

# The Effects of Speech Sound Disorders on Literacy Outcomes of School-age Children

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**Abstract** The importance of identifying the relationship and independent variables of speech sound disorders and their effect on literacy, could have clinical benefits and improving speech and language intervention. In recent studies, researchers have found that deficits in phonological processes could be an indicator for predicting reading outcomes for children with speech sound disorders. It has been theorized that children who exhibit articulatory errors are the result of the inadequacy of the speech perceptual acoustic characteristics of speech phoneme errors.

**Objective:** The purpose of this study is to examine the impact, if any, speech sound disorders have on school-age children and literacy and to determine if a relationship exists between children identified with a speech sound disorder and literacy achievement. **Methods:** A causal-comparative model was employed to investigate what possible effects speech sound disorders of school-age children have on reading achievement, and how it compares to children who are speech and language impaired and the norm group of students. Subjects for the study were collected using a stratified random sampling process from a local school district. Students were randomly chosen from each grade level (Kindergarten through 3<sup>rd</sup> grade) and then randomly selected again from each subgroup studied: 1) students identified as speech and language impairment, articulation (SLI-A), 2) students identified as speech and language impairment, language and articulation (SLI-L&A or DD), and 3) students who do not have an individual education plan (I.E.P.). **Results:** In summary, statistics showed that when comparing the norm group to the SLI-A group, results indicated that there were some significant differences found when comparing the categorical groups at each grade level though effect sizes were small; however, in comparisons using the overall scores there were not any significant differences noted. In comparisons made between the norm group and SLI L&A comorbid group, results indicated that there are significant differences found in all statistical analysis completed. In comparing the SLI-A group and the SLI L&A comorbid groups within each grade level, significant differences were found within all grade levels, including the overall score comparison.

**Keywords:** *speech and language impairment, articulation (SLI-A), speech and language impairment, language and articulation (SLI L&A), developmental delay (DD)*

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## 1. Introduction

For several years, studies have been conducted to determine if children with speech sound disorders (SSD) are at an elevated risk for reading difficulties. A speech sound disorder is defined as impairments in sound production and patterns [4]. In recent studies, researchers have determined that children with speech sound disorders exhibit difficulties with acquiring a skill set and awareness of phonological processes such as sound segmenting, naming tasks, short-term recall, and rhyming; The above processes have been found to positively correlate with literacy outcomes [7]. Current data suggests that as much as 5% of the school-age population is expected to exhibit a communication impairment [5].

According to DeThorne et al. [8], children with a history of speech sound disorders are performing lower on early reading related tasks.

The importance of identifying the relationship and independent variables of speech sound disorders and their effect on literacy may have clinical benefits in improving speech and language intervention. In a study conducted at McGill University, researchers studied the relationship between phonological processing abilities and speech perception of children with SSD in pre-kindergarten, to the literacy skills of children with SSD at the end of first grade.

Researchers explored the possibility of a predictive relationship existing in order to identify children who would be considered to be at-risk for reading disabilities. Participants were followed over a year period and participated in assessments that measured receptive/expressive vocabulary, articulation, speech perception,

phonological awareness, and reading skills. Speech and language samples were analyzed to gather mean length utterance (MLU) and percent of consonants correct (PCC). Results indicated that early phonological processing skills played a key role in predicting literacy outcomes [20].

The effect that a speech sound disorder has on children in conjunction with phonological development impacts how speech and language pathologists develop and implement intervention. In another study, researchers investigated if varying speech production severities were indicative in predicting literacy outcomes. Results from this study indicated that children tested in kindergarten and scoring in the 7<sup>th</sup> percentile in sound production demonstrated poor reading performance in later grades when compared to typical peers. The study also reported that children identified with speech and language impairments early, reported social limitations, difficulty completing tasks, attention, and processing [17]. Findings from this study signify the importance of early identification and recognition of the multitude of independent variables that influence literacy outcomes in school-age children.

## 2. Purpose

The purpose of this study is to examine the impact, if any, speech sound disorders have on school-age children and literacy and to determine if a relationship exists between children identified with a speech sound disorder and literacy achievement. The specific research questions are as follows:

1. Is there a statistical difference in reading achievement scores between children identified with a speech sound disorder and those scores of normed peers?
2. Does the severity of the disorder, articulation only or co-morbid speech and language impairment, impact reading achievement scores differently?
3. What areas of reading were found to be impacted by those identified with a speech sound disorder?

## 3. Literature Review

Current trends have indicated that language learning and literacy are developed when children's sensory and perceptual processing systems collectively use sensory information (i.e. auditory, visual, tactile, etc.) to process new information [14]. According to Catts [7], children must possess three types of phonological skills: phonological awareness, phonological recoding in lexical access, and phonological recoding in working memory to be successful with reading outcomes. Phonological skills such as phonological awareness (rhyming, segmenting sounds, etc.), rapid automatic naming, and phonological memory tasks all impact a child's ability to read and write [18].

In recent studies, researchers have found that deficits in phonological processes could be an indicator for predicting reading outcomes for children with speech sound disorders. It has been theorized that children exhibiting articulatory errors are the result of the inadequacy of the speech perceptual acoustic characteristics of speech

phoneme errors [20]. A current study, Overby et al. [17], examined the relationship between the speech sound production skills of kindergarten children and the literacy outcomes of children in grades first through third. Results indicated that children tested in kindergarten and scoring in the 7<sup>th</sup> percentile in sound production demonstrated poor reading performance in later grades in comparison to typical peers. It was observed that phonological processing skills, not vocabulary, had a greater impact on literacy outcomes. In a similar study, researchers aimed to analyze if children with persistent speech difficulties at the age of six demonstrated poor performance in literacy and phonological awareness tasks. After the study was conducted, results indicated that children with comorbid speech and language difficulty exhibited significantly lower scores on all phonological and literacy tasks in comparison to their peers. Children with isolated speech sound difficulties did not show a statistical difference in performance; however, those with persistent speech sound difficulties after age 6 years; 9 months demonstrated a significant risk to developing literacy problems [13]. In summary, deficits in phonological processing and sound production at early onset could possibly predict elevated risk in literacy in later years.

In reviewing the literature, several studies examined different factors of speech sound disordered children and its impact on predicting literacy outcomes. The first study conducted by researchers from University of Houston (2011), theorized that children with SSDs would exhibit weaknesses in letter knowledge, phonological representation, and phonological awareness thus impacting reading ability. Researchers examined three different groups of children from ages 3.5 years to 5.6 years with and without SSDs. Data was collected annually over a four year span using standardized assessments that measured expressed phonology, oral language, print awareness, phonological awareness, and representation. Results indicated that children with SSDs demonstrated lower scores than peers without an SSD in areas such as expressive phonology and accessing phonology representations. It was also found that children with SSD had difficulty with speech perception when observing misarticulations in others' speech [2]. In a similar study, researchers from the University of Colorado in Denver examined literacy outcomes of children with a speech sound disorder. Researchers focused on two dimensions in the study: broader language function and the pervasiveness of the speech sound disorder.

Results from the study indicated that children with SSD exhibited higher rates of reading disability. It was found that SSD pervasiveness was a determinant factor in predicting literacy outcomes and not broader language. Researchers concluded that phonological awareness was a better predictor in identifying literacy success [19].

In reviewing other studies, it was noted that in two investigations researchers were able to pinpoint what specific areas of phonological processing was most impacted by children with speech sound disorders. The first study investigated if there was a correlation between speech production/articulation and reading disordered children. Researchers explored the possibility that the phonological processing abilities and speech production of children was directly related to reading disorders. Participants in this study were children with reading

disabilities between the ages of 12-15 years. Participants were administered language and spelling assessments to quantify speech production and phonological awareness abilities. Results indicated that there was a correlation between speech production error and performance on the Word Attack and Word Identification subtests. It was observed that children with the poorest reading scores also made the most speech production errors [7]. A second study confirmed these findings; by examining both genetic and environmental effects on speech and language difficulties using 248 pairs of twins with a mean age of 6.08 years from the Western Reserve Reading Project. A multi- method approach was implemented. Parents were sent a survey to gather perspectives on their child's speech and language skills. A Hierarchical Linear Modeling (HLM) approach was applied to compare the children's speech and language status (i.e. articulation only, articulation and language, expressive only, etc.) to results from direct assessments. Results indicated that children with a history of articulation difficulties did not exhibit a statistical difference in IQ in comparison to the unaffected group; however, the children with a history of articulation difficulties did display a statistical difference in the areas of word attack, phonological awareness, and word identification [8].

Some studies found a statistical difference in reading development with speech sound disordered comorbid (SSD + Language), but not with those who were solely SSD. In a study conducted by researchers from Florida University data was used from standardized assessments that measured language and articulation. This data supported their hypothesis that children identified as SSD would perform lower on morphological awareness tasks than that of children who do not have a known SSD. Researchers further hypothesized that morphological awareness skills exhibited in children with SSD can predict their performance in the areas of word-level reading and spelling. Results from the study revealed that children identified with SSD exhibited lower scores than their peers without an SSD in areas such as morphology, phonemic awareness, spelling, articulation, vocabulary, etc. It was noted; however, that both the children with SSD and their typical peers all scored within normal limits [3]. In the second study, researchers from various universities set out to demonstrate if speech sound disorders could be predicted genetically. Children identified as SSD and their siblings identified as typically developing were used and given a battery of assessments that measured oral motor, phonological awareness, short-term memory, vocabulary, speed naming, reading, spelling, writing, and spoken language. Results confirmed that there are both genetic influences and comorbid language impairment (L1) influences in all areas measured. It also found that children with isolated SSD did not demonstrate reading difficulties, but exhibited poor spelling skills relative to individual reading and language abilities [11].

A study conducted by Nathan et. al. [13] investigated the possible connection between children with speech sound disorders, and comorbid speech and language disorders to literacy development. The focus was to discover if there was a difference in literacy performance between children classified as speech sound disordered in comparison to children who were speech and language disordered developing the "critical age hypothesis". The

critical age hypothesis is a theory proposed by researchers Bishop and Adams [6]. It proposed that children with speech difficulties that persist to a point where they require phonological skills for learning to read are at a higher risk for reading problems [13]. This study also aimed to analyze if children with persistent speech difficulties at the age of six demonstrated poor performance in literacy and phonological awareness tasks. After the study was conducted, results indicated that children with comorbid speech and language difficulty exhibited significantly lower scores on all phonological and literacy tasks than in comparison to their peers. Children with isolated speech sound difficulties did not show a statistical difference in performance; however, those with persistent speech sound difficulties after age 6; 9 years demonstrated a significant risk to literacy problems. Bringing to question if persistency of speech sound difficulties past a certain age could impact literacy outcomes in later school age years.

Examining the relationship between speech sound disordered children and literacy achievement has proven to be essential in determining prevention, identification, assessment, and treatment [4]. Research has indicated that there is a need for speech and language pathologists to increase involvement in promoting early literacy outcomes for clients [10] and play an active role in determining factors that affect literacy acquisition for school age children.

In past studies, researchers used both descriptive and inferential data to demonstrate the relationship between speech sound disorders and literacy. The research is meticulous and informational; however, very few compare statistics with normed peers [2]. With the exception of the one study [13], most studies do not distinguish clearly what was considered "speech and sound disordered". Rather researchers compared the statistical differences from children who are demonstrating articulation only difficulties to those identified with phonological processing. In addition, subjects examined were administered assessments that were susceptible to independent testing influences (halo effect, central tendency, etc.) that could affect results.

Implications for this study could provide significant information that could improve how speech and language pathologists prevent, assess, identify, and provide intervention for children who are considered at-risk for literacy acquisition and success. It is felt that oral language and literacy development are a reciprocal process that begins early in school [4].

Identifying what variables influence literacy acquisition for a child with a speech sound disorder aids in efficaciously providing treatment that is both effective and efficient.

## 4. Methodology

### 4.1. Research Design

A quantitative design was implemented to compare and contrast the reading scores of students who are identified as speech and language impaired (SLI-A) to the norm group, and discover if significant main effects between the groups exist. The design provided the capability to

describe and explain what differences existed by collecting numerical data of samples collected and apply statistical analysis to satisfy the research questions posed [9]. A causal-comparative model was employed to investigate what possible effects speech sound disorders of school-age children have on reading achievement, and how it compares to children who are speech and language impaired and the norm group [9].

The causal-comparative study investigated how speech sound disorders (i.e. articulation disorders, stuttering, and phonological processing delay) impact the literacy achievement of school-age students between the grades of kindergarten through third grade. Raw scores of Northern Evaluation Association (NWEA) were used to calculate what statistical differences, if any, exist between the different subgroups.

## 4.2. Subjects

Subjects for the study were collected using a stratified random sampling process.

Students were randomly chosen from each grade level (Kindergarten through 3<sup>rd</sup> grade) and then randomly selected again from each subgroup studied: 1) students

identified as speech and language impairment, articulation (SLI-A), 2) students identified as speech and language impairment, language and articulation (SLI-L&A or DD), and 3) students who do not have an individual education plan (I.E.P.). Students included in the study had to be a registered student with the local public school district for the entire 2013-2014 school year and be native English speakers. Students to be considered in the SLI-A and SLI-L&A group had to have a legally recognized individual education plan (I.E.P.) as defined in the New Mexico TEAM manual [15]. Demographics of the subjects studied are registered male and female students from a local, New Mexico school district from grades kindergarten through the third grade. The reading achievement scores of 60 subjects from each grade level was randomly chosen consisting of 20 subjects per comparison subgroup (SLI-A, SLI-L&A, norm group) for a total of 240 subjects. A matching procedure between comparison groups with more than one extraneous variable (grade level, comparison subgroup, same school district) was used to self-regulate the results of the study [9]. The following chart depicts subjects involved in the study:

Table 1. Subject Comparisons

Subgroup	Kindergarten	First Grade	Second Grade	Third Grade
Norm Group	20 (10 males/10 females)	20 (10 males/ 10 females)	20 (10 males/ 10 females)	20 (11 males/9 females)
SLI-A	20 (11 males/ females)	20 (14 males/ 6 females)	20 (16 males/ 4 females)	20 (12 males/8 females)
SLI-L&A, DD	20 (12 male/ 8 females)	20 (14 males/ 6 females)	20 (13 males/ 7 females)	20 (9 males/11 females)

## 4.3. Setting and Materials

The researcher did not have any contact with the subjects. The students completed the NWEA reading assessment portions using a computer at their school with a trained administrator on hand. The assessments were conducted in the spring season of 2014. Data was later collected and reported to the public school district office to be analyzed.

## 4.4. Evaluation Procedures

Informed consent was presented and accepted by the public school district to ensure that the well-being and privacy of the subjects were followed. There was no contact between the subjects and the researchers; however, data collected was subject to the Family Educational Rights and Privacy Act (FERPA, 2012) and had to follow public school district guidelines and regulations before being released.

Subjects were administered the Northwestern Evaluation Association [16]. The NWEA (also known as MAP) is an assessment that uses the state content standards in all subject areas and assesses student achievement in the following areas: phonological awareness, phonics, concepts of print, vocabulary and word structure, reading comprehension, and writing. These subject areas allow comparisons to be made between the three subgroups: SLI-A, SLI- L&A, and the norm group to predict what skills (i.e. phonemic awareness, phonics, etc.) are better predictors in identifying literacy success [19]. The NWEA does not only identify what areas that the students are exhibiting both growth and decline, but demonstrates how the

student performs in relation to peers with similar demographics [16].

Subjects were assessed using a computer in the school computer lab that is moderated by a trained educational assistant in the technology department with the school district. Students were tested in the spring. Subjects were given questions one at time in each subject area. If the student answered the question correctly, the student was presented with a question that was more challenging. If the student missed a question, the student was presented with a question that was easier. Scores were translated into RIT (rasch unit) interval scores by assigning a predetermined value to each question based on its difficulty [16]. Results of the test was automatically recorded and reported to the testing administrator for the public school district.

Copies of each student's results were compiled into a progress report that measured the student's scores in comparison to others at their grade level in the public school district. RIT scores from the spring assessment period consisted of randomly selected students that fit the profiles of each comparison group that were collected from the school district and analyzed.

Possible confounding variables such as: health of the student the day of the assessment, technical problems with the computer or program itself, and fine and gross motor skills of the student was addressed. Students who exhibited fine and gross motor skills, and are identified in an individual education plan were provided testing accommodations that were approved by the special education team administered as stated on the individual education plan. Other confounding variables addressed, was the population of students that were identified under the student assessment team (SAT) process. A small

percentage of the norm group population may have a speech sound disorder and/or a language disorder, but still have not completed the process of identification. Any outliers discovered in the statistical analysis, was removed to address the other possible confounding variables.

**4.5. Statistical Analysis**

Descriptive analysis of the RIT interval scores was used to find the mean and range scores of each subgroup (SLI-A, SLI- L&A, and norm) for each grade level, kindergarten through third grade [9]. Inferential measures was implemented and parametric tests such as an 3x4 Factorial Independent ANOVA (using an alpha level of p=.05) was completed at each grade level to make comparisons amongst the subgroups to determine what significant differences were found in each reading assessment subgroups: phonological awareness, phonics, concepts of print, vocabulary and word structure, and reading comprehension [9]. Comparisons between the different subgroups (Norm, SLI- A, and SLI-L&A) and the grade levels was done using a 3x4 Factorial Independent ANOVA (using an alpha level of p=.05) to investigate what differences, if any exist amongst the grade levels.

ANOVAs found to exhibit statistical differences were administered a post hoc test, such as the Tukeys test, to determine subgroups exhibiting statistical difference. Then a measure of variance between the two subgroups was administered to determine how much the reading scores differ amongst each other [9].

**5. Results**

Descriptive statistics were completed to determine the range and mean scores at each grade level for each comparison subgroups. 3x4 Factorial Independent ANOVAs were used at the kindergarten, first grade, second grade, and third levels to determine if statistical differences were found between the norm, SLI-A, and SLI L&A comorbid groups in the subtest reading tests or categories: Language and Writing, Foundational Skills, Literature and Informational Texts, and Vocabulary Use and Function.

At the Kindergarten level, overall scores ranged from: 139-186 (norm group), 142-181 (SLI-A group), and 116-168 (SLI L&A comorbid group). Results from the 3x4 Factorial Independent ANOVA indicated that there was no significance found between the different subtest categories (F value 1.12< 2.65 critical value; p= 0.05) and interaction effects of the two factors (F value 0.4< 2.14 critical value; p= 0.05); however, significant differences were found between the different comparison subgroups. A post hoc test Tukey’s, was used to determine if absolute difference was found between any two means (row means, column means, or cell means). Results indicated that differences were found between the SLI-A group and the norm group (8.0375> 5.33 HSD [0.05]), SLI-A group and the SLI-L&A comorbid group (6.3125>5.33 HSD [0.05]), and SLI-L&A comorbid group and the norm group (14.35>5.33 HSD [0.05]). The following graph depicts the results found:

**Table 2. 3x4 Factorial Independent ANOVA comparison of the subgroups: Norm, SLI-A, and SLI L&A to NWEA subtest results for Kindergarten.**

Source	SS	df	MS	F	HSD [0.05]
Rows	8276.58	2	4138.29	20.35	5.33
Columns	683. 21	3	227.74	1.12	6.76
R x C	487.42	6	81.24	0.4	15.01
Error	46371.25	228	203.38		
Total	55818.46	239			

At the First Grade level, overall scores ranged from: 158-201 (norm group), 150-197 (SLI-A group), and 128-179 (SLI L&A comorbid group). Results from the 3x4 Factorial Independent ANOVA indicated that there was no significance found between the different subtest categories (F value 0.48< 2.65 critical value; p= 0.05) and interaction effects of the two factors (F value 0.35< 2.14 critical value; p= 0.05); however, significant differences were found between the different comparison subgroups.

Using the post hoc test Tukey’s, significant differences were found between the SLI-A group and the SLI-L&A comorbid group (17.3625>5.08 HSD [0.05]), and SLI-L&A comorbid group and the norm group (18.825>5.08 HSD [0.05]). There were no significant differences found between the SLI-A group and the norm group (1.4625< 5.08 HSD [0.05]). The following graph depicts the results found:

**Table 3. 3x4 Factorial Independent ANOVA comparison of the subgroups: Norm, SLI-A, and SLI L&A to NWEA subtest results for First Grade**

Source	SS	df	MS	F	HSD [0.05]
Rows	17546.03	2	8773.02	4.71	5.08
Columns	263.75	3	87.92	0.48	6.45
R x C	389.83	6	64.97	0.35	14.31
Error	42190.85	228	185.05		
Total	60390.46	239			

At the Second grade level, overall scores ranged from: 176-208 (norm group), 167-202 (SLI-A group), and 126-188 (SLI L&A comorbid group). Results from the 3x4 Factorial Independent ANOVA indicated that there was not any significance found between the interaction effects of the two factors (F value 0.61< 2.14 critical value; p= 0.05); however, significant differences were found

between the different comparison subgroups (F value 89.45> 3.04 critical value; p=0.05) and the different subtest categories (F value 2.85>2.65 critical value; p=0.05). In the different comparison subgroups (norm, SLI-A, and SLI L&A comorbid), the post hoc test Tukey’s, were performed. Significant differences were found between the SLI-A group and the norm group (10.725>

4.98 HSD [0.05]), SLI-A group and the SLI-L&A comorbid group (17.2125>4.98 HSD [0.05]), and SLI-L&A comorbid group and the norm group (27.9375>4.98 HSD [0.05]). Significant differences amongst the subtest categories were also indicated. Significant differences

were found between *Language & Writing Skills* and *Literature & Informational Comprehension* (6.45>6.32 HSD [0.05]) were found to be significant. The following graph depicts the results found:

**Table 4. 3x4 Factorial Independent ANOVA comparison of the subgroups: Norm, SLI-A, and SLI L&A to NWEA subtest results for Second Grade**

Source	SS	df	MS	F	HSD [0.05]
Rows	31781.33	2	15890.67	89.45	4.98
Columns	1520.28	3	506.76	2.85	6.32
R x C	655.4	6	109.23	0.61	14.03
Error	40502.15	228	177.64		
Total	74459.16	239			

At the third grade level, overall scores ranged from: 161-226 (norm group), 167-205 (SLI-A group), and 151-206(SLI L&A comorbid group). Results from the 3x4 Factorial Independent ANOVA indicated that there was no significance found between the different subtest categories (F value 0.41< 3.06 critical value; p= 0.05) and interaction effects of the two factors (F value 0.07< 2.43 critical value; p= 0.05); however, significant differences

were found between the different comparison subgroups (F value 57.39> 3.06 critical value; p=0.05). Using the post hoc test Tukey’s, significant differences were found between the SLI-A group and the SLI-L&A comorbid group (21.7334>6.2 HSD [0.05]), and SLI-L&A comorbid group and the norm group (26.2834>6.2 HSD [0.05]). The following graph depicts the results found:

**Table 5. 3x4 Factorial Independent ANOVA comparison of the subgroups: Norm, SLI-A, and SLI L&A to NWEA subtest results for Third Grade**

Source	SS	df	MS	F	HSD [0.05]
Rows	23677.08	2	11838.54	57.39	6.2
Columns	168.58	2	84.29	0.41	6.2
R x C	56.32	4	14.08	0.07	14.31
Error	35276.6	171	206.3		
Total	59178.58	179			

An overall comparison using the overall NWEA scores between each categorical group (norm, SLI-A, and SLI L&A) and the K-3 grade levels, was made using a 3x4

Factorial Independent ANOVA. Overall score ranges are depicted below:

**Table 6. Range Comparisons amongst Subgroups and grade levels**

Categorical Group	Kindergarten	First Grade	Second Grade	Third Grade
Norm Group	139-186	163-201	176-208	161-226
SLI-A	142-181	150-197	167-202	167-205
SLI L&A Comorbid	116-168	128-179	140-188	151-206

Results from the 3x4 Factorial Independent ANOVA indicated that there was significance found between all comparison categorical groups (F value 68.5> 3.04 critical value; p= 0.05), all grade levels (F value 81.22> 2.65 critical value; p=0.05), and interaction effects of the factors (F value 2.34>2.14 critical value; p= 0.05). Using the post hoc test Tukey’s, significant differences were found between the SLI-A group and the SLI-L&A comorbid group (15.3>4.55 HSD [0.05]), SLI-A group and norm group (6.575>4.55 HSD [0.05]), and SLI-L&A comorbid group and the norm group (21.9375>4.55 HSD [0.05]). Significant differences using the post hoc test Tukeys also revealed that there was significance between

the Kindergarten and First grade levels (14.2666 > 5.77 HSD [0.05]), First and Second grade levels (13.5834 >5.77 HSD [0.05]); however, there was not significance found between the Second and Third grade scores (3.05<4.55 HSD [0.05]). Significance amongst the interaction effects using Tukey’s revealed that there was not significance found between the norm and SLI-A groups within all grade levels; however there was significance found between the norm and SLI L&A comorbid groups for all grade levels (14.3>12.8 HSD Kindergarten; 19.4>12.8 HSD First Grade; 27.85>12.8 Second Grade; 26.2>12.8 HSD). The following graph depicts the results found:

**Table 7. 3x4 Factorial Independent ANOVA comparison of the subgroups: Norm, SLI-A, and SLI L&A to the NWEA overall scores for each grade level**

Source	SS	df	MS	F	HSD [0.05]
Rows	20279.76	2	10139.88	68.5	4.55
Columns	36066.71	3	12022.24	81.22	5.77
R x C	2076.88	6	346.15	2.34	12.8
Error	33749.55	228	148.02		
Total	92172.9	239			

### 5.1. Summary

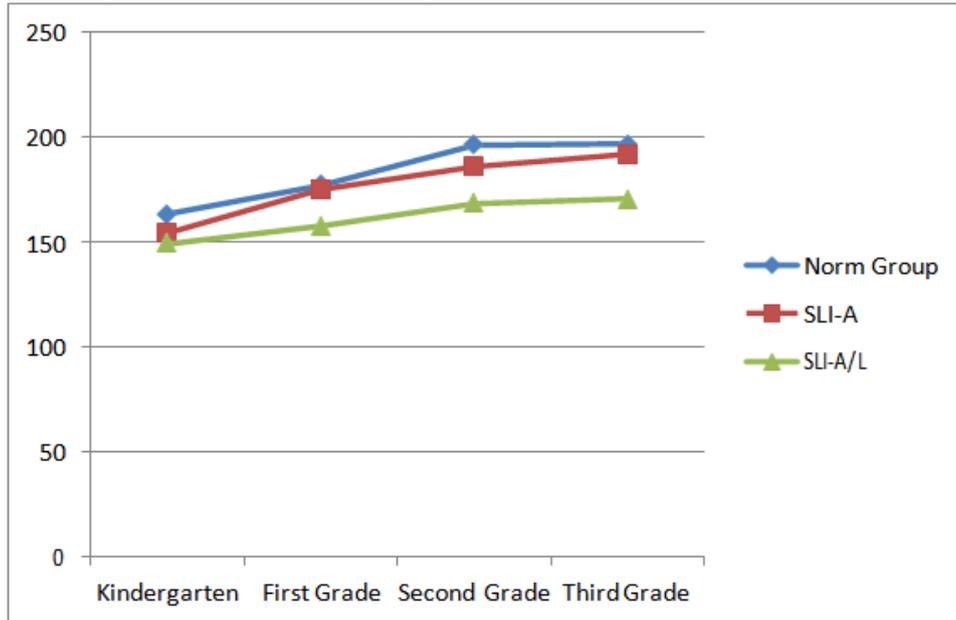
In summary, analysis of ANOVA statistics performed showed that when comparing the norm group to the SLI-A group, results indicated that there were some significant differences found when comparing the categorical groups at each grade level though effect sizes were small; however, in comparisons using the overall scores there were not any significant differences noted. Results using mean overall NWEA scores did demonstrate a slight overall difference when compared. This indicates that while the difference was not found significant between the

norm and SLI-A and norm groups, a small amount of difference does exist and is observed throughout the grade levels. The following graph depicts results collected from mean scores:

**Table 8. Mean comparisons of NWEA overall subgroup (norm, SLI-A, and SLI L&A comorbid) scores across grade levels**

	Kindergarten	First Grade	Second Grade	Third Grade
Norm Group	163.6	177.15	196.3	197.05
SLI-A	154.4	175.2	186.1	192.1
SLI-A/L	149.3	157.75	168.45	170.85

**Table 9. Mean comparisons of NWEA overall subgroup (norm, SLI-A, and SLI L&A comorbid) scores across grade levels**



In comparisons made between the norm group and SLI L&A comorbid group, results indicated that there are significant differences found in all statistical analysis completed. This was also evident when comparing the SLI-A group and the SLI L& A comorbid groups within each grade level.

Significant interaction results comparing the different subtest categories found in the NWEA test did not have any statistical significance with exception to comparisons made at the second grade level between subtest categories *Language & Writing Skills* and *Informational Comprehension* (Table 4: 6.45>6.32 HSD [0.05]); however, the results should be interpreted with caution because both the difference and effect size are very small and the above mentioned categories are not similar enough in content to be thoughtfully compared.

### 6. Discussion

The current study examined if statistical differences were demonstrated in literacy assessment tasks between children diagnosed with speech sound disorders in comparison to the norm group. Past research has argued that literacy outcomes of children with speech sound disorders are determined both by severity (i.e. comorbid speech and language) and age of the child. Based on these arguments, the following questions were proposed: 1) Is there a statistical difference in reading achievement scores

between children identified with a speech sound disorder and those scores of their normed peers? 2) Does the severity of the disorder: articulation only or co-morbid speech and language impairment impact reading achievement scores differently? 3) What areas of reading were found to be impacted by those identified with a speech sound disorder?

**Is there a statistical difference in reading achievement scores between children identified with a speech sound disorder?**

Statistical analysis conducted in the study indicated that there is a significant difference between the NWEA scores of children identified with a speech sound disorder in comparison to their normed peers; however, results also concluded that the differences found children identified with articulation-only (SLI-A) do demonstrate a difference, but is not found to be significant (see Table 8). This result supports past research that suggests that children with speech sound disorders exhibit an impact in literacy outcomes when demonstrating a comorbid disorder (SLI-L&A) rather than an impairment that involves articulation difficulties only Apel and Lawrence [3]. It should be noted; however, that although significant differences were not indicated, it was observed that children with SLI-A consistently scored below their normed peers on the literacy tasks given throughout all grade levels. Implications of this result indicate that although differences are not significant, it's important to monitor children who demonstrate an articulation disorder for

possible reading and/or comprehension for possible identification of an underlying problem with language.

### **Does the severity of the disorder: articulation only or co-morbid speech and language impairment impact reading achievement scores differently?**

This study concluded that the severity of the disorder does impact literacy assessment results. When comparing the scores of SLI-A only children to the SLI- L&A comorbid children, results indicated that significant differences were found with all grades, kindergarten through third grade. Those identified with comorbid impairments (SLI- L&A) consistently performed lower than their norm and SLI-A only peers in all subtest categories. This supports previous research studies that compared the two groups, indicating that children with communication impairments performed statistically lower than their typical peers, and that children with a communication disorder demonstrate lower achievements in reading and writing academics in comparison to their peers [12] making them at a greater risk of becoming reading disordered.

### **What areas of reading were found to be impacted by those identified with a speech sound disorder?**

When comparing the different subgroups (norm, SLI-A, and SLI L&A comorbid) scores to different literacy/reading subtest contained in the NWEA: phonological awareness, phonics, concepts of print, vocabulary & word structure, reading comprehension, and writing, it was found that there were statistical differences between the subgroups being compared; however, children within each subgroup (norm, SLI-A, and SLI L&A comorbid) performed within five to ten points of each subtest given. This implicates that there was not a specific area of literacy impacted more than the other.

## **6.1. Limitations**

Limitations to the study included population, comprehensive demographic information, and time frame. Assessment results were collected from a local public school and consisted of only 240 students, limiting generalization to a population similar to the demographics found in the population collected. Other limitations also included the ability to gain better background knowledge of the participants selected in the study. Due to HIPPA and FERPA regulations, access to student's records and information for each subgroup (norm, SLI-A, and SLI L&A) was limited in accordance with federal laws. The principal investigator had access to directory information only, so other possible variables that may have impacted the study are unknown at this time. Lastly, the data collected is only one sample of evidence from one point in time. Data was collected from the spring testing period and from a single assessment (NWEA). This limited the amount of information and data collected to be analyzed. Evaluating additional reading assessment results from other assessments (i.e. DIBELS, observation, DRA, etc.) would have been beneficial in understanding how speech sound disorders impact literacy for each subject.

## **6.2. Implications for SLPs and Others**

The results of this study support the efforts of other researchers in understanding the impact of speech sound disorders on the literacy outcomes of children, and how to

better predict students who may be at risk of reading disabilities. Early intervention has proven to be successful in closing the gap for those with communication difficulties. If certain predictors or risk factors could be ascertained and aide in monitoring children with speech sound disorders, children who are found to be at-risk for future reading deficits could be exposed to interventions earlier; therefore, producing better literacy outcomes. Though the study concluded that there is not a significant difference of reading scores with those who are SLI-articulation only; therapists, teachers, interventionist, etc. should be encouraged to use curriculum-based therapy to provide continued support for the students in the classroom and continue to closely monitor for any signs of a possible comorbid language problems.

Further research in this area could provide better insight to how speech sound disorders impact literacy and language. Recommendations for this study include, conducting a longitudinal study to investigate and determine if certain variables such as age, persistent articulation deficits, etc. are found to impact literacy acquisition in children. Further research using a triangulation of assessments to determine if any areas (i.e. rhyming, word attack, etc.) to determine if any relationships exist, and commonalities are found to be statistically different amongst those children with speech sound disorders could also be beneficial.

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