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J. N. Andrews Honors Program
Andrews University

HONS 497
Honors Thesis

Efficacy of a Three-Week Intervention Program for Children in the Areas of Language,
Articulation, Phonological Awareness, and Auditory Processing

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April 5, 2019

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Abstract

Competency in the areas of language, articulation, phonological awareness, and auditory processing are essential for children to succeed academically. For the past four summers, select professors and graduate student clinicians in the Speech-Language Pathology and Audiology Department at Andrews University have conducted an intensive three-week therapy program for school aged children to target these areas. By comparing pre/post-test scores, the purpose of the study is to obtain statistical evidence for specific therapy interventions in order to strengthen the effectiveness of the intensive therapy program.

Purpose: This study aimed to determine the efficacy of a three-week summer intervention program targeting language, articulation, phonological awareness, and auditory processing for school-aged children.

Method: Eight children participated in the summer program and participated in therapy three hours a day for three weeks. The intervention programs used were Visualizing and Verbalizing™, Lindamood Phoneme Sequencing®, Lively Letters™, Color My Conversation, and Differential Processing Training Program™, along with snack-craft and game times. Additionally, a clinical comparative (CC) group was formed to determine if children with no intervention could “learn” tests by being reassessed with in a relatively short period of time.

Results: The participants made statistically significant gains in phonemic

awareness/blending, auditory figure ground, and right ear auditory processing ability. The CC group did not improve statistically significantly in all but one measure.

Conclusion: For the children in the therapy program, LiPS®, Lively Letters™, and Differential Processing Training Program: Acoustic Tasks™ directly targeted the areas in which was found statistical significant improvement. The areas in which no statistically significant improvement was found were organization, integration, articulation, and auditory memory. Results of the CC group support the validity of performing pre- and post-testing within a short period.

Recommendations include using at least one additional language test, using a quantifiable method of recording testing behavior, and obtaining a larger sample size through clinical collaboration.

In the twenty-first century, those who succeed academically are more likely to be employed with stable jobs, have more job opportunities, receive higher pay, and have health insurance (Reiger, 2011; Vilorio, 2016). Children who perform well in school are also more likely to have higher self-esteem and are less likely to abuse drugs and alcohol (Centers for Disease Control and Prevention, n.d.; Doodman, 2017). Speech-language pathologists (SLPs) in the school setting play a “critical” role in helping children achieve this academic success (Ehren 2015). The American Speech-Language and Hearing Association (ASHA) states that SLPs “provide a distinct set of roles based on their focused expertise in language” and “contribute significantly to the literacy achievement of students with communication disorders” (ASHA 2010).

Research shows that proficiency in the areas of language, articulation, phonological awareness, and auditory processing are essential for children’s academic success (Cirrin & Gillam, 2008; Farquharson & Boldini, 2018; Goldstein et al., 2017;

Vanvooren et al., 2017). As it is the SLPs role to provide services for children who demonstrate deficits in these four areas, it is important that researchers work to build the evidence base for interventions provided because, as ASHA’s policy states, SLPs must incorporate evidence based practice into therapy they provide (ASHA, 2005).

The services provided for children through public schools are not typically available during the summer months. For these children who struggle to perform well academically, engaging in therapy over the summer can assist in boosting or at least maintaining skills developed during the regular school year. The Department of Speech-Language Pathology and Audiology (SPLAD) at Andrews University has conducted a three-week intensive communication program for school aged children each summer from 2015-2018 in an effort to mediate this gap in therapy services.

During the 2017 “summer camp”, SPLAD and J. N. Honors student Nicole Weis conducted her Honors research project on the efficacy of the program, focusing on

the areas of language, literacy, phonological awareness, and auditory processing. By comparing pre- and post-test scores, her research found that the camp participants statistically improved in literacy, decoding, right ear auditory processing ability, and social communication, and notably did not improve in auditory memory or organization (Weis, 2018).

Based on these results and her recommendations, changes were made for the 2018 camp. There were fewer therapy stations to facilitate more meaningful time with each intervention, the age range was lowered from 1st-8th grade to Kindergarten-3rd grade to increase social compatibility among participants, and On Cloud Nine® was removed from the therapy regiment as the camp is not focused on improving math skills. Additionally, more intentional collaboration between audiology and speech therapy was employed in an effort to better target auditory processing. The audiologist was part of the pre-camp training for the graduate students who conducted the therapy and was present and active throughout the entirety of the camp, providing her professional perspective and advice. Weis' research project has been carried on in an effort to grow the evidence base and thus continually improve the therapy strategies used by the summer program.

The 2018 summer camp implemented four core therapy interventions: Color My Conversation®, Differential Processing Training Program: Acoustic Tasks™, Visualizing and Verbalizing®, and Lindamood Phoneme Sequencing® (LiPS) or Lively Letters™, depending on the age and ability of the child. The clients also participated in snack-craft and game time.

An addition made to this year's research was the formation of a clinical comparative (CC) group, comprised of children of the same age range as clients in the camp. This group was assessed using the same tests as the clients with the same time frame between pre- and post-testing and did not receive intervention. The primary purpose of

this group was to determine if children could "learn" the tests and score significantly higher at post-testing because they were now familiar with the tests. This was to strengthen the validity of any statistical improvement observed in the camp clients.

The tests administered for pre- and post-testing included the Phonological Awareness Test – Second Edition (PAT-2), Common Core Early Language Screener (CCELS), Little Bee Speech – Articulation Test Center Pro, SCAN-C, Phonemic Synthesis Test, CID W-22 Speech-in-noise Test, Staggered Spondaic Word Test (SSW), and an Auditory Memory Task test created by the researchers.

The research questions were: (1) After participating in a three-week intervention program, will the clients show statistically significant improvement in the areas of language, articulation, phonological awareness, and auditory processing?; (2) Will the same areas which showed statistical improvement in Weis' study also show improvement in this study?; (3) Will clients show statistical improvement in areas (specifically auditory memory and organization) where clients in Weis' study did not?; and (4) Will the clinical comparative group demonstrate statistically significant improvement after receiving no intervention when retested after a three-week period?

Method

Participants

Children were enrolled in the summer communication camp by recruitment through advertising to local SLPs and schools, by recommendation by SPLAD's audiologist, or because they were already on the SPLAD clinic's case load from the regular school year. Children part of the CC group were recruited from the local community or were siblings of children in the camp. Approval to conduct this research was received on May 31, 2018 from the Internal Revenue Board through the

Office of Research and Creative Scholarship at Andrews University. Each parent or guardian of children in the therapy camp or in the CC group signed consent forms for their child to take part in the study.

Participant Characteristics

The experimental group included eight children who participated in the summer camp, four boy and four girls. The majority were White (6/8) and the remainder were African American (2/8). They ranged in age from 4:2 to 9:2 with a mean age of 6:11. The primary areas of concern reported by the parents included phonological awareness, disfluency, expressive and receptive language, articulation, breath support, fluency, and auditory processing.

Nine children comprised the CC group, five boys and four girls. The largest racial group was White (4/9) while 2/9 were African American, 2/9 were Asian, and 1/9 was Hispanic. They ranged in age from 5:1 to 10:9 with a mean age of 7:6. Two of the nine were siblings of camp participants. These children were tested without the researchers' prior knowledge of any speech, language or auditory processing deficits.

Intervention

The eight children in the experimental group attended the intensive therapy camp for 11 days over three weeks, with the first and last days devoted to the pre- and post-testing. The program was conducted for three hours each morning and the children spent 25 minutes with each therapy activity. The children rotated in pairs through the four core interventions Color My Conversation®, Differential Processing Training Program: Acoustic Tasks™, Visualizing and Verbalizing®, and Lindamood Phoneme Sequencing® (LiPS) or Lively Letters™, and came together as a whole group for snack-craft and game time. The groups of two were formed based on the children's speech and language ability and the overall perceived

compatibility. Four graduate student clinicians provided therapy, rotating daily which core intervention they administered. All four graduate clinicians, the two SLP and audiologist supervisors, and an additional graduate and undergraduate student collaboratively conducted the snack-craft and game time. The four graduate clinicians rotated being in charge of these group activities.

Color My Conversation®

Color My Conversation® helps children strengthen their pragmatic language skills by learning, for example, how to ask and respond appropriately to who, what, where, when, why, and how questions or by learning how to appropriately comment.

Differential Processing Training Program™

This program trains the child to listen better with both ears simultaneously; differentiate between same and different sound patterns; listen to and demonstrate patterns of pitch, loudness, and duration; and better discriminate between speech sounds. Although this is a three book series, this camp only used the first book which focuses on auditory skills only.

Visualizing and Verbalizing®

This program teaches children to create connections between language and pictures in their head. This is an effective tool for improving reading and listening comprehension, memory, oral vocabulary, critical thinking, and writing because the child is able to create stronger connections in their brain. Words on a page or ideas they hear about become connected to mental imagery and are therefore more easily accessible to the child (Lindamood-Bell Learning Processes, n.d.).

Lindamood Phoneme Sequencing® (LiPS)

LiPS® is a comprehensive multisensory program designed to improve reading and spelling skills by developing phonological awareness and decoding skills. Clients learn how their articulators move to produce each sound. After they are able to produce and organize the sounds, clients then work on associating them with written letters in isolation and then in words (Gander Publishing, 2019; What Works Clearinghouse & Mathematica Policy Research, 2015).

Lively Letters™

Lively Letters™ is designed to teach children the connection between sounds and written letters using fun picture cards, stories, and songs. This program helps children improve in phonemic awareness, phonics, and speech production (Reading with TLC, n.d.).

Snack-Craft

Between the second and third core therapy rotations, the children participated in a snack-craft period. During this time, one of the graduate clinicians would give instructions to the children in order to make an edible craft. Each day the focus of this activity alternated between pragmatics and auditory memory. The children practiced asking for supplies politely and following directions without any visual aid.

Game Time

After the fourth rotation of core interventions, the children gathered outside to play games which also alternated their focus on pragmatic and auditory memory skills. Games played included Simon Says, Mother May I, Red Light, Green Light, and Musical Chairs. Children also practiced following directions while playing with a parachute.

Reinforcement

The children's behavior during the core interventions was monitored by tokens on green, yellow, and red spaces. If the child

displayed good behavior (staying on green) for the entire 25 minute session, they would receive \$1 in play money. Uncooperativeness or otherwise bad behavior would cause the clinician to move the child's token to yellow or red. The child would then receive a decreased amount of play money. At the end of each day, the children had an opportunity to spend (or save) their money at the camp store to buy various prizes.

Testing

Children in the experimental group completed pre-testing within a week before and/or during the first day of the summer camp and completed post-testing within a week after and/or during the last day of camp. Children in the CC group completed both pre- and post-testing during the summer months with at least three weeks in between test dates. Language, articulation, and phonological awareness testing was administered in the clinic's therapy rooms by the graduate clinicians and undergraduate student with supervision by a certified SLP or by the SLP herself. Auditory processing testing was administered in a sound-proof booth with an annually calibrated audiometer by the undergraduate student with supervision by the certified audiologist or by the audiologist herself. The only exception was the auditory memory task testing which was administered in the audiologist's office.

Language Measures

Language was assessed using the Common Core Early Language Screener (CCELS). This test, presented in an iPad app, contains three different assessments for Pre-Kindergarten, Kindergarten, and First Grade. The Pre-Kindergarten level contains 14 subtests including personal questions (name, age, gender), labeling, colors, shapes, counting, and the alphabet. The Kindergarten level contains 15 subtests including phonemic awareness, categories, patterns, prepositions, and comparative vocabulary. The First Grade

level assesses skills in the areas of capitalization, phoneme blending, using digraphs/blends, multiple meaning words, reading sentences, and expressive language. Language was also assessed by the Pragmatic Activities Checklist from the Clinical Evaluation of Language Fundamentals – Fifth Edition (CELF5) which measured verbal and nonverbal communication function and was completed by a parent or guardian of the child. Because of the variability of assessment topics and lack of consistent scoring between the three levels of the CCELS and because the parent/guardian completing the Pragmatic Activities Checklist was not consistent, the SLP supervisor determined that scores obtained from this screener and check list would not be appropriate to statically analyze and have therefore been omitted from our analysis and results.

Articulation Measures

Articulation outcomes were measured using raw scores from the Little Bee Speech – Articulation Test Center Pro. This test, presented in an iPad app, provides a complete assessment of all the sounds a child should be able to produce correctly. It assesses the child's ability to say consonant sounds at the beginning, middle, or end of a word; "r" sounds; vowels; and initial blends.

Phonological Awareness Measures

Standard scores from six subsets of the Phonological Awareness Test – Second Edition (PAT-2) were used to determine outcomes. The subtests evaluate the child's ability to identify and provide rhyming words; segment words, syllables, and phonemes; identify initial, medial, and final sounds in words; delete compound words, syllables, and phonemes; blend sounds; and identify the sounds each letter makes when presented with the letter on a card.

Auditory Processing Measures

Decoding

This area of auditory processing was measured using the Staggered Spondaic Word Test's (SSW) Right Competing raw score, the standard score from the SCAN-C's Filtered Words subtest, the quantitative percentage correct and qualitative raw scores from the Phonemic Synthesis test, and the standard score from the PAT-2's Blending subtest.

According to Katz and Smith (1991), the Right Competing SSW score reflects the child's decoding ability, the capacity to quickly process words at a phonemic level.

The Filtered Words subtest assesses the child's ability to understand muffled speech. The child is required decode words from a degraded auditory signal.

The Phonemic Synthesis test and the Blending subtest from the PAT-2 require the child to blend distinct phonemes into words. Two of the Phonemic Synthesis quantitative scores for the experimental group and one from the CC group were based on picture version of the same test. The Phonemic Synthesis qualitative score was based on how many qualitative markers the child displayed such as needing extra time or not fusing phonemes instead of subtracting the total number of qualitative markers from the quantitative score.

Auditory Figure Ground

Outcomes measures for this area came from the percentage correct CID W-22 Speech-in-Noise test (right and left ears), the Left Competing SSW raw score, and the standard score from the SCAN-C's Auditory Figure Ground subtest.

The CID W-22 Speech-in-Noise test evaluates the child's ability to understand speech in the presence of a static background noise at a +5 dB signal-to-noise ratio.

According to Katz and Smith (1991), the Left Competing score from the SSW correlates with auditory figure ground ability.

The Auditory Figure Ground subtest from the SCAN-C assesses the child's ability to understand speech in the presence of

multi-speaker background noise at a +8 dB signal-to-noise ratio.

Organization

This area of auditory processing was measured by the SCAN-C's Competing Words subtest standard score and by the SSW's Reversals raw score.

The Competing Words subtest requires the child to repeat two words heard simultaneously, one in each ear, saying the word in the right (and then in the left ear) first.

The Reversals score counted how many times the child repeated words from the SSW test in an incorrect order.

Integration

Standard scores from the SCAN-C's Competing Words and Competing Sentences subtests were used as outcome measures.

Competing Sentences presents the child with two different sentences, one in each ear. The child is required to repeat only the sentence heard in the right ear, and then in the left.

Auditory Memory

The audiologist and the undergraduate student created auditory memory tasks and word lists. The first required the child to repeat two and three step directions and then perform those actions in order. The second required the child to repeat lists of three, four, five, and six random words. For both of these tests, the prompt was repeated 1-3 times if necessary to measure how much assistance the child needed to complete the task. For each word or task from each question, the child was awarded 5 points if they were able to repeat it (or act on it) in the correct order on the first attempt, 3 points for the second attempt, 1 point for the third attempt, and 0 points if they were not able to complete task/repeat the word after three repetitions. In this way, the fewer repetitions needed, the higher the score would be.

Statistical Analysis

To determine statistically significant improvement, SPSS was used to perform a two-tailed Wilcoxon Signed Ranks Test on the experimental group and CC group data separately, comparing the pre- and post-test scores. *P* values of 0.05 or less were considered significant. Because a significant *p* value only indicates a significant change in scores, the raw data for each such value was re-examined to determine if this was because of a positive or negative change in scores. The sample size for some of the measures became smaller because of invalid or incomplete tests primarily due to child behavior.

Results

Experimental Group

Articulation

While articulation was not directly targeted during the summer camp, it was hypothesized that articulation scores would improve as a result of improved phonological awareness as targeted by the LiPS® and Lively Letters™ programs. Results showed no statistical improvement for the Little Bee Speech – Articulation Test Center Pro.

Phonological Awareness

It was hypothesized that the children's phonological awareness would improve significantly after participating in the summer camp. Of the six PAT-2 subtests, results showed statistical improvement for Blending, $N=8$, $z=-2.539$, $p=.011$. The median standard score was 4.88 at pre-test and 8.00 at post-test. Rhyming, Segmentation, Isolation, Deletion, and Phoneme-Grapheme Correspondence scores were not found to have significantly improved.

Auditory Processing

Decoding

It was hypothesized that the decoding measures would significantly improve in scores following intervention. Results showed statistical improvement for Blending, $N=8$, $\bar{z}=-2.539$, $p=.011$. The median standard score was 4.88 at pre-test and 8.00 at post-test. Statistical improvement was also found for the Phonemic Synthesis quantitative score, $N=7$, $\bar{z}=-1.997$, $p=.046$. The median percentage correct was 46.71 at pre-test and 61.71 at post-test. Filtered Words, SSW Right Competing, and the Phonemic Synthesis qualitative score were not found to be statistically significant.

Auditory Figure Ground

It was hypothesized that the children's auditory figure ground ability would significantly improve after the summer camp. Statistically significant improvement was found for Speech-in-Noise for the Right Ear, $N=7$, $\bar{z}=-2.032$, $p=.042$. The median percentage correct was 50.86 at pre-test and 60.00 at post-test. SCAN-C's Auditory Figure Ground subtest was also found to be statistically significant, $N=7$, $z=-2.201$, $p=.028$. The median standard score was 4.14 at pre-test and 7.29 at post-test. Speech-in-Noise for the Left Ear and SSW Left Competing were not found to have significantly improved.

Organization

It was hypothesized that organization would not significantly improve because the camp was not focused on improving this higher level skill. Analysis revealed no statistical improvement in the SCAN-C's Competing Words subtest or in the SSW Reversals score.

Integration

It was hypothesized that integration would not significantly improve because the camp was not focused on improving this higher level skill. Neither the SCAN-C's

Competing Words or Competing Sentences were found to have statistical significance.

Auditory Memory

After participating in the summer camp, it was hypothesized that the children would significantly improve on the auditory memory tasks or word lists. Results showed that the experimental group did not significantly improve on any of the auditory memory tasks or word lists. Repeating the third auditory memory task was found to significantly decrease, $N=6$, $\bar{z}=-1.992$, $p=.046$.

Clinical Comparative Group

Articulation

It was hypothesized that the CC group would not significantly improve on this test. Analysis found no statistically significant improvement for the Little Bee Speech – Articulation Test Center Pro.

Phonological Awareness

It was hypothesized that the CC group would not significantly improve on this test. Results showed statistical improvement in PAT-2's Isolation subtest, $N=8$, $\bar{z}=-2.058$, $p=.040$. The median standard score was 8.88 at pre-test and 10.13 at post-test. The remaining five PAT-2 subtests were not found to be statistically significant.

Auditory Processing

It was hypothesized that the CC group would not show statistically significant improvement in Decoding, Auditory Figure Ground, Organization, Integration, or Auditory Memory. Analysis found no statistically significant improvement for any tests measuring the five areas of auditory processing. Speech-in-Noise for the Left Ear was found to significantly decrease, $N=9$, $\bar{z}=-2.254$, $p=.024$. The third auditory memory word lists, repeating lists five words, was also significantly decrease, $N=8$, $\bar{z}=-2.023$, $p=.043$.

Discussion

This study found that following intervention, scores for children who participated in the summer camp statistically significantly improved in Phonemic Synthesis/Blending, Speech-in-Noise – Right Ear, and in the Auditory Figure Ground subtest. LiPS®, Lively Letters™, and Differential Processing Training Program: Acoustic Tasks™ directly targeted these areas. Clinically, four of seven children significantly improved in Phonemic Synthesis, four of eight significantly improved in Blending, four of seven in Speech-in-Noise – Right Ear, and four of seven in the Auditory Figure Ground subtest. Two of the children displayed clinically significant improvement on all four of these tests. One child clinically significantly improved on three of the four tests, two children on two of the four tests, and one child on one of the four tests.

For the experimental group, statistically significant improvement was not found for any of the organization, integration, articulation, or auditory memory measures. Organization and integration were not expected to improve because the camp was not designed to target these skills. Articulation did not appear to improve as a natural result of improved phonological awareness. However, the four core programs provide many opportunities to integrate more intentional articulation intervention in the future, particularly LiPS® and Lively Letters™.

Because of the way the auditory memory tasks and word lists were scored and

because they were not based on normative data, it is believed that this test created by the researchers would be most useful as a screener rather than an assessment tool for a research study. The significant decrease in scores for the third auditory memory task is thought to be due to the use of the word “bow”, as in “bow down”. Several of the children expressed that they did not know what this word meant which would affect their ability to repeat the directions. Overall, the experimental group displayed a considerable difference in behavior than the CC group, which was comprised primarily of typically developing children. The children in the camp were restless, expressed a strong desire to discontinue the testing, and generally struggled to correctly respond while the CC group children did not express any frustration or panic if they were not able to complete a task and performed significantly better. It is recommended that a revised version of these auditory memory tasks be utilized as a screener and tested out on classrooms of elementary students.

Clinically significant improvement in the areas of Decoding, Auditory Figure Ground, and Phonological Awareness was determined for each child if they showed clinically significant improvement in at least two test measures of the larger areas. Five of seven clinically significantly improved in Decoding, three of seven improved in Auditory Figure Ground, and three of eight improved in Phonological Awareness. These findings are summarized in Fig. 1.

Fig. 1

While results from the 2018 camp did not show as many significant test measures as did the 2017 camp, it was found that every child did clinically significantly improve in at least one area. This is mostly likely due to the lack of homogeneity in the experimental group. The range of ability and deficits could account for a lower number of significant measures, considering the very small sample size.

Qualitative improvements for the children who participated in the camp include improved testing behavior, increased participation in the snack-craft and game time activities, and spontaneous parent comments of child's improved ability to take directions, accept help, speak clearly, and converse on the phone.

The Clinical Comparative group did not improve significantly in any area except for the Isolation subtest. It is thought that this may be a subtest that typically developing children can learn or "figure out" without any direct intervention. A lack of statistical improvement in all other test areas supports the idea that children do not learn tests, even when reevaluated just three week later. An exception is the Articulation test because only one of the children from the CC group presented any articulation deficits and therefore the group was incapable of improving significantly as a whole.

Limitations

Statistical findings in this study are limited in strength due to the small sample sizes for both the experimental group and the CC group. In addition, the lack of a consistent deficit/disorder profile among the children participating in the camp may have hindered the discovery of statistically significant improvement. A larger and/or more homogenous sample is needed to determine stronger statistical significance.

Because the test administrators spent significant periods of time with the children in the camp over the three weeks, it is possible that scores for various tests, particularly the auditory processing tests, could have improved due to the test administrators

becoming more accustomed to the speech patterns of clients with significant articulation disorders.

Additionally, the client attendance and level of participation was not tracked in this study. Missing days in a three-week camp would be expected to have a significant impact on outcomes.

Future Summer Camps and Further Research

For SPLAD's 2019 communication summer camp, it is recommended that more intentional articulation intervention be employed and that the language tests used during 2017 study be reinstated. It is also recommended that a quantifiable method of testing behavior be developed.

It is recommended that the researchers of future camps track client attendance and the percentage of time children truly participated. The ability profile of the CC group should also be more comprehensively evaluated to determine any deficits and/or if the child is already at age-norms. Further research is needed to determine if children at age norms could improve on test measures.

Further research is also needed to determine stronger statistical significance. Clinical collaboration among multiple providers conducting a summer camp based on a set protocol is a possible solution.

Future studies could focus on testing a revised version of the Auditory Memory Tasks and Word Lists to establish norms.

Collaboration between speech-language pathology and audiology proved to be helpful for the graduate student clinicians and is believed to have positively impacted the client outcomes. More research is needed examine the benefits of such collaboration when treating children with speech, language, and auditory processing disorders.

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APPENDIX

Experimental Group: Tables 1A-14A

Table 1A: Wilcoxon Signed Ranks Test for Articulation Measures

Test	<i>z</i>	<i>p</i>
Little Bee Speech-Articulation Test Center Pro (Artic)	-1.807	.071

Table 2A: NPar Tests – Descriptive Statistics for Articulation Measures

		Percentiles		
Test	N	25 th	50 TH	75 TH
Pre-Artic	7	79.00	97.00	110.00
Post-Artic	7	82.00	99.00	112.00

Table 3A: Wilcoxon Signed Ranks Test for Phonological Awareness Measures

Test	<i>z</i>	<i>p</i>
Rhyming (RHY)	-.852	.394
Segmentation (SEG)	-.604	.546
Isolation (ISO)	-.631	.528
Deletion (DEL)	-1.625	.104
Blending (BLE)	-2.539	.011
Phoneme-Grapheme Correspondence (PGC)	-1.472	.141

Table 4A: NPar Tests – Descriptive Statistics for Phonological Awareness Measures

		Percentiles		
Test	N	25 th	50 TH	75 TH
Pre-RHY	8	5.50	7.50	9.00
Pre-SEG	8	2.00	7.00	9.00
Pre-ISO	8	1.50	6.50	9.25
Pre-DEL	8	1.50	8.00	8.75
Pre-BLE	8	1.25	5.00	7.50
Pre-PGC	8	8.50	21.50	28.25
Post-RHY	8	3.00	7.50	9.75
Post-SEG	8	3.75	7.00	8.75
Post-ISO	8	1.50	5.00	10.50
Post-DEL	8	4.25	7.50	9.75
Post-BLE	8	4.75	7.50	11.50
Post-PGC	8	13.50	26.00	28.75

Table 5A: Wilcoxon Signed Ranks Test for Decoding Measures

Test	<i>z</i>	<i>p</i>
Blending (BLE)	-2.539	.011
Filtered Words (FW)	-.816	.414
SSW-Right Competing (SSW-RC)	-1.483	.138
Phonemic Synthesis- Qualitative (PS-Qual)	-1.289	.197
Phonemic Synthesis- Quantitative (PS-Quan)	-1.997 ^b	.046

Table 6A: NPar Tests – Descriptive Statistics for Decoding Measures

		Percentiles		
Test	N	25 th	50 TH	75 TH
Pre-BLE	8	1.25	5.00	7.50
Pre-FW	7	2.00	6.00	7.00
Pre-SSW-RC	5	7.50	12.00	17.00
Pre-PS-Qual	5	.50	2.00	23.50
Pre-PS-Quan	7	20.00	47.00	60.00
Post-BLE	8	4.75	7.50	11.50
Post-FW	7	4.00	5.00	8.00
Post-SSW-RC	5	5.00	9.00	12.00
Post-PS-Qual	5	.50	1.00	14.00
Post-PS-Quan	7	56.00	64.00	80.00

Table 7A: Wilcoxon Signed Ranks Test for Auditory Figure Ground Measures

Test	<i>z</i>	<i>p</i>
Speech-in-Noise-Right (SIN-R)	-2.032	.042
Speech-in-Noise-Left (SIN-L)	-.412	.680
SSW-Left Competing (SSW-LC)	-.544	.586
Auditory Figure Ground (AFG)	-2.201	.028

Table 8A: NPar Tests – Descriptive Statistics for Auditory Figure Ground Measures

		Percentiles		
Test	N	25 th	50 TH	75 TH
Pre-SIN-R	7	44.00	52.00	56.00
Pre-SIN-L	7	40.00	52.00	56.00
Pre-SSW-LC	5	15.50	20.00	24.50
Pre-AFG	7	2.00	4.00	6.00
Post-SIN-R	7	52.00	60.00	68.00
Post-SIN-L	7	44.00	48.00	56.00
Post-SSW-LC	5	9.00	14.00	30.50
Post-AFG	7	3.00	7.00	11.00

Table 9A: Wilcoxon Signed Ranks Test for Organization Measures

Test	<i>z</i>	<i>p</i>
Competing Words (CW)	-1.933	.053
SSW-Reversals (SSW-Rev)	-.137	.891

Table 10A: NPar Tests – Descriptive Statistics for Organization Measures

		Percentiles		
Test	N	25 th	50 TH	75 TH
Pre-CW	7	5.00	6.00	9.00
Pre-SSW-Rev	5	2.00	4.00	6.00
Post-CW	7	6.00	8.00	10.00
Post-SSW-Rev	5	1.00	4.00	7.50

Table 11A: Wilcoxon Signed Ranks Test for Integration Measures

Test	<i>z</i>	<i>p</i>
Competing Words (CW)	-1.933	.053
Competing Sentences (CS)	-.957	.339

Table 12A: NPar Tests – Descriptive Statistics for Integration Measures

		Percentiles		
Test	N	25 th	50 TH	75 TH
Pre-CW	7	5.00	6.00	9.00
Pre-CS	7	6.00	8.00	8.00
Post-CW	7	6.00	8.00	10.00
Post-CS	7	5.00	8.00	12.00

Table 13A: Wilcoxon Signed Ranks Test for Auditory Memory Measures

Test	<i>z</i>	<i>p</i>
Word List 1 (WL1)	-.447	.655
Word List 2 (WL2)	-1.261	.207
Word List 3 (WL3)	-.524	.600
Word List 4 (WL4)	-.841	.400
Tasks-Repeat 1 (TR1)	-.756	.450
Tasks-Do 1 (TD1)	-.736	.461
Tasks-Repeat 2 (TR2)	-.135	.893
Tasks-Do 2 (TD2)	-.447	.655
Tasks-Repeat 3 (TR3)	-1.992	.046*
Tasks-Do 3 (TR3)	-.677	.498

*Indicates significant decrease in scores

Table 14A: NPar Tests – Descriptive Statistics for Auditory Memory Measures

		Percentiles		
Test	N	25 th	50 TH	75 TH
Pre-WL1	6	93.75	100.00	100.00
Pre-WL2	6	45.00	55.00	92.50
Pre-WL3	6	46.50	50.00	68.00
Pre-WL4	6	22.50	55.00	68.50
Pre-TR1	6	75.00	100.00	100.00
Pre-TD1	6	80.00	100.00	100.00
Pre-TR2	6	51.75	73.00	100.00
Pre-TD2	6	96.75	100.00	100.00
Pre-TR3	6	53.25	73.00	90.25
Pre-TD3	6	69.75	87.00	100.00
Post-WL1	6	97.50	100.00	100.00
Post-WL2	6	61.25	77.50	100.00
Post-WL3	6	40.50	62.00	70.00
Post-WL4	6	24.75	41.50	50.75
Post-TR1	6	60.00	80.00	100.00
Post-TD1	6	58.25	100.00	100.00
Post-TR2	6	51.50	80.00	90.25
Post-TD2	6	91.75	100.00	100.00
Post-TR3	6	20.25	33.00	53.50
Post-TD3	6	65.25	93.50	100.00

Clinical Comparative Group: Tables 1B-14B

Table 1B: Wilcoxon Signed Ranks Test for Articulation Measures

Test	<i>z</i>	<i>p</i>
Little Bee Speech-Articulation Test Center Pro (Artic)	-.816	.414

Table 2B: NPar Tests – Descriptive Statistics for Articulation Measures

Test	N	Percentiles		
		25 th	50 TH	75 TH
Pre-Artic	8	114.75	118.00	118.00
Post-Artic	8	117.25	118.00	118.00

Table 3B: Wilcoxon Signed Ranks Test for Phonological Awareness Measures

Test	<i>z</i>	<i>p</i>
Rhyming (RHY)	.000	1.000
Segmentation (SEG)	-.351	.726
Isolation (ISO)	-2.058	.040
Deletion (DEL)	.000	1.000
Blending (BLE)	-.680	.496
Phoneme-Grapheme Correspondence (PGC)	-.816 ^b	.414

Table 4B: NPar Tests – Descriptive Statistics for Phonological Awareness Measures

Test	N	Percentiles		
		25 th	50 TH	75 TH
Pre-RHY	8	7.75	11.00	12.00
Pre-SEG	8	8.25	10.00	11.00
Pre-ISO	8	7.00	8.50	10.75
Pre-DEL	8	8.25	10.00	12.00
Pre-BLE	8	7.00	9.50	11.75
Pre-PGC	8	26.00	29.50	31.00
Post-RHY	8	10.00	11.00	11.75
Post-SEG	8	8.00	9.50	11.00
Post-ISO	8	8.25	10.50	12.00
Post-DEL	8	9.00	9.00	11.50
Post-BLE	8	8.00	9.50	11.00
Post-PGC	8	26.75	29.50	30.75

Table 5B: Wilcoxon Signed Ranks Test for Decoding Measures

Test	<i>z</i>	<i>p</i>
Blending (BLE)	-.680	.496
Filtered Words (FW)	-1.018	.309
SSW-Right Competing (SSW-RC)	-.315	.752
Phonemic Synthesis- Qualitative (PS-Qual)	-1.029	.303
Phonemic Synthesis- Quantitative (PS-Quan)	-1.691	.091

Table 6B: NPar Tests – Descriptive Statistics for Decoding Measures

Test	N	Percentiles		
		25 th	50 TH	75 TH
Pre-BLE	8	7.00	9.50	11.75
Pre-FW	9	8.00	8.00	9.00
Pre-SSW-RC	8	4.25	5.50	8.50
Pre-PS-Qual	8	.00	1.00	2.50
Pre-PS-Quan	9	68.00	84.00	88.00
Post-BLE	8	8.00	9.50	11.00
Post-FW	9	7.00	10.00	12.00
Post-SSW-RC	8	1.50	4.50	9.50
Post-PS-Qual	8	.25	2.00	3.75
Post-PS-Quan	9	76.00	88.00	92.00

Table 7B: Wilcoxon Signed Ranks Test for Auditory Figure Ground Measures

Test	<i>z</i>	<i>p</i>
Speech-in-Noise-Right (SIN-R)	-.848	.396
Speech-in-Noise-Left (SIN-L)	-2.254	.024*
SSW-Left Competing (SSW-LC)	-1.357	.175
Auditory Figure Ground (AFG)	.000	1.000

*Indicates significant decrease in scores

Table 8B: NPar Tests – Descriptive Statistics for Auditory Figure Ground Measures

		Percentiles		
Test	N	25 th	50 TH	75 TH
Pre-SIN-R	9	56.00	60.00	78.00
Pre-SIN-L	9	62.00	68.00	70.00
Pre-SSW-LC	8	4.25	12.50	21.75
Pre-AFG	9	5.50	8.00	9.00
Post-SIN-R	9	58.00	72.00	84.00
Post-SIN-L	9	42.00	60.00	68.00
Post-SSW-LC	8	5.00	6.50	19.00
Post-AFG	9	6.50	8.00	9.00

Table 9B: Wilcoxon Signed Ranks Test for Organization Measures

Test	<i>z</i>	<i>p</i>
Competing Words (CW)	-.351	.726
SSW-Reversals (SSW-Rev)	-1.126	.260

Table 10B: NPar Tests – Descriptive Statistics for Organization Measures

		Percentiles		
Test	N	25 th	50 TH	75 TH
Pre-CW	9	7.00	10.00	11.50
Pre-SSW-Rev	8	.50	2.00	10.50
Post-CW	9	8.00	9.00	12.00
Post-SSW-Rev	8	.00	1.00	1.75

Table 11B: Wilcoxon Signed Ranks Test for Integration Measures

Test	<i>z</i>	<i>p</i>
Competing Words (CW)	-.351	.726
Competing Sentences (CS)	-.520	.603

Table 12B: NPar Tests – Descriptive Statistics for Integration Measures

		Percentiles		
Test	N	25 th	50 TH	75 TH
Pre-CW	9	7.00	10.00	11.50
Pre-CS	9	7.00	10.00	11.50
Post-CW	9	8.00	9.00	12.00
Post-CS	9	8.00	10.00	13.50

Table 13B: Wilcoxon Signed Ranks Test for Auditory Memory Measures

Test	<i>z</i>	<i>p</i>
Word List 1 (WL1)	-1.000	.317
Word List 2 (WL2)	-.447	.655
Word List 3 (WL3)	-2.023	.043*
Word List 4 (WL4)	-1.352	.176
Tasks-Repeat 1 (TR1)	-1.000	.317
Tasks-Do 1 (TD1)	-.378	.705
Tasks-Repeat 2 (TR2)	-.378	.705
Tasks-Do 2 (TD2)	.000	1.000
Tasks-Repeat 3 (TR3)	-.135	.892
Tasks-Do 3 (TR3)	-.577	.564

*Indicates significant decrease in scores

Table 14B: NPar Tests – Descriptive Statistics for Auditory Memory Measures

		Percentiles		
Test	N	25 th	50 TH	75 TH
Pre-WL1	8	100.00	100.00	100.00
Pre-WL2	8	100.00	100.00	100.00
Pre-WL3	8	81.00	92.00	96.00
Pre-WL4	8	24.75	48.50	80.00
Pre-TR1	8	100.00	100.00	100.00
Pre-TD1	8	80.00	100.00	100.00
Pre-TR2	8	90.25	100.00	100.00
Pre-TD2	8	100.00	100.00	100.00
Pre-TR3	8	41.75	73.50	87.00
Pre-TD3	8	87.00	100.00	100.00
Post-WL1	8	100.00	100.00	100.00
Post-WL2	8	100.00	100.00	100.00
Post-WL3	8	59.00	87.00	92.00
Post-WL4	8	43.25	61.50	87.00
Post-TR1	8	100.00	100.00	100.00
Post-TD1	8	70.00	100.00	100.00
Post-TR2	8	76.50	100.00	100.00
Post-TD2	8	100.00	100.00	100.00
Post-TR3	8	34.75	56.50	96.75
Post-TD3	8	87.00	100.00	100.00