Investigating Oral Reading Miscues Produced by Students with Down Syndrome: A Descriptive Study

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Abstract

Objective: Individuals with Down syndrome (DS) exhibit difficulties with oral language and reading development. Research is needed to understand the language and reading connections of students with DS to develop effective interventions that ensure academic success in this population. The purpose of this present study was to investigate the oral language and reading processes of six students (mean age: 16; 3) with DS by analysing the oral miscues produced while reading a storybook.

Method: Using a miscue analysis approach, students with DS independently read a storybook out loud and then were asked to retell the story. Oral reading miscues were analysed within the context of the sentence and the entire text to determine semantic and syntactic acceptability, meaning change, correction and graphic and phonemic similarity. In addition, thematic analysis was incorporated to provide an in-depth analysis of the miscue data.

Results: Based on the miscue analysis data, students exhibited higher meaning construction scores as compared to grammatical relations scores (63.67% vs. 46%) and higher graphic similarity scores as compared to phonemic similarity scores (66.34% vs. 60.67%). Using a thematic analysis procedure, students with DS rarely self-corrected miscues, exhibited relative strength with meaning but difficulty with syntax and relied on visual support while reading.

Conclusion: The present study adds to the existing body of literature about the language and reading profile of students with DS by including analysis of their oral reading miscues and provides implications on intervention techniques that may be beneficial with this population.

Introduction

Down syndrome (DS) is the most common genetic syndrome affecting cognition and intellectual development, occurring in approximately one out of every 691 live births in the United States [1]. Although individuals with DS demonstrate an array of cognitive abilities ranging from near normal to severely impaired, approximately 80% demonstrate moderate intellectual delays [2]. Research indicates that individuals with DS display a unique cognitive profile, particularly when matched with individuals with other disabilities, which likely impacts language and reading skills [3]. As a group, individuals with DS demonstrate a relative strength in visuo-spatial skills while auditory short-term memory, specifically phonological and theory of mind are areas of difficulty [4]. Notably, this cognitive profile changes over time such that there is a divergence in visual skills (patterning exceeds visual short term memory) during adolescence [5].

Nearly all individuals with DS exhibit considerable learning difficulties [3]. Although research supports a relation between cognitive skills and oral language development [6], much remains unknown about the language underpinnings and reading connections of individuals with DS. Additional research is needed in order to develop effective interventions for facilitating oral language learning and reading in this population. Thus, the purpose of the present study was to investigate the oral language and reading processes of students with DS by analysing the oral miscues produced while reading aloud a storybook. Theoretically, this article is guided by the postulation that students' underlying oral language processes play a role in their development of reading [7-10]. As stated by the American Speech-Language-Hearing Association [11] position statement, oral language serves as the foundation for reading and individuals who struggle in these areas tend to also have difficulties with oral language.

Oral language and reading of students with DS

Oral language: Oral language development of individuals with DS tends to be one of the most affected domains of functioning, with deficits in this area having the greatest impact on academic success, independent living, interaction with others and successful employment [5,12,13]. While all domains of oral language tend to be impacted, patterns of relative strengths and areas of difficulties emerge when compared to age-matched peers, a finding that suggests a syndrome-specific profile of oral language development [3,14,15]. Overall, research supports a divergence between comprehension and production, with comprehension being a relative strength when compared with production for subjects matched for nonverbal age. More specifically, semantics tends to be superior to syntactic development [5,16].

Reading: Individuals with DS exhibit a wide range of knowledge and skills with regard to reading development, although variability exists based on the sampling methods, cognitive and linguistic profiles and intervention history [17,18]. While some individuals with DS never learn how to read, others are more successful and gain at least basic, functional reading skills [19-21]. In other words, the majority of individuals with DS who acquire reading skills are at the emergent literacy level. Those who are at this emergent literacy level tend to not fall behind the developmental expectations, particularly in the areas of print concepts and letter identification [22,23].

Related to more advanced reading, word identification skills (i.e., sight word reading) tend to be stronger than reading comprehension and decoding of novel words (i.e., word attack skills) for individuals with DS. Some researchers argue that the reason for this discrepancy may be that individuals with DS tend to have stronger visual skills and rely on patterns and whole-word retrieval instead of their knowledge of decoding skills, or lack thereof [24-26]. With regard to decoding abilities, recent research convincingly establishes that phonological awareness, a precursor to decoding and reading is related and that reading does not develop independently of phonological awareness [27].

Overall, while the reading areas of emergent literacy and word identification tend to be relative areas of strength for individuals with DS, much less is known about more advanced areas of reading development, including comprehension. Because very few individuals with DS acquire advanced literacy skills, little is known about reading comprehension, resulting in a seemingly larger body of research dedicated to the literacy areas of emergent literacy and basic decoding skills [3]. For example, Byrne, MacDonald and Buckley [19] found that although the individuals with DS made gains in their single word reading abilities, they made little progress in the area of reading comprehension.

Relationship between oral language and reading: Extant research convincingly supports a reciprocal relationship between language and reading for all individuals [11]. Put simply, oral language predicts reading achievement for typically developing students [28] and those with DS [22,29]. Catts et al. [30] proposed that older students with difficulties in comprehending text had earlier difficulties with oral language. To successfully extract meaning from text, a reader must incorporate knowledge of the semantic, syntactic and phonological domains of oral language [31,32]. Specific to the DS population, the relationship between oral language and reading may be bi-directional. In fact, it is possible that a profile of reading for individuals with DS is consistent with the syndrome-specific language profile [3,14]. Therefore, it is not surprisingly that, in part because of the oral language deficits, the process of learning to read for individuals with DS is particularly challenging.

The majority of the research studies investigating oral language and reading development have focused on the use of standardized assessments and have matched individuals with DS with participants based on a variety of characteristics, including nonverbal mental age [5,13,22,33], language skills [34], age [35] and social factors [13,33]. Although we incorporate aspects of these previously conducted studies in our research design, to the best of our knowledge, none have investigated reading by analysing oral reading miscues.

Miscue analysis

Miscue analysis is a methodological approach that is used to investigate the interplay between oral language and reading development by analysing oral reading miscues, which occur when the student reads or includes aspects that are different from the print [36]. By investigating patterns of miscues, a professional is able to analyse how the reader uses semantic, syntactic and grapho-phonemic cues to modify the text as the reader reads the text. In other words, the cueing systems work together to support meaning, or comprehension, of the text. Analysis of miscues also reveals strengths and difficulties about a student's reading and may help educators develop strategies to improve a student's reading.

Language cueing systems: The semantic cueing system includes the understanding of words and phrases and the relationship among them (i.e., vocabulary). For example, a child may be able to decode a word that he or she has not seen or heard before, but it may not have any meaning (thus he or she may not have any exposure or experience with it). The syntactic cueing system relates to the interaction of words and sentences and includes tense, word order, gender and number. This cueing system allows for speakers of the language to organize words into sentences and highlights the relationship between sentences. Competent users of the language understand the rules of the language and use this information to predict the words based on the structure of the sentence. For example, in English the basic sentence structure is a noun phrase followed by a verb phrase. As the reader reads, he or she will perceive the noun phrase and then expect that a verb phrase follows. Lastly, the grapho-phonemic cueing system includes the orthographic system (spelling, punctuation, print features), phonological system (sounds of the language) and the relationship between the two [37,38]. As readers read, they use grapho-phonemic cues to provide input about the letters, their corresponding sounds and previous knowledge about the language. In summary, although the three language cueing systems are described individually, a reader integrates information from the text simultaneously as the reader makes meaning, or comprehends the text [36].

Miscue analysis with "atypical" populations: To date, only a few studies have included miscue analysis procedures with populations that are "atypical" in nature (e.g., those with language-learning deficits). For example, Gillam and Carlisle [39] analysed the oral reading miscues of 12 school-age children with language impairment (LI) and typically developing peers, who were matched on single word reading ability. The authors concluded that the children with LI produced a higher percentage of oral reading miscues and used significantly fewer self-correction strategies when compared to their typical matched peers. Further, the miscues produced by the group with LI were less semantically, syntactically, pragmatically and grapho-phonemically similar to the presented text than those of the control group.

In addition, Laing [40] incorporated a similar procedure with eleven children with average reading, language and cognitive abilities (nonlanguage-learning disordered—NLLD) and eleven students with below-average reading and language performance and average cognition (language-learning disordered—LLD) who were matched on chronological age. Children in the LLD group produced different types of miscues than children in the NLLD group, which included a greater number of phonologically similar miscues that maintained the meaning of the presented text. In contrast to the Gillam and Carlisle [39] study, both groups were equally likely to make errors that were grapho-phonemically similar or were nonsense words. In summary,

both of these studies support that students with "disordered" oral language skills produce quantitatively different oral reading miscues when compared with their typically developing (TD) peers, likely because of their underlying language skills. Thus, there may be implications for educational strategies to support the oral language development of individuals with disordered language, including students with DS.

The current study

Although previous research suggests that individuals with DS may demonstrate a distinct language and cognitive profile, which likely impacts reading acquisition and ultimately academic success, much remains unclear about the nature and extent of knowledge and skills while reading a storybook. Thus, the aim of the present study was to investigate the oral reading miscues produced by students with DS. This research adds to the existing body of literature about the oral language and reading profile of students with DS and may highlight clinical intervention implications related to facilitating oral language and teaching reading to this population.

Methods

Participants

This study included six students with DS (five males and one female). All the participants were Caucasian/White with a mean age of 16 years, 3 months (range: 13 years, 1 month to 19 years, 8 months). Participants had a confirmed diagnosis of Trisomy 21 and no history of other health or related conditions, such as autism (per parent report). All participants passed a pure tone hearing screening at 25 dB. Although typical hearing screening requirements use 20 dB as the criterion, we used 25 dB because of the documented hearing difficulties of students with DS [13,16,41].

Following Institutional Review Board approval, participants were recruited via a newsletter posting and email sent to all parents who were registered with the local DS parent chapter/group. Once parental permission was granted, students were administered the Rate and Accuracy subtests (which were combined to form an overall "Fluency" score) of the Gray Oral Reading Test—Fourth Edition (GORT-4) to qualify students for the study [42]. Students were enrolled in the study if their Fluency raw score fell within the range of 20 to 27. This raw score range corresponds with a reading grade equivalent between 1.4 (fourth month in the first grade) and 2.0 (before the first month in the second grade) as described in the GORT-4 examiner's manual. This criterion was selected based on the expectations of the oral language and reading levels of the students with DS. In total, 27 students with DS were screened and ten met the criterion. Most students with DS did not qualify for the present study because their raw scores on the Fluency section of the GORT-4 fell below the required range. For the purposes of the present study, a subset of six individuals with DS was included. See Table 1 for demographic information as well as GORT-4 Rate, Accuracy and Fluency raw scores.

Materials

Assessment measures: The GORT-4 is a norm-referenced, frequently used reading assessment used to identify children who have difficulties with reading. It is a reliable (internal consistency, test-retest and inter-rater reliability coefficients range from .85 to .99) and valid (criterion, construct and content validity data are moderately strong) measure

that can be used for students who are at least 6 years of age. This standardized measure includes 14 reading passages of increasing complexity and five multiple-choice questions that students answer once finished with the short passages. Five subtest scores are available: Rate (time required to read the passage), Accuracy (number of accurately produced words in the passage), Fluency (combination of Rate and Accuracy scores), Comprehension (score based on responses to five multiple choice questions after reading the passage) and Overall Reading ability (Fluency and Comprehension scores—Oral Reading Quotient). As previously described, raw scores from the Rate and Accuracy subtests were used to qualify participants in the present study; raw scores from the Comprehension subtest were collected but not used.

Book selection: The book, See You Tomorrow, Charles by Cohen [43], was read by all students. Prior to initiation of the study, parents of participating students completed a brief questionnaire that stated that their child did not have previous exposure to this book. The reading level for this book is 2.3, meaning that students in the third month of the second grade should be able to read it independently. This book was chosen because it was above the students' level of reading but not so difficult that they were unable to read it.

Procedure

All data were collected in a quiet room at a local of the participant's choice and occurred over two sessions lasting between 30 and 60 minutes each. The first session included a hearing screening. If a participant had received a hearing screening within the past six months, it was not re-assessed. The GORT-4 was also administered during this session; procedures described in the GORT-4 examiner's manual were followed. During the second session, students read the selected book. Prior to reading, they were asked to read the text aloud as if they were reading alone. They were told that they would not be interrupted or receive help or suggestions while reading. After the reading, participants were asked to retell the story in their own words. Oral readings and retellings were videotaped for analysis following data collection.

Miscue analysis: Miscue analysis procedures were followed for each student's oral reading of the entire book. Fifty consecutive miscues were coded for all students. Coding began after the first page was read to allow each participant to become familiar with the text. All miscues that were substitutions, omissions and insertions were numbered and coded, even if they were corrected. Repetitions and pauses were marked on the typescript but were not coded as miscues for the purposes of this research. The percent of oral reading miscues was determined for each participant by dividing the total number of coded miscues by the total number of words read to that point. In addition, the percent of miscues that were self-corrected was found by dividing the number of miscues that were self-corrected by the total number of miscues.

Each miscue was analysed within the sentence and the entire text in terms of semantic and syntactic acceptability, meaning change, correction and graphic and phonemic similarity. Specifically, the following questions were asked to identify patterns for meaning construction, grammatical relations and graphic and phonemic similarity:

- Was the miscue corrected? (self-correction)
- Did the miscue maintain a structure that is semantically acceptable in the reader's dialect? (semantic acceptability)

- Did the miscue maintain a structure that is syntactically acceptable in the reader's dialect? (syntactic acceptability)
- Did the miscue change the meaning in the context of the entire book? (meaning change)
- Did the miscue look like the text word? (graphic similarity)
- Did the miscue sound like the expected response? (phonemic similarity).

Patterns for constructing meaning showed how the reader made sense of the text. This included information from the columns for semantic acceptability, meaning change and correction. The coding patterns included:

- No loss of meaning (miscues that were semantically acceptable with no meaning change or miscues that were corrected)
- Partial loss of meaning (miscues that were fully semantically acceptable with some meaning change or partially semantically acceptable)
- Loss of meaning (miscues that were semantically unacceptable with no correction or miscues that were unsuccessfully corrected).

Grammatical relations identified patterns that showed the participant's ability to read texts that were syntactically appropriate. This included information from semantic and syntactic acceptability and correction. The four patterns that were included in grammatical relations were:

- Strength (miscues that were syntactically and semantically acceptable as well as miscues that were corrected)
- Partial strength (miscues that were syntactically acceptable but not completely semantically acceptable or corrected)
- Overcorrection (miscues that were semantically and syntactically acceptable and did not require correction but were corrected by the reader)
- Weakness (miscues that were not syntactically or semantically acceptable or successfully corrected).

Miscues were also coded for graphic and phonemic similarity at the word level. Graphic similarity examined the extent to which the miscue "looked like" the word in the text (i.e., letters of the word) and phonemic similarity examined the extent to which the miscue "sounded like" the word in the text (i.e., phonemes). Both of these categories were judged to have:

- High similarity (miscues that were greater than 50% similar to the expected response in the text)
- Some similarity (miscues that were between 0% and 49% similar to the expected response in the text)
- No similarity (miscues that did not have any part or sound that was similar to the text).

To determine graphic similarity, the letters of the miscue and intended word were compared and the percent of accuracy was calculated by dividing the number of the same letters by the number of letters in the intended word. For the category of sound similarity, the miscue and intended word were transcribed phonetically and the percent of accuracy was calculated by dividing the number of the same phonemes by the total phonemes in the intended word. Although all students produced intelligible speech, if an individual demonstrated a minor articulation error that was consistent across all study procedures (e.g., informal conversation, formal assessment, oral reading, etc.), it was not coded as a miscue (i.e., it was a misarticulation).

Miscue analysis taxonomy: The following are examples (i.e., substitutions, omissions, insertions) of the coding taxonomy and procedure that was used in the present study.

Substitutions occurred when the reader produced a word or words that were different from the printed words in the text. Substitution miscues were written above the appropriate text.

home

I rode a horse to town.

In this example, the substitution was coded as syntactically acceptable (i.e., "yes") because both words are nouns; however, it is not semantically acceptable (i.e., "no") to say "home" and "horse" because these two nouns do not have any associated meanings. The miscue was not corrected (i.e., "no"). This miscue was coded as having a loss of meaning construction, partial strength in grammatical relations, some graphic similarity and some sound similarity.

In the above example, if the reader had read "pony" for "horse" then the analysis results are different.

pony

I rode a horse to town.

As in the above example, "pony" for "horse" is syntactically acceptable (i.e., "yes") because both words are nouns. The determination for semantic acceptability requires several more steps, however. The sentence was read as the reader produced it except for the miscue in question. If the miscue was semantically acceptable within the sentence, then it was determined if the miscue was semantically acceptable within the entire story or passage. If the miscue was acceptable within the entire story, the miscue was coded as being semantically acceptable; however, if it was acceptable at only the sentence level, the miscue was coded as partially acceptable. In this case, the miscue "pony" for "horse" is semantically acceptable within the entire story; therefore, it is coded as semantically acceptable (i.e., "yes"). As a result, the overall meaning did not change; the miscue was not corrected. This miscue was coded as having no loss of meaning construction, strength in grammatical relations yet no graphic and sound similarity.

Omissions occurred when the reader left out a word or words in the text. These miscues were circled in the typescript to indicate that they had been omitted.

The mother worked at home every day.

In this example, the words "at home" were omitted. Omission miscues were analysed using the same procedures as described above.

Insertions occurred when the reader added a word or words to the text. When this occurred, a caret (^) was used to indicate where the insertion occurred within the text.

other   to

He dropped the ^ end down ^ the chimney.

Insertion miscues were analysed using the same procedures as described above.

Reliability: A second examiner, who had extensive experience with miscue analysis procedures and scoring, independently coded (from the video-recordings) and scored (from the typescripts) ten percent of the miscue analysis data. Specifically, the second examiner had in-depth clinical, teaching and research experience using miscue analysis

procedures. Thus, for the purposes of the present study, the second examiner was provided with brief "refresher" training about the procedures for the present study, but no additional training was completed. Reliability was determined for one randomly selected participant with DS. Once the second examiner independently coded and scored the miscues, results from the initial coder and second examiner were compared and yielded inter-rater agreements of 95% for the identification of miscues (95 agreements out of 100 judgments/miscues) and 96.5% for syntactic and semantic acceptability, meaning change and correction (386 agreements out of 400 judgments), which were considered acceptable [39].

Thematic analysis: In addition to the descriptive information from the miscue analysis procedures, a qualitative coding method was used to analyse, categorize and outline the miscue analysis data in this study. A thematic analysis approach was chosen because it allows for an in-depth interpretation of the miscue analysis findings (which include percentages). Using a modified approach described by Braun and Clarke [44], an independent coder who was trained in this procedure, performed a thematic analysis of the miscues and retellings produced by six participants with DS. The analysis was completed in a two-month period to allow time for the coder to revise and refine themes. First, the coder became familiar with each student's oral reading, miscue analysis results and retelling data. In phase 1, the coder highlighted ideas and marked potential patterns for each participant. Second, the coder began the initial-coding phase and compared patterns within and across all participants. During phase two, the coder marked examples in the data set that were applicable to each code created. During phase three, the coder categorized examples into potential themes. Themes were created from broader and more general concepts that were supported by specific examples. In phase four, all themes were examined and outlined within and across participants to create finalized, central themes. In the fifth phase, all themes were named, which corresponded to their main idea. At the end of this fifth phase, specific examples in each theme were further analysed and supported by the literature to finalize an appropriate meaningful 'theme name.' Finally, the sixth phase of the thematic analysis procedure will be described in the results section, where themes will be listed with their supporting examples from the data set [44].

Results

Descriptive data, including means, standard deviations and ranges (reported in percentages), were determined from the raw data obtained from miscue analysis (Table 2). Specifically, participants with DS produced miscues about a quarter of the time (22%) while orally reading the story; few of these miscues were self-corrected (8%). About a third (36%) of the miscues were coded to have complete loss of meaning, over half (54%) did not include an appropriate grammatical structure and about one-third (33% and 39% respectively) did not follow the graphic or phonemic structures of the intended word. Meaning construction scores (no or partial loss) were higher than grammatical relation (strength, partial strength, or overcorrection) scores for every participant in the study (63.67% vs. 46%)

In order to gain a more in-depth perspective, thematic analysis was included to qualitatively analyse the miscue analysis data, as previously described. The following three themes emerged: participants with DS self-corrected miscues infrequently demonstrated a relative strength in semantics with particular difficulty in the area of syntax, and they tended to rely on visual supports as they produced miscues that maintained the letter structure (graphic similarity) of the intended

word." Below, we discuss these themes and provide specific examples as to how the qualitative analysis supports the descriptive findings reported in Table 2.

Self-correction: Although variability existed in the number and type of self-corrected miscues, all of the participants with DS, with the exception of one, self-corrected miscues while orally reading. A more in-depth analysis of participants' use of self-correction revealed that they tended to self-correct miscues that had partial semantic or syntactic acceptability. For example, one participant with DS read, "That's because I went to" and then accurately self-corrected himself to say, "That's because I wanted him to…" In this example, the participant self-corrected "wanted" for "went" and added "him," miscues that were judged to be partially syntactically and semantically acceptable.

Meaning construction: Meaning construction scores (no or partial loss) were higher than grammatical relation (strength or partial strength) scores for every participant with DS (63.67% vs. 46%). In other words, participants with DS were more likely to produce miscues that maintained a structure that was semantically but not syntactically acceptable. As an example, one participant read, "She took out the math book." for "She took out the math rod." Here, the participant substituted "book" for "rod." In addition to substituting a noun for a noun, she demonstrated understanding that a noun typically follows an adjective (e.g., "math"). This type of miscue that maintained the overall meaning of the sentence and text was more common than those that kept the overall grammatical structure.

Discussion

Although the miscue analysis data supports that participants with DS tend to produce miscues that are semantically acceptable, further investigation suggests that they may have difficulty with inferential or "deep level" information. Specifically, in the book, the main character is blind; however, the author never explicitly states this. Instead, readers need to "read between the lines" to understand this based on details described in the book (e.g., he learns to read with his fingers, he has a "special" teacher helping him learn math with math rods, he used his hands, not eyes, to help him feel along the wall to open the door). Based on the oral story retellings, two of the participants with DS were able to spontaneously describe this critical point. Interestingly, these two participants had the two highest percentages of miscues that maintained the meaning. Despite significant, direct prompting during the retellings, none of the remaining participants with DS were able to indicate that the main character was blind.

Syntax: During the reading task, participants with DS often exhibited difficulties with grammar. Specifically, they demonstrated tense changes (e.g., "came" for "come" and "know" for "knew") and omitted articles (e.g., "a" and "the"), contraction words (e.g., "could" for "couldn't" and "you" for "you'll") and possessive –s (e.g., "Margaret" for "Margaret's" and "teacher" for "teacher's"). Interestingly, these same errors were noted during the retelling task, which suggests that these difficulties were pervasive across both oral language (i.e., retelling) and reading. Further, even though participants were initially told that they were to independently retell the story, participants with DS struggled considerably with this task. Thus, they were provided with a variety of supports, including carrier phrases (e.g., "Charles is…", wh-questions (e.g., "Who is the main character?") and questions using reducing choice (e..g, "Did the book take place at home or school?"), to aid their memory of details in the book and to facilitate at least a portion of a retelling.

Visual support: Students relied heavily on visual support throughout the reading and retelling task. In addition to the percentages for graphic and phonemic similarity, it was noted that each participant with DS tracked print from left to right with his or her finger while reading the entire book. This strategy may be used by participants with DS to ensure that they read every word on the page. Likewise, participants with DS frequently paused and looked at the pictures on each page. This suggests that they understood that the corresponding pictures had meaning and they needed to seek additional visual input to supplement their oral readings. For example, one participant looked at the picture before starting to read the page and asked, "What's this?" while pointing to a picture of clay. He proceeded to read the first sentence and then he said, "Oh, that's clay." On the same page, he read the next sentence, "Jim worked on a dog." and then asked, "Where's the dog?" These two examples show how this participant used visual support from the pictures to provide additional information about the overall meaning of the text.

In addition, thematic analysis results suggest that if a participant with DS did not immediately recognize a word, he or she relied on the first letter and predicted or invented a word based on this letter and basic grapho-phonemic knowledge about decoding. For example, one participant with DS consistently produced "cheese" for "Charles," the main character in the book. In another example, a participant read "patching" for "punching," a miscue that was judged to be unacceptable within the sentence and the entire text. These two examples highlight how both participants relied on grapho-phonemic cues while reading. Notably, in both examples, the miscues were words in the same word class (i.e., noun/noun, verb/verb), as previously discussed. For the retelling task, participants often looked back at the pictures and graphics in the book to provide additional support in helping them remember details from the story.

Conclusion

The purpose of the present study was to investigate the oral reading miscues produced by students with DS using the methodological reading tool of miscue analysis. Descriptive statistics as well as qualitative information from an in-depth thematic analysis are described. Results revealed that about a third of the miscues have complete loss of meaning, over half did not include an appropriate grammatical structure and about one-third did not follow the graphic or phonemic structures of the intended word. Although miscues were self-corrected infrequently, we provide evidence that students with DS attempted to use strategies, including visual supports, to support the meaning of the text. Meaning construction scores (no or partial loss) were higher than grammatical relation (strength or partial strength) scores for every participant in the study. Lastly, students with DS exhibited particular difficulties with syntactic skills as supported by higher meaning construction scores as compared to grammatical relation scores. Below, these main findings are discussed, which have clinical implications and add to the existing body of literature about the language and reading profile of individuals with DS.

First, although students with DS did not self-correct miscues frequently, further analysis of self-corrections provide preliminary evidence that they are able to recognize when miscues do not "fit" within the meaning or structure of the intended text. Specifically, they tended to self-correct miscues that were considered to be partially semantically or syntactically acceptable. This suggests that they recognized, at times, when miscues did not fit within the meaning or structure of the intended text as demonstrated by the likelihood for miscues that were partially acceptable to be self-corrected. However, we noted that individuals with DS did not tend to self-correct miscues that were not acceptable at all. This suggests that they were not fully proficient at reading for meaning, an area of difficulty for students with DS [5,16]. Overall, this finding is consistent with previous research that indicates that more proficient readers self-correct miscues more often than less proficient readers [45].

Second, students with DS exhibited a relative strength in the area of semantics. Specifically, meaning scores were higher than grammatical scores for every participant. This finding is consistent with the previously described literature, which supports that the area of semantics or vocabulary is a relative strength in this population [3]. In contrast, students with DS exhibited difficulties with syntactic skills. In the area of grammatical relations, nearly half of the miscues produced by the students with DS did not maintain the overall syntactic structure of the sentence and text. In addition, students demonstrated difficulties with tense changes and often omitted contractions, possessive –s and sight and/or article words in the oral reading and retelling. Based on the literature, students with DS exhibit difficulties with expressive syntactic skills [3]. During the retelling task, students often needed carrier phrases, wh-questions and questions using reducing choice to support their memory and expressive analysis of the book. Based on research, students with DS who exhibit difficulties with expressive syntactic language tend to use shorter and less complex sentences [3]. This would explain the support needed during the retelling tasks. Given that syntactic development is particularly challenging for individuals with DS [16], we are not surprised by this finding. Although these findings are consistent with the syndrome-specific profile for students with DS, it diverges from miscue analysis research, which suggests that readers tended to produce more syntactically than semantically acceptable miscues [36].

Lastly, students with DS relied on visual support and produced more miscues that were graphically similar but not phonemically similar to the printed word. With regard to graphic similarity, this finding supports research indicating that the area of word recognition for students with DS is a relative strength [22,25] despite the underlying oral language deficits. We hypothesize that students with DS were attempting to rely on their relative strength in the area of visual skills to read unfamiliar words [25,26]. In addition, during the retelling task, students often relied on pictures from the book to support their memory of important details and also tracked print from left to right. With regard to phonemic similarly, nearly half of the miscues produced by individuals with DS demonstrated no phonemic similarity with the intended word. This finding suggests that the participants with DS had particular difficulty with decoding ("sounding out") unknown words and not as much with identifying whole words [33]. Given the on-going challenges with phonological memory and phonological awareness [27], it is not surprising that individuals with DS produced more miscues that were not phonemically similar to the printed word.

Taken together, these findings reflect that individuals with DS demonstrated relative strengths in the area of incorporating graphic information while reading yet had particular difficulties with syntactic and phonemic details. Thus, perhaps individuals with DS compensate for their oral language deficits (i.e., syntax) by relying on their relative strength in visual skills as they attempt to read [3,24]. It is also possible that students with DS were overly focused on surface-level details (e.g., graphic cues) and were unable to adequately attend to meaning-related aspects of the text (i.e., comprehension), a finding that is consistent with the research literature [3,19]. While students with DS were able to

retell basic, surface-level details from the story, especially with prompts, they struggled with inferential or "deep level" information.

Limitations and Future Research

Several study limitations must be acknowledged. First, the sample size is small with six students with DS. However, further examination of the results revealed consistency across all of the students with DS such that meaning construction and graphic similarity were areas of relative strength while grammatical relations and sound similarity were particularly challenging. Thus, the results can be interpreted with relative confidence as a similar pattern or profile is seen across all students with DS. Additionally, the inclusion of cognitive and auditory memory assessments was not within the scope of this research; therefore, the relationship among cognition, memory, language and reading cannot be explicitly addressed in this manuscript. Furthermore, many students with DS were currently receiving or had previously received speech and language services and all of the students with DS received additional services and support at school. There is no way to examine the possible impact of these intervention factors on the students' performance. For example, perhaps students with DS were taught via a sight-word approach, which places emphasis on whole words and not on letter-sound correspondence [27].

Although the oral language and reading skills of individuals with DS have been studied extensively over the past years, there continues to be insufficient information about the most effective methods of assessing their skills, providing appropriate treatment and teaching these students how to effectively communicate and read. Additional areas of research remain open for further investigations of the oral language and literacy skills of individuals with DS. For example, the current study could be expanded by revising the criteria for participation in the study to include a wider range of reading skills (based on the GORT-4), extending the time period to collect additional reading samples for miscue analysis, assessing additional areas, including cognition and auditory short term memory and including additional methodologies, such as eye tracking, to objectively determine where participants are looking while reading. Further, in-depth analyses of oral language and reading skills should be included; these data could be correlated with results from miscue analysis (e.g., examine areas of language strength and areas of difficulty in relation to types of miscues) and have direct implications to the design of interventions and students' outcomes. Lastly, future research could compare miscue analysis results of students with DS with groups with other diagnoses, including fragile X syndrome, Williams syndrome and language impairment [6,1].

	M	SD	Range
Chronological age	16.3	2.4	13.1-19.8
GORT Rate	11.2	1.83	8.00-13.00
GORT Accuracy	10.7	2.25	9.00-15.00
GORT Fluency	21.8	1.17	20.00-23.00
GORT Comprehension	8.2	3.13	5.00-13.00

Table 1: Age and Gray Oral Reading Test—Fourth Edition Raw Scores.

Note: Chronological age is in years and months. GORT-4 Rate and Accuracy subtest raw scores are summed to determine the Fluency subtest raw score.

	M	SD	Range
Overall miscues	22.17	13.25	12.50-31.65
Self-corrected miscues	8	5.66	0.00-18.00
Meaning construction			
No loss	20.67	7.07	8.00-44.00
Partial loss	43	15.56	32.00-46.00
Loss	36.33	8.49	10.00-48.00
Grammatical relations			
Strength	39.33	7.07	22.00-74.00
Partial strength	5	2.83	2.00-8.00
Overcorrection	1.67	2.83	0.00-6.00
Weakness	54	7.07	22.00-76.00
Graphic similarity			
High	44.67	12.73	32.00-62.00
Some	21.67	5.66	12.00-30.00
None	33.66	18.38	18.00-50.00
Phonemic similarity			
High	34.67	14.14	22.00-56.00
Some	26	4.24	16.00-42.00
None	39.33	18.38	24.00-56.00

Table 2: Miscue Analysis Descriptive Results for Individuals with DS.

Note: Results are presented as percent.

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