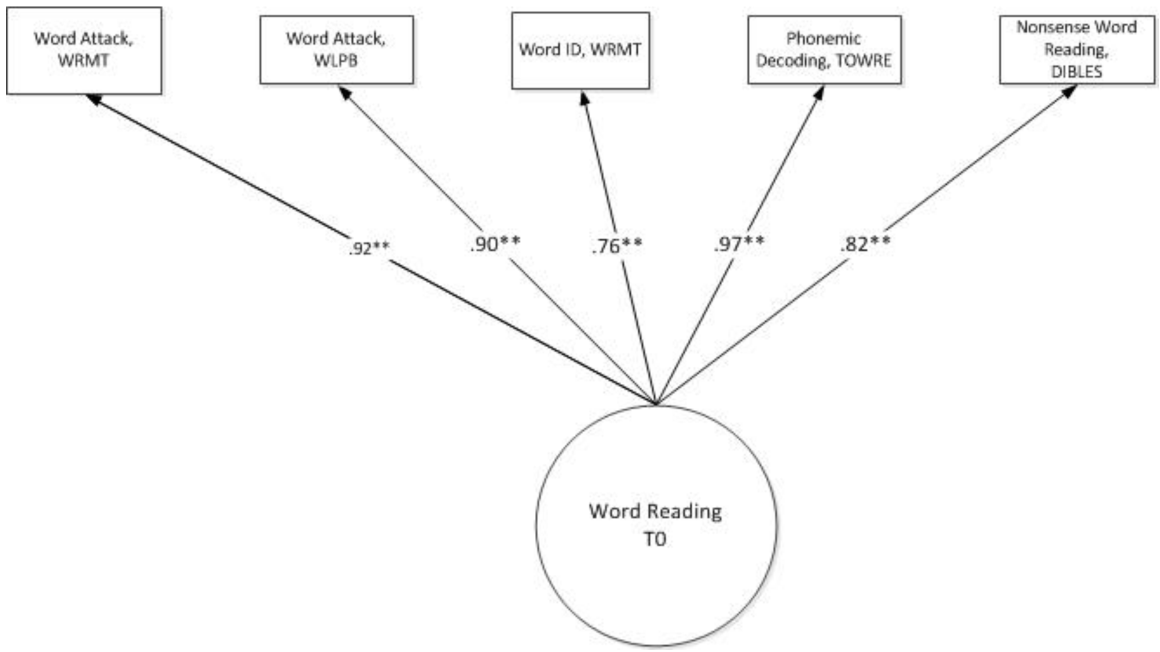
Figure 3 *One-factor model of reading at Time 0.*



Note. Factor loadings are standardized estimates; ** < .001

We explored other models of reading cited in the literature to improve our overall fit. We first parsed speeded and non-speeded measures (Model 2), χ^2 (143, n = 95) = 1033.05, p < .001, RMSEA = .27, CFI = .45, TLI = .41, SRMR = .40. As reported by Torgesen et al., (1997), we fit a three-factor model of word reading, phonological awareness, and fluency (Model 3). This model also exhibited poor fit χ^2 (132, n = 95) = 521.326, p < .001, RMSEA = .176, CFI = .76, TLI = .72, SRMR=.09. Finally, we explored a simpler, one-factor model of word reading to include single real and pseudoword reading tasks (Model 4). Model 4 exhibited good absolute fit and relative fit: χ^2(5, n = 95) =10.82, p =.0551, RMSEA = .11, CFI = .99, TLI = .98, SRMSR = .02 (Figure 4). Factor loadings ranged from .76 to .97 and were all significant. To compare these models, we examined AIC fit statistics across the four models (Table 5). As Model 4 demonstrated the best overall fit as well as more than 10 points difference on the AIC statistic, we proceeded with this model of reading as it exhibited the best fit for our data (Burnham & Anderson, 2004).

Figure 4 *One-factor model of word reading at Time 0.*



Note. Factor loadings are standardized estimates; ** < .001, *n* = 95.

Table 6 *Parameter estimates for word reading model.*

Relation/Variable	Estimate	SE	Ratio	*p*	Std
Factor Loadings					
Word Reading by					
Word Attack, WRMT	1.00	__[a]	__	__	.92
Word Attack, WLPB	.59	.04	14.63	<.001	.90
Word ID, WRMT	2.37	.24	9.95	<.001	.76
Phonemic Decoding, TOWRE	1.14	.06	18.41	<.001	.97
Nonsense Word Read, DIBLES	4.29	.37	11.58	<.001	.82
Observed/Error Variances					
Word Attack, WRMT	4.77	.88	5.40	<.001	.15
Word Attack, WLPB	2.13	.38	5.63	<.001	.19
Word ID, WRMT	106.72	16.63	6.42	<.001	.42
Phonemic Decoding, TOWRE	2.49	.77	3.23	.001	.07
Nonsense Word Read, DIBLES	29.73	2.75	10.82	<.001	.33
Factor Variance					
Word Reading	26.18	4.47	5.86	<.001	__

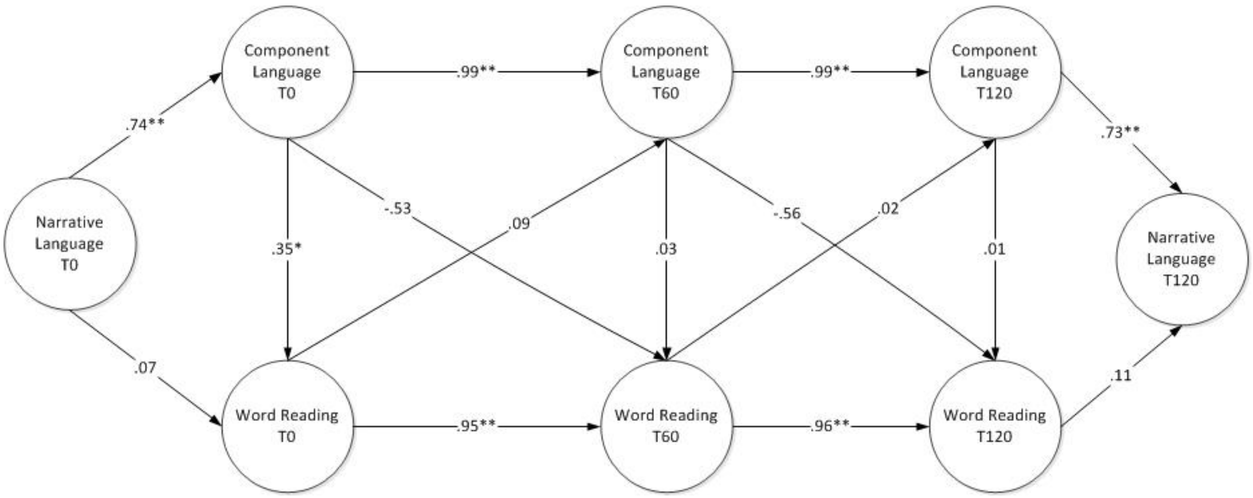
Note. [a **;] Std = standardized estimates; n = 95; WLPB = Woodcock Language Proficiency Battery; WRMT = Woodcock Reading Mastery Test; TOWRE = Test of Word Reading Efficiency; NWF = Non-word reading fluency; DIBLES = Dynamic Indicators of Basic Early Literacy Skills

3.2 Longitudinal Panel model

To explore the relationship of component language and reading skills over time to narrative language at baseline and post-intervention, we constructed a longitudinal panel model between component language skills and reading across all three time points (i.e., after 0, 60, and 120 hours of intervention). Prior to running this model, we conducted invariance testing on both the language and word reading factors to provide the most parsimonious model. When fit with increasingly constrained parameters, the language factor achieved partial metric invariance (Table 7). At this level, the factor loadings are constrained to be the same across time. This suggested that the same measures well-define the language construct at each time point with the exception of the CELF subtest, Word Classes. The word reading construct achieved configural invariance, which suggested that the measures do not load equally onto the construct overtime (Table 5).

We used the partial metric invariance constraints and the configural invariance model for language and word reading, respectively in the panel model (Figure 5, Table 7). The model fit well χ^2 (623, n = 95) = 821.40, p < .001, RMSEA = .05, CFI = .96, TLI = .95, SRMR = .06. Predictably, component language at baseline predicted the student's performance on these measures at Time 60, and component language at Time 60 significantly predicted component language skills at Time 120. Word Reading followed a similar pattern. word reading and component language at baseline predicted the students' performance on these factors at T60, and T60 performance predicted T120. The cross-lagged paths did not reveal any predictive relationship between language and reading skills over time except at baseline. At baseline, the variance in word reading significantly predicted the variance in component language (.34, *p = .01*). Contrary to our hypothesis, narrative language at baseline only predicted component language (.74, *p* = .05), not word reading (.07, *p* = .66), at baseline. Similarly, component language predicted narrative language at T120 (.73, *p* < *.001*) but word reading did not (.11, *p* = .17).

Figure 5 *Longitudinal Panel Model*



Note. Factor loadings are standardized estimates; ** < .001, n = 95.

Table 7 *Invariance Testing model fit comparison for component language at Time 0, 60 and 120.*

Model tested	X^2	*df*	*p*	ΔX^{2*}	Δ df	*p*	RMSEA	RMSEA 90%CI	CFI	Δ CFI	TLI/NFI	Δ TLI	SRMR	Pass
Configural	188.37	165	.10	--	---	--	.039	.00 - .063	.99		.988		.030	yes
metric	212.13	177	.04	23.76	12	.02	.046	.01 - .067	.985	.005	.982	.006	.052	no
Partial metric (free word class)	202.12	175	.08	13.75	10	.19	.040	.00- .063	.989	.004	.986	.004	.044	yes
Scalar	229.73	186	.02	41.36	21	.005	.05	.023 - .07	.982	.007	.979	.007	.059	no

Note. *change calculated from the the configural model.

Table 8 *Invariance testing model fit comparison for word reading at Time 0, 60, and 1*

Model tested	X^2	*df*	*p*	ΔX^2	Δ df	*p*	RMSEA	RMSEA 90%CI	CFI	Δ CFI	TLI/NFI	Δ TLI	SRMR	Pass
Configural	150.86	72	<.001				.11	.08-.13	.96		.94		.04	yes
Metric	187.82	80	.04	36.96	12	<.001	.12	.10 - .14	.95	.01	.93	.01	.08	no

Table 9 *Parameter estimates for longitudinal panel model*

Relation/Variable	Estimate	SE	Ratio	*p*	Std
Factor Loadings					
Word Reading Time 0 by					
Word Attack, WRMT	1.00	__[a]	__	__	.91
Word Attack, WLPB	.61	.04	14.63	<.001	.92
Word ID, WRMT	2.25	.23	9.98	<.001	.75
Phonemic Decoding, TOWRE	1.14	.06	17.58	<.001	.96
Nonsense Word Read, DIBLES	4.30	.38	11.39	<.001	.81
Word Reading Time 60 by					
Word Attack, WRMT	1.00	__[a]	__	__	.92
Word Attack, WLPB	.56	.04	15.07	<.001	.90
Word ID, WRMT	1.92	.18	10.61	<.001	.77
Phonemic Decoding, TOWRE	1.00	.07	14.35	<.001	.89
Nonsense Word Read, DIBLES	3.85	.33	11.58	<.001	.82
Word Reading Time 120 by					
Word Attack, WRMT	1.00	__[a]	__	__	.92
Word Attack, WLPB	.63	.04	16.34	<.001	.93
Word ID, WRMT	1.53	.14	10.78	<.001	.78
Phonemic Decoding, TOWRE	.91	.07	12.88	<.001	.86
Nonsense Word Read, DIBLES	3.23	.29	11.30	<.001	.81
Component Language Time 0 by					
PPVT[a]	12.77	1.27	10.07	<.001	.82
Concepts and Foll. Direc,CELF[a]	5.66	.54	10.51	<.001	.85
Word Struc, CELF[a]	4.04	.38	10.69	<.001	.86
Recal Sent., CELF[a]	7.45	.79	9.38	<.001	.79
Formulated Sentence, CELF [a]	6.31	.58	10.80	<.001	.86
Word Classes, CELF	6.53	.68	9.67	<.001	.84
Sentence Structure, CELF[a]	3.17	.29	10.78	<.001	.85
EVT[a]	7.17	.68	10.53	<.001	.83
Component Language Time 60 by					
PPVT[a]	12.77	1.27	10.07	<.001	.84
Concepts and Foll. Direc,CELF[a]	5.66	.54	10.51	<.001	.83
Word Struc, CELF[a]	4.04	.38	10.69	<.001	.84
Recal Sent., CELF [a]	7.45	.79	9.38	<.001	.77
Formulated Sentence, CELF [a]	6.31	.58	10.80	<.001	.81
Word Classes, CELF	5.06	.60	8.38	<.001	.77
Sentence Structure, CELF[a]	3.17	.29	10.78	<.001	.87
EVT[a]	7.17	.68	10.53	<.001	.86
Component Language Time 120 by					
PPVT[a]	12.77	1.27	10.07	<.001	.84
Concepts and Foll. Direc,CELF[a]	5.66	.54	10.51	<.001	.87
Word Struc, CELF[a]	4.04	.38	10.69	<.001	.83
Recal Sent., CELF[a]	7.45	.79	9.38	<.001	.76
Formulated Sentence, CELF [a]	6.31	.58	10.80	<.001	.79

Word Classes, CELF	4.87	.55	8.84	<.001	.80
Sentence Structure, CELF[a]	3.17	.29	10.78	<.001	.86
EVT[a]	7.17	.68	10.53	<.001	.86
Component Language Time 60 on					
Component Language Time 0	1.09	.05	21.12	<.001	1.06
Word Reading Time 0	-.001	.01	-.06	.95	-.002
Component Language Time 120 on					
Component Language Time 60	1.02	.04	21.01	<.001	.98
Word Reading Time 60	.003	.007	.49	.63	.01
Word Reading Time 60 on					
Word Reading Time 0	1.17	.09	13.43	<.001	.94
Component Language Time 60	2.90	1.90	1.53	.13	.68
Component Language Time 0	-2.89	1.98	-1.47	.14	-.66
Word Reading Time 120 on					
Word Reading Time 60	1.12	.09	12.32	<.001	.94
Component Language Time 120	5.44	4.30	1.27	.21	1.12
Component Language Time 60	-5.58	4.42	-1.26	.21	-1.11
Word Reading T0 on					
Component Language Time 0	1.23	.52	2.35	.02*	.34
Word Reading T0 on					
NSS Composite Time 0	.08	.13	.61	.54	.09
Component Language Time 0 on					
NSS Composite Time 0	.18	.02	7.44	<.001	.71
NSS Composite Time 120 on					
Component Language Time 120	3.10	.40	7.68	<.001	.72
Word Reading Time 120	.09	.07	1.39	.17	.11
Observed/Error Variances					
Word Attack, WRMT Time 0	5.42	.95	5.73	<.001	.17
Word Attack, WLPB Time 0	1.71	.32	5.40	<.001	.15
Word ID, WRMT Time 0	101.96	15.82	6.45	<.001	.43
Phonemic Decoding, TOWRE Time 0	3.17	.75	4.23	<.001	.09
Nonsense Word Read, DIBLES Time 0	241.43	37.43	6.45	<.001	.34
Word Attack, WRMT Time 60	7.03	1.26	5.58	<.001	.15
Word Attack, WLPB Time 60	2.75	.48	5.73	<.001	.19
Word ID, WRMT Time 60	99.72	15.46	6.45	<.001	.41
Phonemic Decoding, TOWRE Time 60	9.86	1.72	5.73	<.001	.20
Nonsense Word Read, DIBLES Time 60	276.70	45.62	6.07	<.001	.32
Word Attack, WRMT Time 120	10.17	1.88	5.41	<.001	.16
Word Attack, WLPB Time 120	3.19	.65	4.95	<.001	.13
Word ID, WRMT Time 120	82.64	13.04	6.34	<.001	.40
Phonemic Decoding, TOWRE Time 120	15.92	2.63	6.05	<.001	.26
Nonsense Word Read, DIBLES Time 120	296.04	46.99	6.30	<.001	.34
PPVT[a] Time 0	159.183	26.161	6.085	<.001	.33
Con & FD ,CELF[a] Time 0	25.927	4.295	6.036	<.001	.29
Word Struc, CELF[a] Time 0	12.017	1.974	6.088	<.001	.27

Recal Sent., CELF [a] Time 0	69.563	10.845	6.414	<.001	.38
Formulated Sentence, CELF [a] Time 0	27.089	4.500	6.020	<.001	.25
Word Classes, CELF Time 0	36.403	5.999	6.068	<.001	.30
Sentence Structure, CELF[a] Time 0	8.082	1.323	6.109	<.001	.29
EVT[a] Time 0	45.552	7.346	6.201	<.001	.31
PPVT[a] Time 60	149.692	24.313	6.157	<.001	.30
Con & FD,CELF[a] Time 60	30.918	4.914	6.291	<.001	.31
Word Struc, CELF[a] Time 60	14.611	2.329	6.273	<.001	.29
Recal Sent., CELF [a] Time 60	80.845	12.370	6.536	<.001	.40
Formulated Sentence, CELF [a] Time 60	44.299	6.924	6.398	<.001	.34
Word Classes, CELF Time 60	37.951	5.792	6.552	<.001	.41
Sentence Structure, CELF[a] Time 60	6.643	1.101	6.036	<.001	.24
EVT[a] Time 60	37.768	6.139	6.152	<.001	.26
PPVT[a] Time 120	158.912	25.395	6.258	<.001	.30
Con & FD ,CELF[a] Time 120	24.101	4.074	5.915	<.001	.25
Word Struc, CELF[a] Time 120	16.456	2.627	6.264	<.001	.30
Recal Sent., CELF [a] Time 120	93.324	14.404	6.479	<.001	.42
Formulated Sentence, CELF [a] Time 120	56.500	8.816	6.409	<.001	.38
Word Classes, CELF Time 120	29.933	4.690	6.382	<.001	.35
Sentence Structure, CELF[a] Time 120	8.378	1.362	6.150	<.001	.27
EVT[a] Time 120	40.888	6.759	6.049	<.001	.26
NSS Composite T120	16.915	2.595	6.519	<.001	.40
Covariances					
Component Language T0 with T60	-.15	.07	-2.10	.04	-.52
Component Language T0 with T120	.001	.05	.01	.99	.01
Component Language T60 with T120	.02	.02	1.37	.17	.65
Word Attack, WRMT T0 with T60	.51	.78	.65	.51	.08
Word Attack, WRMT T0 with T120	2.58	.99	2.61	.01	.35
Word Attack, WRMT T60 with T120	-.40	1.10	-.36	.72	-.05
Word Attack, WLPB T0 with T60	-.14	.27	-.51	.61	-.07
Word Attack, WLPB T0 with T120	.05	.32	.16	.87	.02
Word Attack, WLPB T60 with T120	-.15	.40	-.37	.71	-.05
Word ID T0 with T60	99.99	14.76	6.23	<.001	.91
Word ID T0 with T120	75.07	12.86	5.84	<.001	.82
Word ID T60 with T120	82.7	13.31	6.20	<.001	.90
Phonetic Decoding T0 with T60	-.57	.80	-.72	.48	-.10
Phonetic Decoding T0 with T120	.03	.98	.04	.97	.01
Phonetic Decoding T60 with T120	3.39	1.59	2.14	.03	.27
Nonsense Word Read T0 with T60	79.41	.20.86	2.57	.01	.31
Nonsense Word Read T0 with T120	117.15	32.30	3.63	<.001	.44
Nonsense Word Read T60 with T120	143.09	37.32	3.83	<.001	.50
PPVT T0 with T60	74.623	20.137	3.706	<.001	.48
PPVT T0 with T120	85.995	20.574	4.180	<.001	.54
PPVT T60 with T120	70.669	19.671	3.592	<.001	.46
Word Structure T0 with T60	5.366	1.671	3.211	<.001	.41
Word Structure T0 with T120	4.967	1.732	2.868	<.001	.35

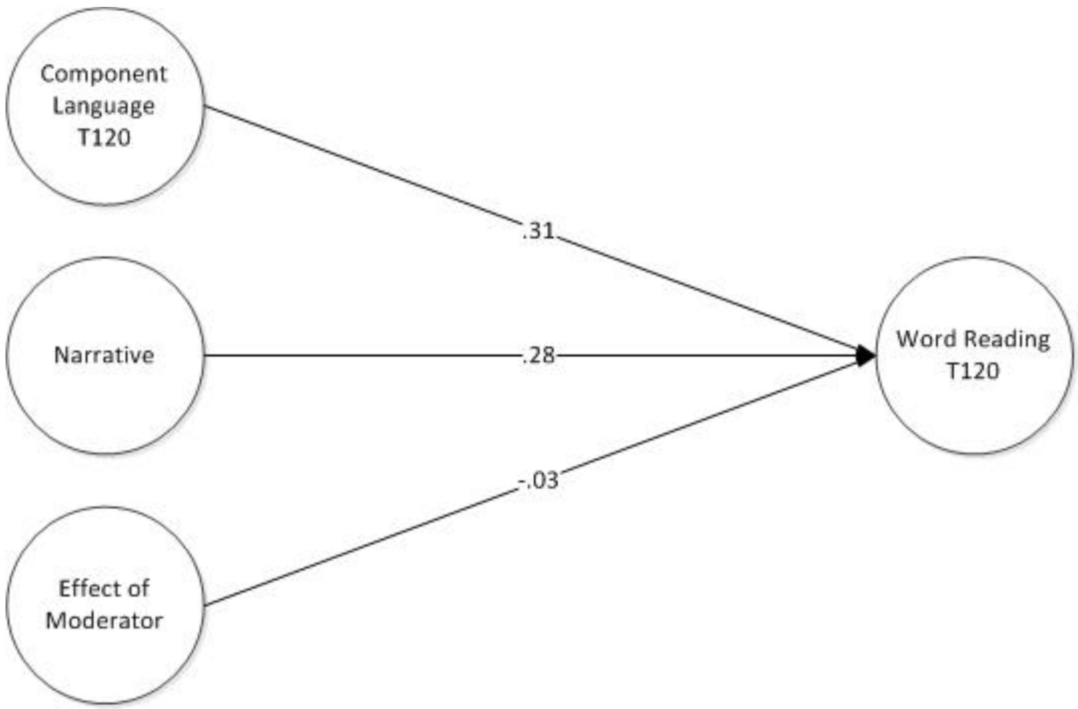
Word Structure T60 with T120	8.241	2.017	4.086	<.001	.53
Recalling Sentence, T0 with T60	40.086	9.334	4.294	<.001	.54
Recalling Sentence, T0 with T120	52.775	10.532	5.011	<.001	.66
Recalling Sentence, T60 with T120	65.531	11.839	5.535	<.001	.75
Formulated Sentences T0 with T60	6.607	4.075	1.621	.11	.20
Formulated Sentences T0 with T120	8.148	4.579	1.779	.07	.21
Formulated Sentences T60 with T120	11.782	5.723	2.059	.04	.24
Word Classes T0 with T60	15.181	4.499	3.375	.001	.41
Word Classes T0 with T120	13.186	4.033	3.269	.001	.40
Word Classes T60 with T120	18.856	4.264	4.422	<.001	.56
Sentence Structure T0 with T60	2.416	0.915	2.640	<.001	.33
Sentence Structure T0 with T120	3.096	1.026	3.018	<.001	.38
Sentence Structure T60 with T120	3.785	0.987	3.836	<.001	.51
EVT T0 with T60	18.445	5.230	3.527	<.001	.45
EVT T0 with T120	20.463	5.500	3.721	<.001	.47
EVT T60 with T120	24.504	5.454	4.493	<.001	.62
Concepts and Foll. Dire T0 with T60	11.226	3.551	3.162	.002	.40
Concepts and Foll. Dire T0 with T120	7.778	3.095	2.513	0.012	.31
Concepts and Foll. Dire T60 with T120	10.891	3.423	3.182	.001	.40
Factor Variance					
Component Language T0	1	__	__	__	__
Component Language T60	0.077	0.046	1.686	0.092	__
Component Language T120	0.018	0.019	0.952	0.341	
Word Reading T0	21.505	3.778	5.692	<.001	.83
Word Reading T60	2.437	0.861	2.831	<.001	.06
Word Reading T120	3.469	1.161	2.987	<.001	.06

Note. [a]loading constrained across time point, see Table 7. n = 95. NSS = Narrative Scoring Scheme; SALT = Systematic Analysis of Language Transcripts; MLU = mean length of utterance in morphemes; WLPB = Woodcock Language Proficiency Battery; PPVT = Peabody Picture Vocabulary Test; EVT = Expressive Vocabulary Test; CELF = Clinical Evaluation of Language Fundamentals; Con & FD = Concepts and Following Directions; WRMT = Woodcock Reading Mastery Test; TOWRE = Test of Word Reading Efficiency; DIBLES = Dynamic Indicators of Basic Early Literacy Skills

3.3 Moderation

To explore if different levels of narrative language moderated the relationship between component language and reading skills, we conducted a simple cross-sectional moderation analysis at baseline and time 120 (Figure 6). Contrary to our hypothesis but consistent with our panel model results, narrative language did not moderate the relationship between component language and reading at Time 120. The model did not converge for Time 0.

Figure 6 *Component Language*Narrative at T120*



Note. Factor loadings are standardized estimates. n = 95.

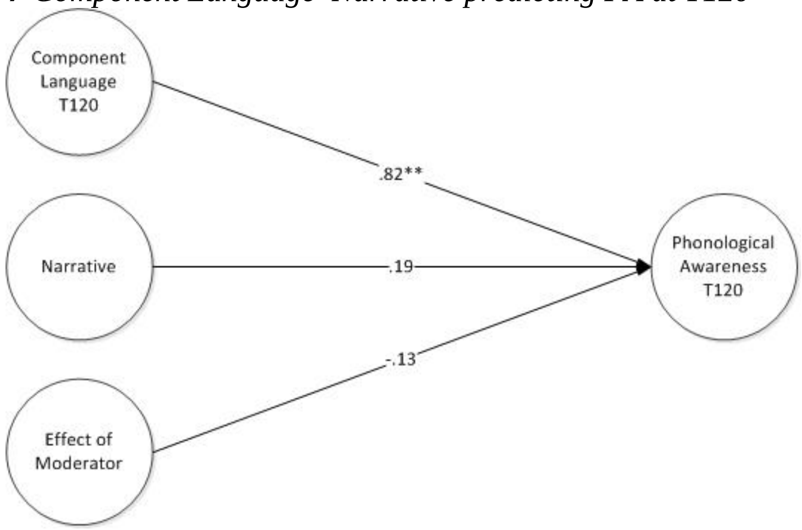
***Table 10** Parameter estimates for moderation model.*

Relation/Variable	Estimate	SE	Ratio	p	Std
Factor Loadings					
Word Reading by					
Word Attack, WRMT	1.00	__[a]	__	__	.91
Word Attack, WLPB	.62	.04	15.58	<.001	.92
Word ID, WRMT	1.71	.15	11.39	<.001	.81
Phonemic Decoding, TOWRE	.91	.07	12.54	<.001	.85
Nonsense Word Read, DIBLES	3.30	.29	11.22	<.001	.81
Component Language by					
PPVT	1.00	__[a]	__	__	.02
Concepts and FD, CELF	25.46	2.17	11.75	<.001	.89
Word Structure, CELF	16.71	1.65	10.15	<.001	.82
Recalling Sentences, CELF	33.03	2.99	11.06	<.001	.79
Formulated Sentences, CELF	23.50	2.50	9.40	<.001	.75
Sentences Structure, CELF	12.44	1.24	10.00	<.001	.83
EVT, CELF	31.36	2.60	12.05	<.001	.88
Word Reading on					
Component Language	5.86	5.23	1.12	.26	.31
Component Language x NSSComposite	-.10	.30	-.33	.74	-.02
Word Reading on					
NSSComposite	.30	.16	1.91	.06	.28
Observed/Error Variances					
Word Attack, WRMT	10.03	2.12	4.74	<.001	.17
Word Attack, WLPB	3.60	.78	4.57	<.001	.16
Word ID, WRMT	73.71	12.26	6.01	<.001	.34
Phonemic Decoding, TOWRE	15.76	2.76	5.70	<.001	.27
Nonsense Word Read, DIBLES	286.02	47.79	5.99	<.001	.34
PPVT	471.84	67.97	6.94	<.001	1
Concepts and FD, CELF	22.07	4.47	4.94	<.001	.20
Word Structure, CELF	16.80	2.96	5.75	<.001	.31
Recalling Sentences, CELF	88.20	14.50	6.08	<.001	.38
Formulated Sentences, CELF	56.01	9.00	6.22	<.001	.43
Sentences Structure, CELF	9.19	1.58	5.80	<.001	.31
EVT, CELF	37.96	7.25	5.23	<.001	.22
Factor Variance					
Word Reading	42.64	7.46	5.72	<.001	.87
Component Language	.13	.03	4.90	<.001	_1_

Note. SE = standard error. [a] Dashes indicate a parameter fixed for model identification, which was not tested for statistical significance. WLPB = Woodcock Language Proficiency Battery; WRMT = Woodcock Reading Mastery Test; TOWRE = Test of Word Reading Efficiency; DIBLES = Dynamic Indicators of Basic Early Literacy Skills.

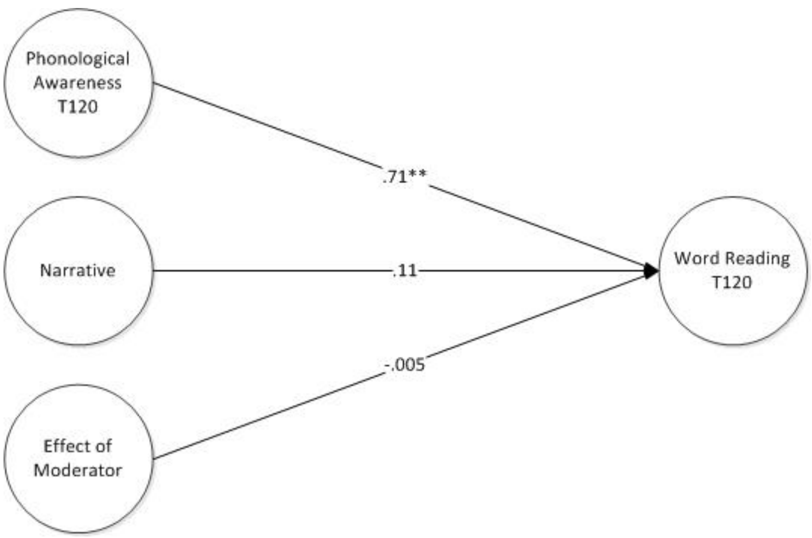
To further explore narrative as a moderator, we examined if different levels of narrative language ability would moderate the relationship between component language and phonological awareness (PA) skills (Figure 7). Component language did significantly predict PA (.82, $p < .001$), however the effect of the moderator was not significant (-.13, $p = .15$). Lastly, we tested if narrative language would moderate the relationship between PA and word reading (Figure 8). Phonological awareness did significantly predict Word Reading (.71, $p < .001$) but the moderation was not significant (-.005, $p = .96$).

Figure 7 *Component Language*Narrative predicting PA at T120*



Note. Factor loadings are standardized estimates. n = 95.

Figure 8 Component PA*Narrative predicting word reading at T120



Note. Factor loadings are standardized estimates. n = 95.

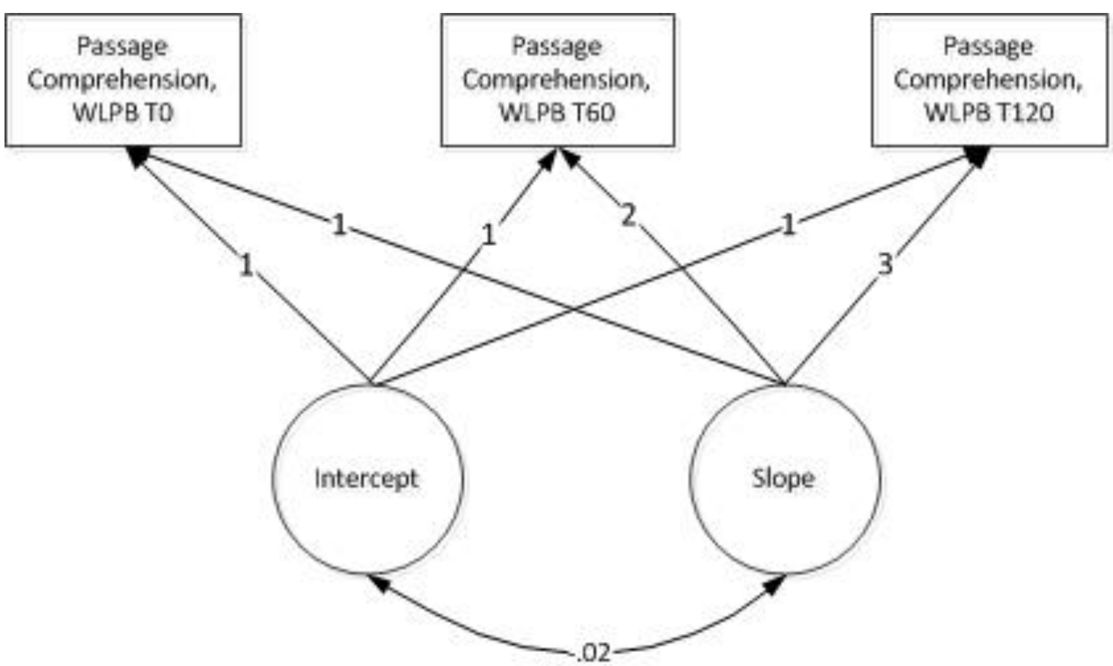
3.4 Growth curve

To investigate changes in narrative comprehension over three time points, we used a latent growth curve model (Figure 9). The model fit the data well, $\chi 2(N = 95, 1) = 0.185$, $p = .67$, RMSEA = <.001, CFI = 1.000, TLI = 1.00, SRMR = .005. The average baseline score on the passage comprehension subtest of the WLPB was 6.836, and there was significant variability in these scores across individuals at baseline ($\psi 00 = 18.282$, $p < .001$). On average, scores on the passage comprehension subtest significantly increased by 1.660 ($p < .001$) points at each time point. Slopes did not significantly vary ($\psi 11 = 0.269$, p = .78), suggesting that all individuals changed over time at approximately the same rate. There was no correlation between baseline scores and slopes ($\psi 01 = -0.052$, $p = .96$). This indicates that regardless of the student's baseline score on the passage comprehension subtest, the amount of change observed across students was similar.

To investigate changes in receptive vocabulary over three time points, a latent growth curve model was tested (Figure 10). The model fit the data well, $\chi 2(N = 95, 1) = 0.02$, $p = .90$, RMSEA < .001, CFI = 1.000, TLI = 1.00, SRMR = .002. The average baseline score on the support scale was 70.51 ($\alpha 0 = .394$), and there was significant variability in these scores across individuals at baseline ($\psi 00 = 459.424$, $p < .001$). On average, scores on the PPVT significantly increased by 3.71 ($p < .001$) points at each time point. Slopes did not significantly vary ($\psi 11 = -3.40$, p = .90), suggesting that all individuals changed over time at approximately the same rate. There was no correlation between baseline scores and slopes ($\psi 01 = -9.32$, $p = .76$). This indicates that regardless of the student's baseline score on the PPVT, the amount of change observed across students was similar.

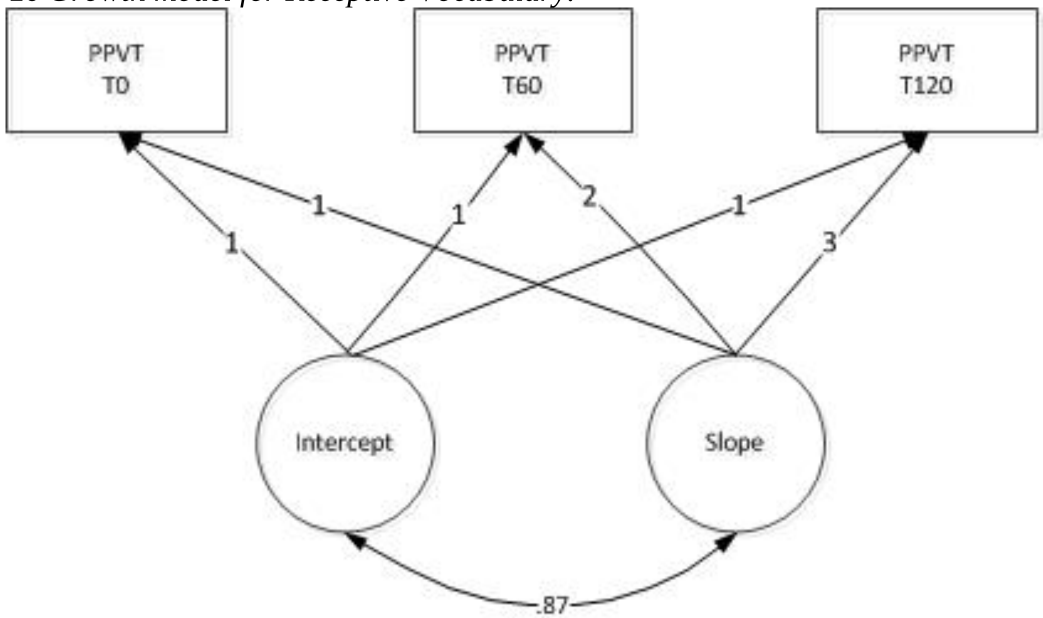
To investigate changes in word attack on the WRMT over three time points, a latent growth curve model was tested (Figure 11). The model fit the data well, $\chi 2(N = 95, 1) = 0.175$, $p = .68$, RMSEA <.001, CFI = 1.000, TLI = 1.00, SRMR = .006. The average baseline score on the support scale was 4.160, and there was significant variability in these scores across individuals at baseline ($\psi 00 = 25.103$, $p < .001$). On average, raw scores on the word attack subtest significantly increased by 2.640 (p = <.001) at each time point. Slopes did not significantly vary ($\psi 11 = 1.388$, p = .581), suggesting that all individuals changed over time at approximately the same rate. There was no correlation between baseline scores and slopes ($\psi 01 = 5.147$, $p = .06$), indicating that regardless of the student's baseline score on the Word Attack subtest, the amount of change observed across students was similar.

Figure 9 *Growth model for narrative comprehension.*



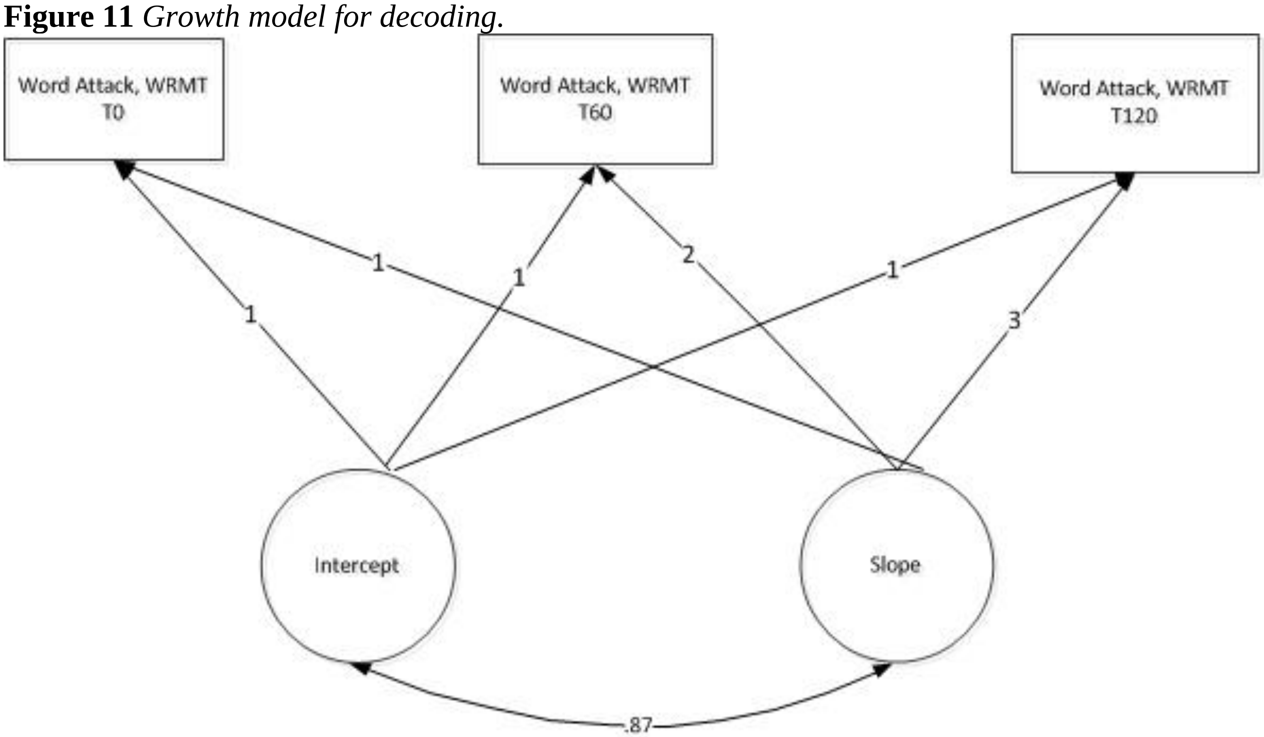
Note. covariance loading is standardized estimate. *<.01, **<.001. $\chi 2(N = 95, 1) = 0.185$, $p = .67$, CFI = 1.000, SRMR = .005

Figure 10 *Growth model for Receptive Vocabulary.*



Note. covariance loading is standardized estimate. *<.01, **<.001. $\chi 2(N = 95, 1) = 0.02$, $p = .90$, RMSEA < .001, CFI = 1.000, TLI = 1.00, SRMR = .002.

Figure 11 *Growth model for decoding.*



Note. covariance loading is standardized estimate. *<.01, **<.001. $\chi 2(N = 95, 1) = 0.175$, $p = .68$, CFI = 1.000, SRMR = .006

3.5 Multivariate growth

We examined the relationship between the intra-person rate of change on narrative comprehension and word attack and reading comprehension in three separate multivariate growth curve models (Figures 12 - 14) on the larger n = 228 sample. The model fit for each of these models was very good (Table 11).

In the multivariate model examining the relationship between change in narrative comprehension and decoding skills (see Table 12, Figure 12) and the intercepts for decoding and narrative comprehension were significantly covaried (.80, $p < .001$). This suggested that at baseline these skills were correlated. The intercept of narrative comprehension significantly covaried with change in word attack (.36, $p = .04$), which suggested that where a student begins in narrative skill is correlated with the amount of change they make in decoding skills over time. Similarly, the amount of change in decoding and narrative comprehension were significantly covaried (.71, $p = .025$), which described that the amount of change that students make over time is similar on both a measure of the skills targeted (i.e., decoding) and one that was not specifically targeted, narrative comprehension. These results confirm the results of the growth curve analysis of narrative comprehension that reported significant change in narrative comprehension scores over time.

In a multivariate model that examined the relationship between narrative comprehension and reading comprehension the model fit very well (see Table 13, Figure 13). Results of this model were similar to that of the previous multivariate model. Notably, baseline scores for both narrative and reading comprehension were highly corelated as was the amount of change students made over time on both measures. Baseline narrative comprehension scores also were significantly correlated with the amount of change observed in reading comprehension. Differing from the decoding measure in the previous model, reading comprehension skills at baseline were significantly correlated with the amount of change observed in this variable. Additionally, we ran these analyses with the sample of 95 students for a consistent comparison using the same sample as the longitudinal panel model (see Appendix 1.1).

Table 11 *Fit indices for multivariate growth models*

Model Comparison	χ^2	df	p	CFI	RMSEA	SRMR
Narrative comp and Word Attack	2.82	7	.90	1.00	.00	.007
Narrative comp and Reading Comp	7.93	7	.34	.999	.02	.01
Narrative comp and PPVT*						

Note. *Model converged but PPVT slope factor demonstrated difficulties.

In a third multivariate growth model we examined the relationship between narrative language and component language, specifically receptive vocabulary as measured by the PPVT. Although the base model had excellent fit, the latent slope variance for PPVT did not converge due to high collinearity between the measures. After constraining the residual variance of this latent factor to one, we were able to get the model to run. This constrained model had good fit (see Table 14, Figure 14). Overall, the model suggested that the baseline skills of both narrative and receptive language were significantly related. The change in narrative language over time was not significantly correlated with the baseline of either skills or the change in receptive language overtime.

Table 12 Parameter estimates for multivariate growth model of narrative comprehension and decoding.

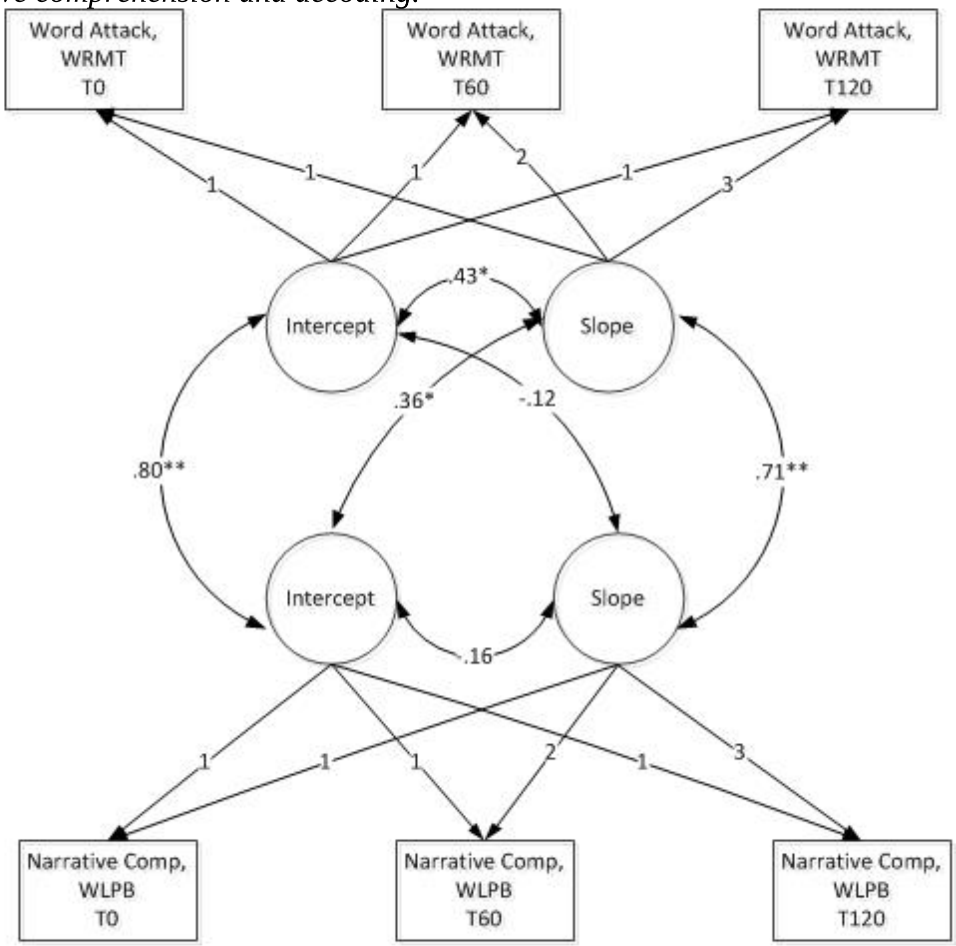
Relation/Variable	Estimate	SE	Ratio	*p*	Std
Factor Loadings					
Word Reading Intercept					
Word Attack, WRMT Time 0	1.00	—[a]	—	—	.92
Word Attack, WRMT Time 60	1.00	—[a]	—	—	.84
Word Attack, WRMT Time 120	1.00	—[a]	—	—	.74
Word Reading Slope					
Word Attack, WRMT Time 0	0.00	—[a]	—	—	.00
Word Attack, WRMT Time 60	1.00	—[a]	—	—	.18
Word Attack, WRMT Time 120	2.00	—[a]	—	—	.31
Narrative Comp Intercept					
Narrative Comp, WLPB Time 0	1.00	—[a]	—	—	.95
Narrative Comp, WLPB Time 60	1.00	—[a]	—	—	.94
Narrative Comp, WLPB Time 120	1.00	—[a]	—	—	.95
Narrative Comp Slope					
Narrative Comp, WLPB Time 0	0.00	—[a]	—	—	.00
Narrative Comp, WLPB Time 60	1.00	—[a]	—	—	.21
Narrative Comp, WLPB Time 120	2.00	—[a]	—	—	.42
Observed/Error Variances					
Narrative Comp, WLPB Time 0	2.07	.88	2.36	.02	.09
Narrative Comp, WLPB Time 60	3.17	.45	6.50	<.001	.13
Narrative Comp, WLPB Time 120	1.24	.85	1.46	.15	.05
Word Attack, WRMT Time 0	6.48	2.01	3.23	<.001	.16
Word Attack, WRMT Time 60	6.96	1.13	6.13	<.001	.14
Word Attack, WRMT Time 120	10.05	2.45	4.10	<.001	.16
Covariances					
Word Attack Slope with Word Attack Intercept	3.06	1.44	2.13	.03	.43
Narrative Intercept with					
Word Attack Intercept	21.26	2.43	8.76	<.001	.80
Word Attack Slope	2.01	.76	2.64	.008	.36
Narrative Slope with					
Word Attack intercept	-.64	.57	-1,13	.26	-.12
Work attack slope	.89	.22	4.02	<.001	.71
Narrative intercept	-.76	.60	-1.30	.20	-.16
Factor Variance					
Word Attack Intercept	33.65	4.00	8.51	<.001	1.00
Word Attack Slope	1.51	1.12	1.34	.18	1.00
Narrative intercept	20.91	2.21	9.45	<.001	1.00
Narrative Slope	1.03	.43	2.39	.02	1.00

Figure 12

Multivariate growth model of

Note. SE = standard error, Std = standardized loadings. n = 228. [a] Dashes indicate a parameter fixed f model identification, which was not tested for statistical significance. WLPB = Woodcock Langua Proficiency Battery; WRMT = Woodcock Reading Mastery Test; X^2 = 2.82, p = .90, RMSEA = .00, CFI 1.00, SRMR = .007.

narrative comprehension and decoding.



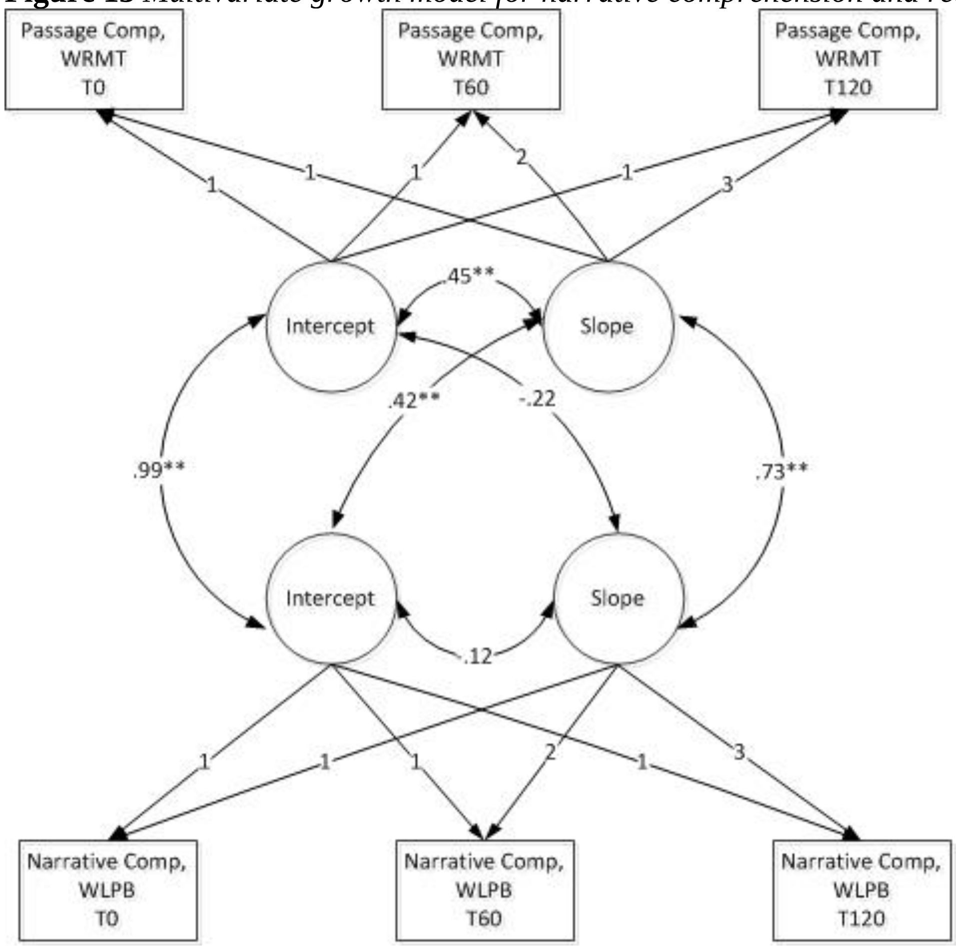
Note. Factor loadings are standardized estimates. *<.01, **<.001; n = 228.

Table 13 *Parameter estimates for multivariate growth model of narrative comprehension and reading comprehension.*

Relation/Variable	Estimate	SE	Ratio	*p*	Std
Factor Loadings					
Reading Comp Intercept					
Passage Comp, WRMT Time 0	1.00	__[a]	__	__	.92
Passage Comp, WRMT Time 60	1.00	__[a]	__	__	.84
Passage Comp, WRMT Time 120	1.00	__[a]	__	__	.74
Reading Comp Slope					
Passage Comp, WRMT Time 0	0.00	__[a]	__	__	.00
Passage Comp, WRMT Time 60	1.00	__[a]	__	__	.21
Passage Comp, WRMT Time 120	2.00	__[a]	__	__	.37
Narrative Comp Intercept					
Narrative Comp, WLPB Time 0	1.00	__[a]	__	__	.94
Narrative Comp, WLPB Time 60	1.00	__[a]	__	__	.94
Narrative Comp, WLPB Time 120	1.00	__[a]	__	__	.93
Narrative Comp Slope					
Narrative Comp, WLPB Time 0	0.00	__[a]	__	__	.00
Narrative Comp, WLPB Time 60	1.00	__[a]	__	__	.17
Narrative Comp, WLPB Time 120	2.00	__[a]	__	__	.33
Observed/Error Variances					
Narrative Comp, WLPB Time 0	2.64	.61	4.36	<.001	.11
Narrative Comp, WLPB Time 60	2.79	.35	7.91	<.001	.12
Narrative Comp, WLPB Time 120	2.19	.65	3.39	<.001	.09
Passage Comp, WRMT Time 0	8.29	1.60	5.19	<.001	.12
Passage Comp, WRMT Time 60	6.16	.84	7.30	<.001	.09
Passage Comp, WRMT Time 120	6.32	1.80	3.52	<.001	.08
Covariances					
Reading Comp Slope with Reading Comp Int	4.95	1.37	3.60	<.001	.45
Narrative Comp Intercept with					
Reading Comp Intercept	29.67	2.98	9.95	<.001	.99
Reading Comp Slope	3.13	.83	3.79	<.001	.42
Narrative Comp Slope with					
Reading Comp intercept	-1.21	.65	-1.88	.06	-.22
Reading Comp slope	.97	.24	4.08	<.001	.73
Narrative Comp intercept	-.45	.52	-.86	.40	-.12
Factor Variance					
Reading Comp Intercept	43.82	4.80	9.14	<.001	1.00
Reading Comp Slope	2.73	.93	2.93	.003	1.00
Narrative Comp intercept	20.55	2.16	9.50	<.001	1.00
Narrative Comp Slope	.64	.31	2.04	.041	1.00

Note. Std = standardized loading. n = 228. [a] Dashes indicate a parameter fixed for model identification, which was not tested for statistical significance. WLPB = Woodcock Language Proficiency Battery; WRMT = Woodcock Reading Mastery Test; $X^2 = 7.93$, $p = .34$, RMSEA = .02, CFI = 1.00, SRMR = .01.

Figure 13 *Multivariate growth model for narrative comprehension and reading comprehension.*



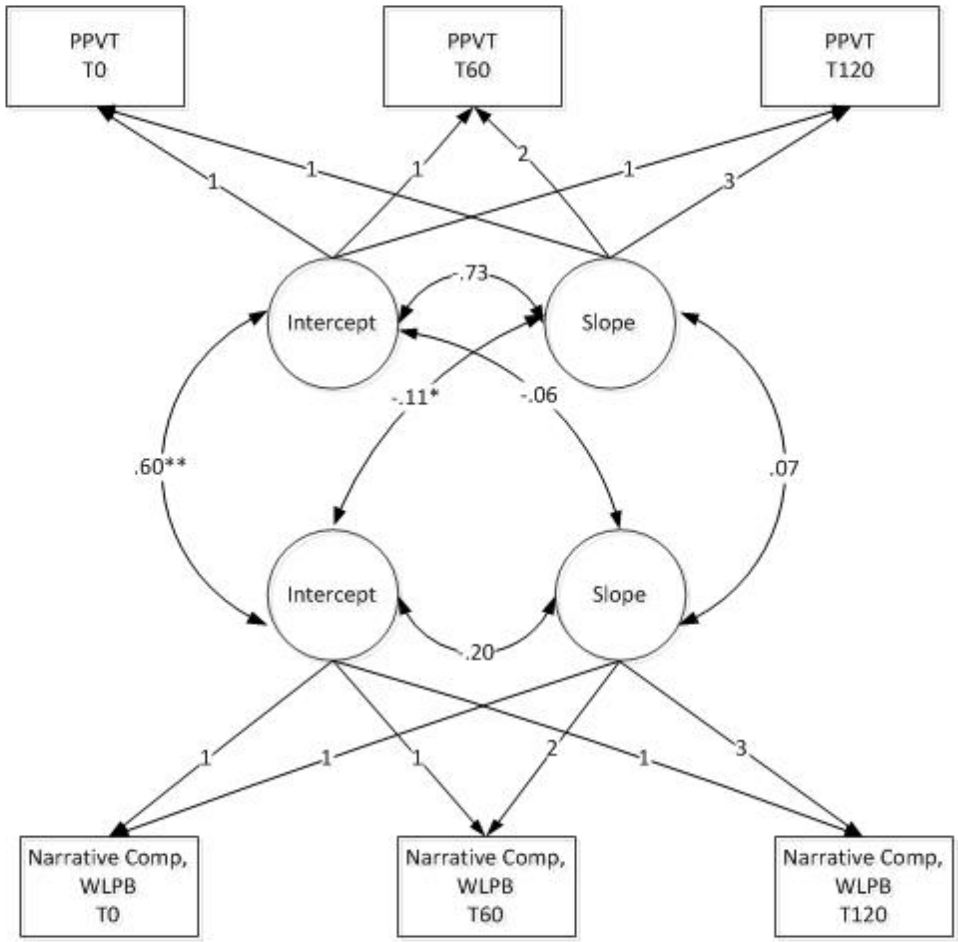
Note. Factor loadings are standardized estimates. *<.01, **<.001; n = 228.

Table 14 Parameter estimates for multivariate growth model of narrative comprehension and receptive vocabulary.

Relation/Variable	Estimate	SE	Ratio	*p*	Std
Factor Loadings					
Receptive Vocab Intercept					
PPVT Time 0	1.00	—[a]	—	—	.91
PPVT Time 60	1.00	—[a]	—	—	.94
PPVT Time 120	1.00	—[a]	—	—	1.01
Receptive Vocab Slope					
PPVT Time 0	0.00	—[a]	—	—	.00
PPVT Time 60	1.00	—[a]	—	—	.05
PPVT Time 120	2.00	—[a]	—	—	.10
Narrative Comp Intercept					
Narrative Comp, WLPB Time 0	1.00	—[a]	—	—	.97
Narrative Comp, WLPB Time 60	1.00	—[a]	—	—	.94
Narrative Comp, WLPB Time 120	1.00	—[a]	—	—	.96
Narrative Comp Slope					
Narrative Comp, WLPB Time 0	0.00	—[a]	—	—	.00
Narrative Comp, WLPB Time 60	1.00	—[a]	—	—	.22
Narrative Comp, WLPB Time 120	2.00	—[a]	—	—	.46
Observed/Error Variances					
Narrative Comp, WLPB Time 0	1.50	1.07	1.40	.16	.07
Narrative Comp, WLPB Time 60	3.40	.60	5.65	<.001	.14
Narrative Comp, WLPB Time 120	.95	1.10	.86	.39	.04
PPVT Time 0	89.23	12.42	7.18	<.001	.18
PPVT Time 60	82.38	11.09	7.42	<.001	.18
PPVT Time 120	44.31	9.45	4.70	.001	.11
Covariances					
Receptive Vocab Slope with					
Receptive Vocab Int	-14.71	8.73	-1.69	.09	-.73
Narrative Comp Intercept with					
Receptive Vocab Intercept	56.14	7.93	7.10	<.001	.60
Receptive Vocab Slope	-5.08	1.95	-2.61	.008	-1.1
Narrative Comp Slope with					
Receptive Vocab intercept	-1.23	1.99	-.62	.53	-.06
Receptive Vocab slope	.08	.54	.14	.89	.07
Narrative Comp intercept	-1.01	.68	-1.49	.14	-.20
Factor Variance					
Receptive Vocab Intercept	405.80	45.09	8.99	<.001	1.00
Receptive Vocab Slope	1.00	—	—	—	1.00
Narrative Comp intercept	21.38	2.31	9.25	<.001	1.00
Narrative Comp Slope	1.24	.54	2.30	.02	1.00

Note. SE = standard error. Std = standardized estimates. n = 228. [a] Dashes indicate a parameter fixed for model identification, which was not tested for statistical significance. WLPB = Woodcock Language Proficiency Battery; PPVT = Peabody Picture Vocabulary Test; X^2 = 13.84, p = .09, RMSEA = .06, CFI = 1.00, SRMR = .02.

Figure 14 *Multivariate growth model of receptive vocabulary and narrative comprehension*



Note. Factor loadings are standardized estimates. *<.01, **<.001; n =228.

4 DISCUSSION

4.1 General findings

This study evaluated the relationship between reading intervention and language skills, specifically narrative language, among elementary school children with mild intellectual disability (MID). Overall, we found that narrative language was a separate but related skill to component language. We did not find significant effects for narrative language as a moderator between component language and reading. However, our models did support that narrative language was significantly correlated with reading across the three time points of the intervention.

4.2 Narrative and component language factor structure

The first aim was to examine the nature of the narrative and component language constructs and determine if they were best defined at a single or two-factor model. Our findings supported our hypothesis that a two-factor model of narrative and component language fit better than the single factor model. These findings are consistent with literature in other populations (e.g., dyslexia) that describe narrative and component language skills as separate but closely related skills.

4.3 Relationship of component language and narrative skills overtime

The second aim was to examine the relationship between narrative language and the latent factors of reading and component language over time. Our longitudinal panel model did not support our hypothesis. Narrative language at pre-intervention only predicted component language not reading. Similarly, narrative language at post intervention was only predicted by component language, not reading, at post-intervention. Component language and reading factors significantly covaried at each time point, however cross-lagged paths between component language and reading factors were only significant at baseline. This did not align with previous research (e.g., Piasta eta., 2018) that described significant connections between these skills. These differences may be explained by several factors. First, our study included an older sample, third and fourth graders. The children in other studies were primarily younger, preschoolers or kindergarteners. Second, prior to this study the literature has not included children with IDD in these comparisons. It is likely that older children with IDD may have had different experiences with both reading, language, and narratives when compared to younger children who were TD or those with language and learning disorders. Boudreau and Chapman (2000) note that increased exposure to narrative texts may give older students with DS relatively better narrative abilities than language matched younger children who are TD. Additionally, it is possible that our narrow definition of reading as "word reading" might have impacted our ability to detect these relationships.

4.4 Moderation effects

We hypothesized that narrative language would moderate the relationship between component language and reading at Time 120. This hypothesis was not supported by our analyses but was consistent with the results of the longitudinal panel model. Examining narrative language as a moderator has not been reported previously. Piasta and colleagues (2018) found that emergent literacy skills (e.g., phonological awareness) mediated the relationship between narrative skills and word reading. Therefore, we tested additional moderation models for our sample to explore if the moderation effect was any different. First, we examined if narrative language moderated the relationship between component language and phonological awareness. Our findings did not support moderation for this analysis. Also, we examined if phonological awareness moderated the relationship between narrative and word reading. The findings for this analysis were not significant. Although none of these models were supported, we believe that further examination of moderation/mediation effects are warranted with a larger sample to provide more power to detect potential effects.

4.5 Growth of skills over time

Our third aim was to examine the growth of narrative comprehension, decoding, and receptive vocabulary across the three time points. For each of the measures, significant increases were observed over time and the variance in slopes supported that students changed at approximately the same rate. Across all three growth models, we found that baseline scores were not correlated with the amount of change measured over time. This suggested that regardless of where a student began the intervention in these baseline skills, they still changed at approximately the same rate on all three measures by the end of the intervention. Although we did not have a developmental control group, the growth observed in narrative comprehension overtime is significant given that it was not a specific target of the intervention like decoding and vocabulary. Previous literature has cited that narrative language abilities and intervention may predict reading outcomes (e.g., Catts, 2001; Feagans & Appelbaum, 1986), but our study may be one of the first studies to suggest that reading intervention may also influence the amount of change in narrative abilities. That is to say that reading intervention may play some role in supporting narrative language development.

4.6 Relationship of growth of skills over time

Lastly, we conducted a series of multivariate growth models in which we compared growth in narrative comprehension to decoding, receptive vocabulary, and reading comprehension over time. These models supported that the relationship of these skills at baseline significantly covaried. Also, we observed that baseline skills in narrative comprehension were significantly related to the change observed in decoding and reading comprehension overtime. Similarly, the change observed in narrative comprehension significantly covaried with change observed in reading comprehension and decoding as well. The multivariate growth models that charted the relationship between narrative comprehension with decoding and reading comprehension differed slightly. In the multivariate model that included decoding, the intercept and the slope were not significantly related, however they were in the reading comprehension model. These findings supported the robust literature that describe reading comprehension as not simply a skill that can be taught but a confluence of skills including background knowledge and language skills. These results also are consistent with previous findings by Catts and colleagues (1999) that reported reading abilities, regardless of IQ, were closely linked to narrative skills.

4.7 Implications

Theoretical relationships between component language, narrative language, and reading have been proposed in the literature (Snow, 1991), but prior to this study have not been directly tested. The major findings of this study did not support our hypothesis that narrative language would moderate the relationship between reading and component language skills, however there are many indicators in our models that support narrative language as an important and related factor to both reading and component language skills. Much of the previous literature included both oral narratives and narrative comprehension as a component of a language factor (e.g., Storch & Whitehurst, 2002). Our findings support examining narrative language as a separate but related skill may be helpful to increase clarity of these models in future studies.

Historically, children with IDD have been excluded from classroom education and neglected in academic research when examining phonological based reading development and its connection to other skills. These findings support the mounting evidence that including children with IDD in research about reading and language development is crucial to better understand how to support these children in the classroom. Our study found that proposed models of these relationships in children who are TD and those with language and learning disorders may not be a good fit for this population. While we know that children with IDD respond well to phonological based reading intervention, additional work is needed to clarify the connections to other skills.

4.8 Future research directions

Understanding language development in children with IDD not only consists of component language skills (e.g., receptive vocabulary) but the impact these skills have on a student's communication abilities in real world settings. Narrative language offers a rich medium to study the integrative nature of language and its impact on communication and social abilities. There are few studies that target narrative language among children with IDD, and even fewer that have investigated the theoretical background of narrative language development and its connections to other academic skills in this population. It is essential to understand the relationship between component language, narrative language, and reading skills to improve interventions across each of these areas. Interventions commonly target these skills in isolation; understanding their integrative relationship may improve efficacy of the intervention and generalization of the skills. Although we did not see causal links between reading and narrative language in this study, it will be important to continue investigating these relationships with a larger sample. As this work included children with mild IDD, investigating the relationship between narrative, component language, and reading skills among students with moderate and severe IDD also is necessary. This will likely come with the challenge of including students who use augmentative and alternative methods to communicate. Future directions also may include assessing the efficacy of current measures of narrative language comprehension and expression and its relationship to working memory and executive functioning skills for this population.

In this study, we had difficulty fitting phonological awareness measures into our models despite testing models of reading that have been suggested in the literature for other populations. It may be that for students with IDD, phonological awareness may factor into the model differently. Previous work (Wise et al., 2010) has shown that phonological awareness skills are predictive of later reading comprehension outcomes among students with IDD. However, modeling reading in this sample was more complicated than anticipated. A simple model of "reading" that included all the reading measures did not fit well, nor did models that included additional latent variables (e.g., fluency and phonological awareness). While we know that phonological awareness skills are foundational and predictive of reading comprehension, more investigation is warranted to understand the relationship between phonological awareness, word reading, and narrative language skills among students with IDD.

4.9 Limitations

This study had several limitations. First, the power in our models was low due to a relatively small sample size. Despite the small sample for running structural equation models, it is important to note that for this population the sample for this study was quite large. It may be important to consider meta-SEM techniques to draw more robust findings with larger and more diverse samples in the future. Second, we used raw scores to increase the variability in the scores. Although this likely improved our model fit, we weren't able to draw any conclusions about standardized change on the measures. Lastly, the oral narrative measure was administered only at Time 0 and Time 120. Therefore, we could not examine the growth of oral narrative skills, only narrative comprehension. The literature supports that narrative comprehension is a closely related skill to oral narratives, but future studies would benefit from examining oral narrative skills at the same time points as reading and language measures.

Narrative language is a complex, functional language skill that is related to other language and reading skills. For children with disabilities, narrative language can provide important information concerning their ability to use language above and beyond typical measures of component language (e.g., PPVT). Snow (1991) and Westby (1989) theorized that narrative language ability may influence the relationship between component language and reading skills. Our findings did not directly confirm this theory but supported that these skills are positively related overtime. Continued investigation into the complexities of narrative language and its relationship to component language and reading skills will deepen our understanding of these variables and may inform future intervention practices.

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APPENDICES

Appendix A

Appendix A.1 Multivariate Growth Results for n = 95

In a multivariate model that examined the relationship between narrative comprehension and reading comprehension the model fit very well (X^2 = 3.29, p = .86, RMSEA = <.001, CFI = 1.00, SRMR, = .017). Results of this model were similar to that of the multivariate model with the sample of 228 students but there were some differences. Baseline scores for reading comprehension were significantly covaried with baseline scores of narrative comprehension (r = .83, p <.001). Similarly, the change in narrative comprehension overtime covaried with the change in reading comprehension over time (.54, p= .002). Baseline narrative comprehension skills covariance with the amount of change in reading comprehension trended towards significance (.30, p = .06).