

THE EFFECTS OF EXPLICIT INSTRUCTION ON THE WRITING ABILITY OF A STUDENT WITH NOONAN SYNDROME

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In this study, we sought to determine the effectiveness of a sentence creation intervention on the sentence writing ability of a young writer with Noonan Syndrome. Noonan syndrome is an autosomal dominant condition characterized by shortness in stature, with neck and ear anomalies, hypertelorism, ptosis of the eyelids, low set ears, and instances of cardiac anomalies that may impact motor skills, language, attention and memory. As a result of these characteristics, children with Noonan syndrome may have difficulty with academic tasks such as writing. Our purpose in this study was to increase the quality and structure of the student's sentences through practice with reading new words and applying those words within sentences. The intervention consisted of ten lessons that used sight words and picture prompts to help the writer create sentences that described the picture. Reassembly and copying tasks were also modeled and practiced. Two measures, sentence quality and construction, were used to document changes from baseline to post-treatment. A visual analysis of the means for holistic quality and number of words was used to compare baseline to post-treatment data for each student. In addition to this visual analysis, data were analyzed using the percentage of non-overlapping data (PND) procedure described by Scruggs, Mastropieri, and Casto (1987). Post intervention improvements in sentence quality and sentence structure were noted. Implications and recommendations for future research and practice are provided.

Introduction

An essential goal of a child's education is to learn to write well. While in school, writing is the principal method of documenting student knowledge and academic performance (Graham, Harris, & Hebert, 2011). Students must also write effectively enough to satisfy Federal and state-mandated accountability testing. Furthermore, college entrance examinations place a premium on the written statement a student provides in their application package. Beyond the classroom, a recently graduated adolescent will find that many jobs require basic written language ability (Writing and School Reform, 2006). Teachers must therefore ensure all students achieve some level of competence with written expression.

However, learning to write effectively can be challenging because of the complexity involved while composing. Writers must create thoughts and ideas that can be read and understood by a reader. Often the writer must be skilled enough to create a message that can stand alone, or the reader will not have an opportunity to question the writer directly about intent and meaning.

While composing, a writer must learn to manage physical processes such as letter formation when handwriting, or key stroking when using a word processor. Writers must also direct mental processes including planning what to say and revising their words to better match their ideas (Graham & Harris, 2009). An understanding of the formatting and particular requirements of the different writing genres such as persuasion and narration is also necessary. Another important task for writers is the ability to self-regulate, as such skills may help an individual maintain focus on the process of composition while also allowing them to handle frustrations (Asaro-Saddler & Bak, 2012; Asaro & Saddler, 2009; Graham, Harris, & Hebert, 2011; Harris, Graham, & Mason, 2006). Self-regulatory skills also enable writers to reflect on strategies they found helpful, and to understand and acknowledge any accomplishments

(Harris, Graham, & Mason, 2006). Without an ability to engage in self-regulatory behaviors independently, a writer could struggle to maintain attention, be unable to work through frustrations, and fail to monitor progress towards objectives (Graham & Harris, 2009). When considering all that a writer must do to create an effective message, it's understandable that many students struggle with writing and that writing can be particularly difficult for students with low achievement (Salahu-Din, Persky, & Miller, 2008).

Characteristics of Writers with Disabilities

Characteristically, children with writing disabilities engage in little or no planning prior to writing (Graham & Harris, 2009). Without an adequate plan, they then create brief compositions that are not well organized and that lack important information a reader might need to better enjoy or understand the message. Because many of these writers lack skill in revising or choose not to revise, they cannot improve their product (Graham & Harris, 2009). These writers may also find handwriting, grammar, punctuation, and spelling difficult (Graham, Harris, & Hebert, 2011). Because of these struggles writing may present, many children who have writing disabilities with less positive images of their writing and their ability as writers (Graham et al., 2011).

Characteristics of Noonan Syndrome

One particular group of learners that may struggle with writing is children with Noonan syndrome. Noonan syndrome, an autosomal dominant condition that affects approximately one in 1000-2500 children worldwide, has observable physical and cognitive manifestations (Noonan Syndrome Support Group, 2012). Physically, children with NS are characterized by shortness in stature, with neck and ear anomalies, hypertelorism, ptosis of the eyelids, low set ears, and instances of cardiac anomalies (Pierpont, Pierpont, Mendelsohn, Roberts, Tworog-Dube, & Seidenberg, 2009; Roberts, Allanson, Tartaglia, & Gelb, 2013; Wingbermuhle, Egger, van der Burgt, & Verhoeven, 2009). Cognitively, children with NS have widely varying intellectual profiles, with many having below-average intellect, and others ranging from moderate intellectual disability to superior ability (Pierpont, Tworog-Dube, & Roberts, 2013). Perhaps as many as 50% of children with NS have special educational needs (Shaw, Kalidas, Crosby, Jeffery, & Patton, 2007), similar to a student with a mild to severe learning disorder (LD; Pierpont Roberts, Tworog-Dube, Pierpont, Mendelsohn & Seidenberg, 2010).

NS can be an underlying cause of a variety of other signs and symptoms of academic and social deficits. For example, children with NS may struggle with important academic functioning. In addition, these students have communication impairments that occur more frequently in NS than in the general population (Pierpont et al., 2010). Language skills of children with NS tend to develop slowly, and severe impairments in speech and language development, most notably articulation, may be present (Wingbermuhle, Egger, van der Burgt, & Verhoeven, 2009). Students with Noonan syndrome who have impaired language skills may also be more likely to struggle in literacy achievement such as reading, writing, and spelling (Pierpont et al., 2010).

Children with NS may also experience difficulties with simple and sustained attention (Horiguchi & Takeshita, 2003; Lee, Portnoy, Hill, Gillberg, & Patton, 2005) and information processing speed (Wingbermuhle, Egger, Verhoeven, van der Burgt, & Kessels, 2012), with variable memory skills noted in working memory and memorizing (Horiguchi & Takeshita 2003; Wingbermuhle et al., 2012). In addition, many children with NS experience hearing loss (Roberts, Allanson, Tartaglia, & Gelb, 2013) and may be socially immature (Wingbermuhle et al., 2009) and social isolation and depression (Noonan Syndrome Support Group, 2012). No specific treatments for Noonan syndrome exist, nor does a *cure* exist. Instead the focus should be on controlling the disease's symptoms and complications.

Noonan Syndrome and Writing Difficulty

Writing may be particularly problematic for children with NS for several reasons: first, weak phonological memory skills may lead to difficulties with basic written language (Pierpont et al, 2010). Furthermore, specific weaknesses in spatial knowledge and planning abilities may lead to difficulty organizing academic tasks (van der Burgt et al., 1999). Spelling is also problematic, and significant difficulty with a language's grammatical structure including morphology and syntax (Wilson & Dyson, 1982) may impact written language. Difficulty in visual-motor coordination and fine motor coordination may also impact copying and handwriting tasks (Horiguchi & Takeshita, 2003).

Unfortunately, little is known about how to help children with NS to write more effectively. In fact, there are no published studies that have documented effective methods of teaching writing to children with

NS. Theoretically, because children with NS share similarities with children who have LD, we can imagine that interventions validated to work with children with LD may also work with children who have NS. However, these interventions may not work, may work to some degree, or may need adaptations/modifications. Therefore, this study is a first effort within the literature to both explore the characteristics of writers with NS and to investigate the effects of a potentially effective sentence level writing intervention.

Methods

Participant

Aaron (a pseudonym) was a male Caucasian second grade student within this school who had Noonan Syndrome as diagnosed by a pediatrician. Aaron was classified for special education services and support by his school district under the Other Health Impaired (OHI) category. Aaron was 7 years, 8 months old at the time of the intervention and was referred to us by his teacher because he was experiencing significant difficulties with written expression.

Physically, Aaron displayed typical characteristics associated with his condition including short stature and neck, eye, and ear anomalies. He was also diagnosed with ptosis and Attention Deficit Hyperactivity Disorder (ADHD). Cognitively he was considered by the school to be below grade level with most academic tasks. He achieved a full scale standard score of 85 on the Wechsler Preschool and Primary Scale of Intelligence, 3rd edition (WPPSI -III; Wechsler, 2002) with a processing speed and performance standard scores of 88 and 82 respectively. He had significant difficulty with short and long term memory related tasks. Aaron also displayed substantial behavioral problems such as extreme distractibility and aggression towards other children that warranted weekly counseling support.

Aaron received instruction within a 12-1-2 self-contained classroom for students with emotional and behavioral disabilities. Although there were no written expression goals on his Individualized Education Plan, writing presented significant challenges for Aaron. One of the teacher aides in Aaron's classroom was routinely assigned to work with him during writing related tasks which almost always involved drawing pictures and writing sentences to depict comprehension of a reading selection. Typically this process involved Aaron dictating ideas to the aide, who wrote the ideas on a dry erase tablet and would then prompt him to read the ideas back to her. Aaron would then copy those sentences onto paper. There was little or no spelling or handwriting practice and no other routinely used writing interventions.

Aaron's teacher described him as an emergent reader and writer who could read only a few words and could draw a detailed picture to tell a story or write a simple sentence with significant teacher support. He could write very few words from memory, but was observed to utilize a few of the sight words from the class word wall in his writing; however he could not consistently spell these words correctly. His teacher reported that his oral language ability exceeded his written language production and that he could adequately convey his thoughts and ideas orally; even his oral vocabulary, however, was very limited.

The third author administered the Test of Early Written Language - 2 (Hresko, Herron, & Peak, 1996) basic writing subtest to verify Aaron's existing skill levels in writing prior to the intervention. This test measures a writer's ability with basic conventions of writing such as directionality, letter features, punctuation, capitalization, and spelling along with linguistic and conceptual components including sentence combining, syntactic maturity, and metalinguistic knowledge. TEWL-2 results revealed an age equivalent score of 6-8 with normal curve equivalent score of 27, a percentile rank of 14, and a writing quotient of 84. Taken together, these scores suggest that Aaron was performing well below grade level with scores in the below average range according to the TEWL-2 interpretation guide.

During pre-intervention testing we observed that Aaron's verbal language skills were intact and he could respond correctly to oral prompts; however he was not willing to put his thoughts into written words and therefore scored very poorly on any item that required a written response. He could not produce a complete sentence in writing to describe a picture prompt, instead writing the same five words he said he *knew* randomly for each picture with no thought to their relation to the picture. He had tremendous difficulty with spelling and did not incorporate any punctuation elements or capital letters. He also had difficulty with letter, word, and sentence copying tasks and his handwriting was slow and labored. Finally he became distracted quite easily during testing and required constant redirection back to the task.

Based on the results of the TEWL-2 and consultation with his teacher we designed a writing intervention to address Aaron's difficulty with sentence production. Our desire was to increase the quality and structure of his sentences through practice with reading sight words and instruction in applying those words within sentences that effectively describe pictures. We believed these elements had high social importance for the student while also reflecting the concerns of the teacher. Our intervention supplemented Aaron's regular writing curriculum by providing direct instruction in these areas.

Experimental Design

Three experimental conditions were used: baseline, intervention, and post treatment, with sentence elements serving as the baseline to intervention phase change variable. The conditions were as follows:

Baseline

During baseline, Aaron completed three sentence writing probes (one per day for three days) to establish pre-intervention skill level. The instructor read scripted directions for testing administration in which Aaron was prompted to write a sentence that tells something about a picture. The teacher then said, *If you do not know how to spell a word just do the best you can, but don't let spelling slow you down.* Five minutes were allotted for Aaron to complete his sentence. When Aaron finished writing, he read the sentence to the instructor, who made notes for any unreadable text.

Intervention

The intervention began within three calendar days of the final baseline probe. Once the intervention commenced, the instructor followed the instructional lessons described in the following section. Ten teaching sessions lasting between 25 and 45 minutes occurred three times per week. The sessions were scheduled during the time when the participant would normally have been scheduled for writing instruction in the classroom. About two-thirds of the sessions took place in a separate location with few distractions. The other sessions took place in a section of the classroom physically separated from the rest of the group but within earshot. All lessons were recorded as a fidelity check (described subsequently). During the intervention no new writing concepts or instruction were applied in his classroom.

Post Treatment

In this stage, Aaron again wrote three sentences, under baseline conditions, with the first probe given within three days of the conclusion of the intervention. Aaron was given one post-test per day for three days. Maintenance and generalization probes were not collected, as the intervention finished at the end of the school year.

Materials

Black-and-white line-drawn pictures depicting activities of interest to young children (baking a giant cookie, rabbits teaching school, parachuting dogs) were used as prompts at baseline and post treatment. All prompts have been used in prior studies with similar aged students (cf. Saddler, 2006). Pictures were randomly assigned to pretest and post treatment conditions.

Procedures

The curriculum consisted of lessons that directly taught sight words and sentence composition through modeling and self-regulatory components. To address Aaron's behavioral problems, an incentive of motivating school supplies was offered each week for positive effort. In addition, the classroom teacher rewarded Aaron for a report of *job well done* with tickets from the classroom token economy after each session.

Lessons 1 to 4

Each of the first four lessons began with either the presentation or review of basic sight words from the Dolch pre-primer word list and student self-monitoring of progress. We believed that if Aaron had a better store of words he could read that he might be able to use these words in his writing. Initially ten words were written on flashcards which Aaron practiced reading orally. If he had difficulty, the instructor suggested that he use the sounds in the word to sound it out. Words were carried over from lesson to lesson until the student achieved mastery in terms of decoding fluency, meaning he could read the word correctly three times without assistance. Aaron tracked his own progress of words pronounced correctly by coloring in a graph with the number of words decoded correctly during each session. We viewed this progress monitoring as a type of self-regulatory behavior, and believed that helping Aaron

develop self-regulation might help him be more engaged and motivated throughout the sentence writing process.

Word practice was followed by the creation of a sentence from a picture prompt and the dictation of that sentence in proper grammatical form. After the word drills, the instructor reminded the participant that these words could be used to help in reading and sentence writing by saying *these are words that you will see when you read books. They are also good words to use when you write down your ideas into sentences. Practicing reading these words will help you when you read a book because you will remember what the word is without thinking about it too much. Practicing reading these words will also help when you write because you will have more words to use in your sentences.*

The instructor then modeled writing a sentence using a picture prompt and explicit self-talk about the task and the steps necessary to complete it. The instructor reminded Aaron that the words on the index cards from the first part of the lesson could be used to make sentences. Then the instructor wrote a sentence that described the picture and incorporated the target sight words. Aaron followed suit and created a sentence for the next picture with some conversation and discussion, pulling out the sight words used and pointing to them when saying the sentence. Aaron was encouraged to use at least two of the words he had been learning throughout the study in his sentences.

The instructor wrote the dictated sentence on a sentence strip. Next, the instructor cut the strip into individual words, and Aaron read the words while reassembling the sentence. Aaron then read the reassembled sentence out loud and copied it onto the page under the picture prompt for inclusion in a book of sentences he would share with his classroom teacher and keep after the study. The instructor reminded Aaron that he could use the words in sentences in his classroom by saying, *try to use these words we are learning in the sentences you write with your teacher and at home. I will ask you if you used any of the words when I see you again.*

Lesson 5-10

In these lessons the number of new words introduced was adjusted based up on the participant's frustration level, and varied from 5-10 words. Modeling was phased out and Aaron dictated his own sentences related to picture prompts with little or no instructor support. The instructor wrote the sentence and cut it into component words for the participant to reconstruct and read. The last step of the session again entailed the participant writing his sentence under the picture prompt and placing it in the book of sentences he had been creating.

Treatment Fidelity

To assess treatment fidelity each of the sessions was tape recorded. One third of the tapes were randomly selected to be reviewed by a graduate student who listened with a copy of the lesson script, checking each step off as it was completed. The tapes indicated that 90% of the steps were followed with precision, while other steps were followed but required modifications due to Aaron's behavioral tendencies.

Preparation of the Samples for Scoring

Before scoring, all writing samples were typed into Microsoft Word© by the first author, who entered the student's spelling and punctuation exactly as it was written on the paper (i.e., with word spacing and other features, such as capitalization, maintained as well). Any identifying information was removed. An independent researcher verified that all essays were entered exactly as written on the student's papers.

Measures of Writing Quality and Scoring Procedures

Two measures, sentence quality and construction, were used to document changes from baseline to post-treatment. The second author and a doctoral student in Special Education were trained to score the writing samples by the first author. During training, the first author discussed the scoring rubrics and provided sample sentences to rate. For quality, for example, raters were provided with exemplar sentences that represented anchor points for a 0, 4, and 8 point sentence. After raters independently scored each sentence, interrater reliability was established, and, if necessary, discussion of the rating ensued. Training continued until the raters obtained agreement of 80% of the training samples. Agreement within one point during training was 100%.

Sentence Quality

The quality of each sentence was calculated using an 8-point holistic scale. Scores on the scale ranged from 0, representing the lowest quality of writing, to 7, representing the highest. Examiners were asked to read each paper attentively, but not laboriously, to obtain a general impression of overall sentence quality. Interrater reliability was calculated first between the two raters and then scores for each rater were averaged to arrive at the final reported scores for quality.

Sentence Construction Elements

Sentence construction elements were measured using a 6-point scale created by the second author (See Figure 1). This scale considered if the sentence directly related to some aspect of the picture prompt, if the sentence was correct in terms of syntax, punctuation, capitalization, and noun-verb agreement, and if the sentence reflected a complete thought. Raters were asked to read each sentence carefully and then to assign a score for each criteria of the scale. Interrater reliability was calculated first between the two raters and then scores for each rater were averaged to arrive at the reported scores for sentence construction.

Sentence Probe: _____ Total Score: _____

Sentence rubric	No	Yes
	0	1
Is directly related to the picture?		
Syntactically correct?		
Is punctuated correctly?		
Is capitalized correctly?		
Complete sentence (not a fragment)?		
Noun-verb agreement?		

Figure 1. Sentence construction elements rubric.

Data Analysis

A visual analysis of the means for holistic quality and number of words was used to compare baseline to post-treatment data for each student. In addition to this visual analysis, data were analyzed using the percentage of non-overlapping data (PND) procedure described by Scruggs, Mastropieri, and Casto (1987). Using this procedure, 90% of the post-treatment points exceeding extreme baseline values indicates the treatment was very effective, 70-90% indicates the treatment was effective, 50-70% indicates a questionable treatment, and less than 50% indicates the treatment was ineffective. This type of analysis has been used in single-subject research designs (cf. Asaro-Saddler & Bak, 2012) and has been validated for identifying intervention effects (Campbell, 2004).

Results

Before instruction, Aaron could not write a complete sentence and had difficulty with letter, word, and sentence copying tasks (see Figure 2). He would use a very small selection of words to describe pictures even if the words had no connection to the picture. He could not accurately spell even basic grade level words and he did not incorporate any punctuation elements or capital letters in his writings. His handwriting was slow and labored. After instruction, gains were made in both sentence quality and elements.

Quality

As can be seen in Figure 3 and 4, Aaron improved the overall quality of his sentences from baseline to post treatment, increasing his average from 0.17 to 3.34. PND for quality was 100%, exceeding the 90% effect-size criterion to qualify as a very effective treatment (Scruggs, Mastropieri, & Casto, 1987). Interrater agreement for quality was .67%; agreement within one point was 100%.

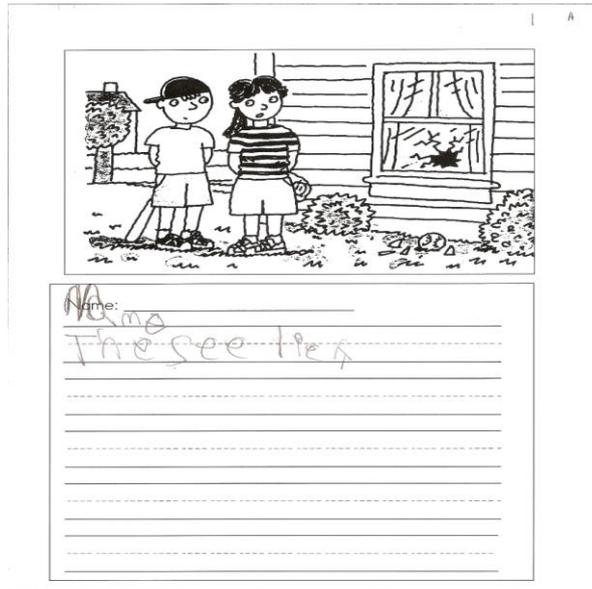


Figure 2. Baseline writing.

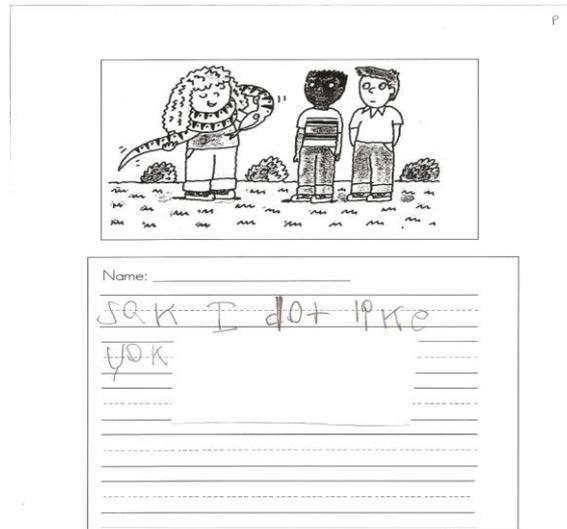


Figure 3. Post treatment writing sample.

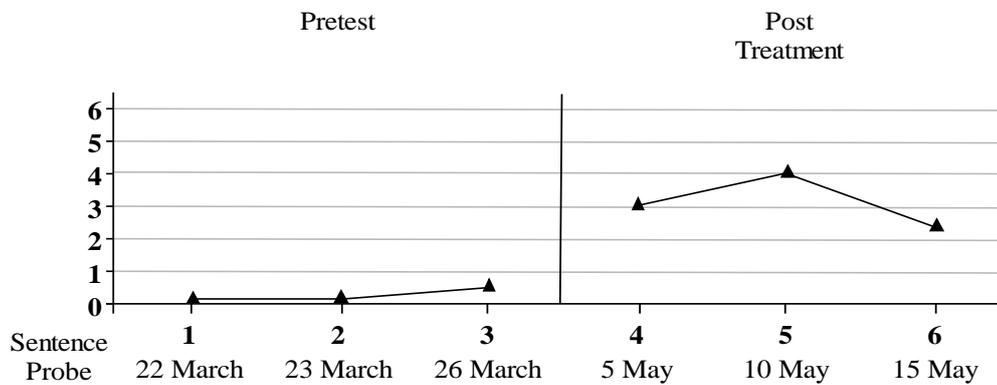
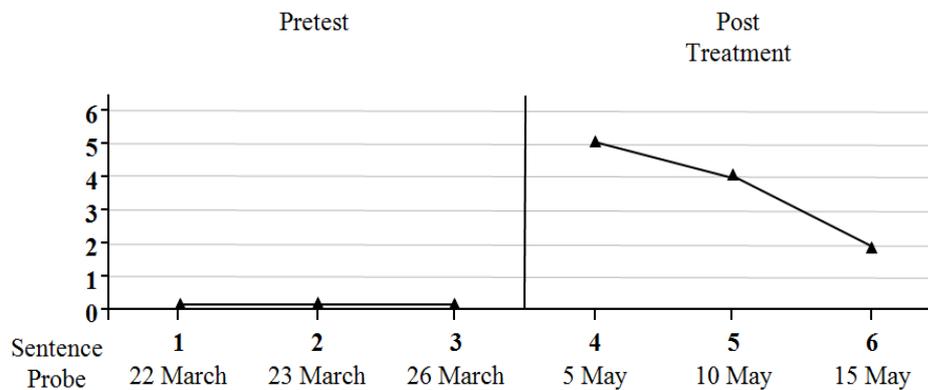


Figure 4. Sentence quality.

Elements

As Figure 5 depicts, Aaron also improved the six elements we considered important within his sentences from baseline to post treatment. He increased his sentence construction scores from an average of 0 at baseline to 3.67 at post-test. PND for elements was 100%, also exceeding the 90% effect-size criterion to qualify as a very effective treatment. Exact interrater agreement for construction was 100%.



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Figure 5. Sentence elements.

Discussion

We wanted to test the effectiveness of a sentence creation intervention on the sentence writing ability of a young writer with NS who struggled with written expression. Our dependent measures (sentence quality, sentence construction elements) had high social importance and reflected the concerns of his teacher. Our participant, Aaron, possessed many of the physical and cognitive characteristics associated with NS including difficulties with simple and sustained attention and memorization. Aaron also struggled with phonological memory and spelling. He could not independently write grammatically correct sentences.

As expected, given these characteristics, our intervention improved Aaron's sentence quality and elements. The intervention helped Aaron increase his ability to write his thoughts about a picture. At baseline he did not want to put his thoughts into words and could only produce a string of fragmented words that could not be considered a sentence and that did not relate to any part of the pictures. At post treatment, however, he was able to create written representations of his ideas that were accurate sentences in terms of completeness of thought, correctness of syntax, noun-verb agreement, and that directly related to the pictures. These sentences were also rated to be of higher overall quality than his baseline sentences.

Although these results are encouraging, we hoped for even greater improvements. There are several reasons why our results were not stronger that researchers and teachers need to be mindful of when working with students who have challenging conditions such as NS. First, we underestimated the degree of Aaron's distractibility and short attention span. He would often need directions restated or assistance due to lack of focus and forgetfulness. He often needed to be *reeled back* into the session. His lack of attention became more problematic as the intervention progressed causing us to reduce the number of words practiced during the lessons. In addition, the final posttest results were directly impacted by his distractibility as the location for this test was a busy location in the school that prevented him from concentrating on the task. These symptoms, which reflect his co-morbid diagnosis of ADHD, had a pronounced impact on his writing, supporting the findings of Jacobson and Reid (2010) who found that children with ADHD have difficulty with written expression.

Second, Aaron had significant difficulty transferring words learned in isolation to his writing, despite having the words modeled in sentences by the instructor and having the instructor prompt for word usage. This was not surprising, as children with NS often have difficulty with language (Pierpont et al., 2010), and deficits in expressive language which tend to be related to difficulty in writing (Puranik & Lonigan, 2012). It should be noted, however, that Aaron understood that the new words were important

and could help him write his thoughts; unfortunately, the effect of learning fewer words, poor memory, and difficulty with transfer meant that few new words actually appeared in his writing.

Third, although self-monitoring is an important element of strategy instruction for children with disabilities (Harris, Graham, & Mason, 2006), it was not effective for Aaron and actually became a barrier to learning. When Aaron felt he did not read enough of the words correctly, he resisted completing the progress monitoring chart, and became non-compliant. He would also sometimes disagree with the instructor about his accuracy, causing a loss of instructional time. In these instances the instructor recorded his progress and moved on to the next part of the session to keep Aaron engaged and the session positive.

Finally, the short length of the intervention did not allow for enough practice. Aaron could have benefited from additional opportunities to learn more words and create sentences before post testing. Ten sessions were likely not enough time to reach higher levels of sentence writing proficiency given Aaron's low initial skill level.

Implications for Practice

This research has several important implications for teaching students with NS and writing problems. First, children such as Aaron present a complex assortment of writing deficiencies that cannot be easily or quickly remediated. It may be helpful for children such as Aaron if instruction concentrates on a limited number of writing skills at a time, as we did in this project. For example, we mainly emphasized ideation in an effort to help Aaron produce more text to describe his thoughts in writing. We did not focus on spelling and only briefly discussed capitalization and punctuation, as we believed that Aaron would become overwhelmed if we placed too many demands on him. We would suggest teachers follow a similar course.

Secondly, children such as Aaron may need to engage in a variety of writing and reading tasks to prevent disengagement. For this project we simplified the intervention to allow us to focus on what we believed would be important elements, however in the classroom, a teacher should rotate the activities we used with other engaging tasks that support practice with sight words, while promoting greater generalization to writing.

Third, children such as Aaron require dedicated time and direct assistance to improve their writing skills. It was difficult to move Aaron's skill level along with the amount of time allotted for this study even given the direct support of a skilled instructor. Allowing a child with severe writing needs to only write occasionally and with minimal support within a classroom will likely not lead to improvements. As recommended in a recent report by Graham and colleagues (2012), students need daily opportunities to engage in the writing process. A minimum of one hour per day of specific writing instruction and practice is recommended (Graham et al., 2012).

Fourth, teachers should be sensitive to progress monitoring efforts as they may not be motivating for all children. Aaron became upset and uncooperative when the progress monitoring chart did not show improvement. Teachers may need to modify or eliminate this element if children cannot emotionally handle failure.

Limitations and Future Research

In any single case design, the low number of participants is a key limitation. In this study one student with NS participated. Naturally because children with NS are diverse, the results must be generalized with caution. However, since this is the first study to explore the singular effects of a writing intervention with children with NS, it is a meaningful contribution. Future research should attempt to replicate the results with more participants of varying ability levels. Maintenance data should also be collected. In addition, reading activities should be directly incorporated to help with word acquisition and transfer, and other sentence writing practice activities such as sentence frames, sentence completion tasks, and cloze activities could be explored. Finally, because students with NS often experience difficulty with handwriting (Horiguchi & Takeshita, 2003), it may be advantageous to utilize alternate methods, such as keyboarding, to help them express their thoughts and to demonstrate their knowledge. Students who struggle with handwriting, such as Aaron, might still make gains through systematic practice; however, future research should explore if eliminating the barrier of handwriting would further improve quality of writing output for students with NS.

Conclusion

This study is the first to explore the effects of an intervention on the sentence writing ability of a child with Noonan Syndrome. While results were modest, the study provides insights into the writing abilities of children with NS along with possible intervention ideas. Furthermore, the intervention was applied with high fidelity over a minimum amount of time and can be replicated by other teachers and researchers in typical educational contexts. Instruction that includes frequent practice and time spent writing interspersed with preferred activities and direct instruction and modeling in taking words learned in isolation and transferring them to connected text have the potential to lead to improved writing outcomes for students with Noonan syndrome. Although the evidence from our study is promising, future research is warranted to further investigate how to improve the writing of this unique and challenging population of children.

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