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

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Abstract

Research demonstrates that competency in the areas of language, literacy, phonological awareness, and auditory processing is vital to academic success in children, as well as in navigating adult life. The study's purpose is to measure the efficacy of an intensive, three-week summer camp therapy program for school-aged children in addressing these areas, and to identify areas of strength and weakness in the program and interventions implemented. Programs utilized during the summer camp included Visualizing and Verbalizing™, Lindamood Phoneme Sequencing®, On Cloud Nine®, Color My Conversation, Differential Processing Training Program™, as well as science experiments, and snack and crafts time.

Purpose: The study aimed to gather empirical and statistical data on the efficacy of the three-week language, literacy, phonological awareness, and auditory processing intervention program that the graduate program of the department of Speech-Language Pathology and Audiology conducts each summer for school-aged children.
Method: A total of 10 children (age 8;0 to 15;9 [years;months]) were enrolled in the program who presented with deficits in one or more of the following areas: language, literacy, phonological awareness, and/or auditory processing. The children received intensive intervention for three hours a day for three weeks. The intervention programs used were Visualizing and Verbalizing™, Lindamood Phoneme Sequencing®, On Cloud Nine®, Color My Conversation, and Differential Processing Training Program™, as well as a craft station, a snack craft station, and a science experiment station.
Results: The participants made statistically significant gains in the areas of social language, literacy, fundamental phonological awareness skills, right ear auditory processing ability, and decoding.
Conclusion: The improvement seen in the areas of significant gain indicate the effectiveness of the Visualizing and Verbalizing™, Lindamood Phoneme Sequencing®, Color My Conversation, and Differential Processing Training Program™ in this intervention program. Significant improvement was not observed in the following areas: auditory memory, auditory organization, age-appropriate phonological awareness skills, and following directions. Retrospective analysis indicates little to no direct intervention in auditory memory and organization. The level of therapy in following directions was not consistently systematic, and the level of therapy in phonological awareness was not skill-appropriate. It is proposed that reducing following directions and phonological awareness tasks to more rudimentary levels with more incrementally defined level shifts would improve therapeutic outcomes.

The areas of language, literacy, phonological awareness, and auditory processing are crucial to the academic success of children. The term "language" encompasses four concepts: expressive language (what is spoken), receptive language (what is heard), written language (reading and writing skills), and pragmatic language (social aspects of language). Children with difficulties in the area of language have a significantly higher risk of social and academic problems not only in school but also leading into young adulthood (Cirrin & Gillam, 2008).

The term "literacy" refers specifically to reading and writing skills. Children struggling with literacy are at risk for poor performance in school as well as the daily functions of life (Coleman et al., 2013).

The term "phonological awareness" refers to a child's "awareness of the sound structure of spoken language." A child who lacks skills in phonological awareness is missing an essential link between spoken and written language, a deficiency which is strongly associated with reading impairment (Gillon, 2000).

The term "auditory processing," also known as central auditory processing, refers to a wide range of abilities and processes that the brain employs when dealing with auditory information. The official definition of (central) auditory processing disorders given by the American Speech-Language and Hearing Association (ASHA) is "difficulties in the processing of auditory information in the central nervous system (CNS) as demonstrated by poor performance in one or more of the following skills: sound localization and lateralization; auditory discrimination; auditory pattern recognition; temporal aspects of audition, including temporal integration, temporal discrimination (e.g., temporal gap detection), temporal ordering, and temporal masking; auditory performance in competing acoustic signals (including dichotic listening); and auditory performance with degraded acoustic signals" (ASHA, 2005a).

Difficulties in the area of auditory processing can lead to or be associated with difficulties in learning, speech, language, attention, social, and related functions (ASHA, 2005a). Three specific areas of auditory processing were assessed in the program: decoding (the ability to take separate sounds and put them together to make something meaningful), integration (the brain's ability to use both hemispheres to complete a task), and tolerance fading memory (the brain's ability to process auditory information in the presence of background noise, and its short-term auditory memory).

Speech-language pathologists serve clients in all of these four areas and rely on evidence-based practice (EBR) to provide effective services. However, there is a relatively small, and in some areas, weak, evidence base of research supporting effective intervention practices. Additional research is needed in order to provide effective intervention for children in these areas, especially in language and auditory processing (Cirrin & Gillam, 2008; Gillon, 2000; Fey et al., 2011; Coleman et al., 2013).

The pursuit of empirical and statistical data leading to evidence-based practice is imperative to the work of speech-language pathologists. According to the position statement on evidence-based practice released by the American Speech-Language Hearing Association in 2005, speech-language pathologists are to apply evidence-based practice (EBP) when making decisions in order to "provide high quality clinical care." This position is in keeping with the Individuals with Disabilities Education Act of 2004 (IDEA) which mandates speech-language pathologists to utilize evidence-based practice in making decisions for patient care. Obtaining empirical and statistical data on how the participants in the summer camp program improve or do not improve enables identification of the parts of the program that prove to be effective interventions and how to improve the program as necessary.

During the school year, services to public school children are made available through the school's speech-language pathologist, however, during the summer, these normal services are not offered. There are two options available during the summer: Extended School Year services and summer camp programs. Communication "summer camps" have grown in popularity greatly and there are now a significant number of camps nationwide including a considerable representation of university communication science disorders departments hosting summer camps each summer. The Department of Speech-language Pathology and Audiology at Andrews University is one of these, and with this special model of service delivery facilitates communication opportunities that ordinarily would not be available to children in typical treatment rooms (The ASHA Leader, 2014). Previous summer camps in 2015 and 2016 at Andrews University have resulted in observed improvement, but this is the first camp in which an exploratory study was conducted where the gathered data was analyzed for statistical significance.

The intervention programs implemented during the camp include Visualizing and Verbalizing™ (V&V), Lindamood Phoneme Sequencing®: 4th Ed. (LiPS), On Cloud Nine®, Color My Conversation: 2nd Ed., and Differential Processing Training Program: Acoustic Tasks™. Science experiments, snack, and craft time were also included.

Tests administered to the participants to gather pre and post-test data include the Lindamood Auditory Conceptualization Test (LAC-3), the Test of Integrated Language & Literacy Skills (TILLS), the Symbol Imagery Test (SIT), and a battery of central auditory processing tests. This battery included the four auditory memory subtests of the Test of Auditory Processing Skills - TAPS-3 (Numbers Forward, Numbers Reversed, Word Memory, and Sentence Memory), the SCAN-C (for participants younger than 12 years) and the SCAN-A (for participants 12 years and older), the Phonemic Synthesis test, the Staggered Spondaic Word Test (SSW), the CID W-22 Speech-in-Noise Test, the Pitch Pattern Sequence Test, and the Dichotic Digits Test.

Our research question for this study was as follows: After the three-week intervention program, will participants show statistically significant improvements in the areas of language, literacy, phonological awareness, and auditory processing as compared to their pre-intervention tests?

Method

Participants

For the current study, a group of twelve children were enrolled in the program through clinical referral and community advertisement. This study does not have a randomized component, and as such presents a quasi-experimental design. IRB approval was obtained through the Office of Research and Creative Scholarship at Andrews University. Each participant and his/her guardian completed consent forms to take part in the study.

Two of the children were unable to be included due to unreliable data collection and incompatibility with the program.

Participant Characteristics

The ten children included in the study consisted of five girls and five boys. They ranged in age from 8;0 to 15;9, with a mean age of 11;7. A majority of the children were White (6/10), the second largest racial/ethnic group was African American (3/10), with one Asian participant. All but three children were paired with another child who was chosen according to perceived compatibility.

Not all of the children in the study displayed impaired skills in all four of the areas. The parents' reported primary concerns for their children included articulation, rate of speech, expressive language, receptive language, pragmatic language, central auditory processing disorder, apraxia, dyslexia, phonemic awareness, and cognitive skills.

Most of the participants' guardians enrolled their children in the intervention program hoping to improve academic success and reading for their children, but without a specific knowledge of language or auditory processing or why their children were having difficulty in school and reading. After completion of the auditory processing pre-testing, it was found that a large number of the participants presented with difficulties in the three areas the auditory processing tested. Participants were said to have a deficit if they presented below age expectations in at least three the test measures. A total of seven out of the ten participants presented with a decoding deficit, eight out of the ten presented with an integration deficit, and eight out of the ten presented with a tolerance fading memory deficit.

Intervention Procedures

The intervention was completed within a three-week time period, for a total of eleven sessions of intensive therapy, with two days of testing. During the three-week period, each child attended a morning program for five days a week for three hours. Each child was assigned a rotation schedule through the eight stations and spent twenty minutes in each of the stations every day. A total of eight graduate clinicians rotated through the eight stations throughout the camp providing the intervention. The eight stations consisted of Visualizing and Verbalizing™ (V&V), Lindamood Phoneme Sequencing® (LiPS), On Cloud Nine®, Color My Conversation, Differential Processing Training Program: Acoustic Tasks™, science experiments, snack craft, and craft time. Table 1 describes the intervention programs.

Table 1: Interventions

Station	Targeted Area	Area(s) of the Camp
V&V™	Developing concept imagery as a basis for comprehension and higher order thinking.	Language, literacy
LiPS®	Developing phonological awareness, decoding, spelling, and reading skills.	Phonological awareness, auditory processing, literacy
On Cloud Nine®	Developing concept imagery and symbol imagery while integrating language to improve both mathematical reasoning and mathematical computation.	Language
Color My Conversation	Developing social awareness, self-regulation, executive function, and meta-cognitive and meta-linguistic skills	Language
Differential Processing™	Training sound awareness for skills in auditory attention and discrimination through dichotic listening, temporal patterning, and auditory discrimination.	Auditory processing
Science Experiment	Developing expressive and receptive language skills, higher order thinking, and vocabulary.	Language, auditory processing
Snack Craft	Developing expressive and receptive language skills, auditory memory, and following directions.	Language, auditory processing,
Craft	Developing expressive and receptive language skills, auditory memory, and following directions.	Language, auditory processing

Visualizing and Verbalizing™

This is a research-validated program produced by Lindamood Bell that has been endorsed by the Council of Administrators of Special Education (CASE). In this program, children were given a picture either of a noun or a story scenario accompanied by a passage read by the graduate clinician. Through the use of structure words (what, where, size, color, etc.) they were taught to describe the picture and answer higher order thinking questions about it using the image they developed in their heads.

LiPS®

This is a research-validated program produced by Lindamood Bell. In this program, children were taught sound-letter associations first through kinesthetically exploring the movement and sensations of their articulators (mouth, lips, tongue), then progressing to the sounds in language, and then finally to associating those movements and sensations with letters. In-depth knowledge of sound letter association helps children develop phonemic awareness and abilities needed for reading and spelling.

On Cloud Nine®

This is a research-validated program produced by Lindamood Bell. In this program, children were taught to use imagery and language to answer mathematical word problems and develop mathematical reasoning.

Color My Conversation

This is a dynamic program that uses colors, movement, and explicit instruction to guide children in how conversation flows. The participants started with basic greeting skills and worked toward more complex conversations.

Differential Processing Training Program: Acoustic Tasks™

This program builds auditory awareness and attention, helping to strengthen a child's overall active listening abilities. The participants wore headphones and were presented with monaural (using one ear) listening, alternating monaural listening, and dichotic (using both ears) listening tasks via a prerecorded audio CD in conditions of steady to variable background noise.

Science Experiment

A different science experiment was conducted each day with the participants, in order to engage them in expressive and receptive language, higher order thinking, and new vocabulary.

Snack Craft

Each day different food items were given to the children with instructions for making an edible craft. This was done in such a way as to encourage expressive and receptive language, auditory memory, following directions, and the use of polite requests.

Craft

Each day the participants were directed in making a craft in such a way as to encourage expressive and receptive language, auditory memory, following directions, and the use of polite requests.

Reinforcement

Children received rewards in each of the stations such as verbal praise or play money that could be redeemed for prizes at the "camp store" for good behavior. The money could be taken away from the children for being uncooperative or for bad behavior. At the end of each day, the children could take their money to the camp store and choose a prize.

Data Collection During the Intervention

Graduate student clinicians collected data during each twenty-minute session in the form of notes organized by subjective data (impressions of the participant's awareness, mood, attention, etc), objective data (measurable percentages of participant performance), assessment of participant skills and performance, and the plan for continuation of therapy (SOAP). SOAP note data for each of the stations were shared at the end of each day of therapy with the graduate clinician in charge of the station the next day and with the supervising clinicians to facilitate the development and appropriate continuation of therapy.

Measurement of Targeted Areas

Test protocol as outlined in the examiner manuals for the SIT, the LAC-3, the TILLS, and the auditory processing test battery was followed. The appropriate equipment (sound-isolated chamber, annually calibrated audiometer) for completing the auditory processing tests were utilized. All testing was completed at 50 dB HL (normal conversational speech level) for both ears. Once administered, the outcome measures were checked for accuracy by a certified supervising clinician. The same graduate clinician/clinical supervisor/participant pairing was preserved in all pre and post-testing in order to maintain test consistency.

Language Measures

Standard scores from five subtests of the TILLS were used for outcome measures: Vocabulary Awareness, Listening Comprehension, Reading Comprehension, Following Directions, and Social Communication.

These subtests were chosen because they evaluate the areas of expressive and receptive language skills specifically addressed by the camp.

The Vocabulary Awareness subtest assessed the participant's "lexical knowledge, awareness of semantic relationships, and cognitive linguistic flexibility."

In this test, the participants were asked to "identify a pair of semantically related words from a triplet of three words, and then switch sets to identify a second semantic pairing."

The Listening Comprehension subtest assessed the participant's ability to "comprehend the complex syntax of academic language and to draw inferences allowed by the text."

In this test, the participants listened to very short stories and answered either "yes," "no," or "maybe" to questions about the story they had just heard.

The Reading Comprehension subtest assessed the participant's "written comprehension in parallel with the Listening Comprehension subtest."

In this test, participants read the stories themselves and answered either "yes," "no," or "maybe" to questions about the story.

The Following Directions subtest assessed the participant's ability to listen to a list of directions, comprehend what he/she needed to do, and hold the directions in short-term memory long enough to carry them out.

In this test, participants were given a series of oral directions to mark a set of graphic symbols on a response form provided to them.

The Social Communication subtest assessed the participant's pragmatic ability to respond appropriately in social contexts.

In this test, a short scene was read to the participants in which a response was requested to describe how the person would react and what they would say.

Literacy Measures

Standard scores from the SIT were used for outcome measures.

The SIT was selected because of its large correlations with measures of word attack, word recognition, spelling, and paragraph-reading fluency and comprehension. It assessed the participant's ability to create mental imagery for the sounds and letters within words.

In this test, the participants were shown and recalled letters in different contexts, listened to and were asked to spell nonwords, and were shown and asked to manipulate one-syllable and multisyllabic nonwords.

The Reading Comprehension subtest standard scores (described above) were also included in measuring literacy.

Phonological Awareness Measures

Raw scores from the four subtests of the LAC-3 as well as the test composite standard scores were used for outcome measures.

The LAC-3 was chosen because of its ability to measure the participant's ability to perceive and conceptualize speech sounds using a visual medium. It also assessed the participant's "cognitive ability to distinguish and manipulate sounds."

In this test, the participants were asked throughout the five subtests to arrange colored felt squares and blocks to visually represent and track the changes in the phoneme and syllable patterns read to them by the graduate clinician.

Auditory Processing Measures
Decoding

Standard scores from two subtests of the SCAN (Competing Words and Filtered Words), quantitative raw scores from the Phonemic Synthesis test, and raw scores from the right competing measure of the SSW test were used as outcome measures.

The Competing Words subtest from the SCAN was used because it assesses ear advantage and the participant's ability to complete a dichotic (using both ears) task in which two different words are presented at the same time, one in each ear. The participant was asked to repeat the two words in a specific order, left ear first, and right ear first during the test.

The Filtered Words subtest from the SCAN was used because it assesses the participant's ability to understand speech that has some acoustic information removed. Speech has redundant information, thus filtering or removing some acoustic information challenges the auditory system to correctly identify words. In this test, the participant listened to a list of filtered words and was asked to repeat the words.

The Phonemic Synthesis test was used because it assesses the participant's ability concerning "discrimination of individual speech sounds, the degree to which they are remembered effectively, and how such sounds are synthesized into words" (Katz & Harman, 1981). This test is a good indicator for decoding deficits. In this test, individual phonemes were presented one at a time (about 1 to 1.5/second) and the participant was asked to say the word that was produced.

The right competing measure of the SSW test was used because significant errors in this category is a strong indicator of difficulty using phonemic information. In this test, the participants were asked to repeat four words, two that were presented in the right ear and two that were presented in the left ear, with the middle two words presented simultaneously.

Integration

Standard scores from two subtests of the SCAN (Competing Sentences and Competing Words), and percentage correct of the left and right ears in the Dichotic Digits test were used as outcome measures.

The Competing Sentences and Competing Words subtests of the SCAN were used because they are useful in determining levels of "auditory maturation and hemispheric dominance in language" at "both simple and more complex linguistic levels of auditory stimuli."

In the Competing Sentences test, two sentences were presented simultaneously, one in the left ear, and one in the right. The participants were asked to ignore the sentence in one ear while repeating the sentence in the other ear and did so for both ears.

The Dichotic Digits test was used because it assesses binaural (both ears) integration skills in asking the participant to process different information being presented to the left and right ears simultaneously.

In this test, four numbers were presented to the participants, two in the left ear, and two in the right ear simultaneously. The participants were asked to repeat the four numbers in any order.

Tolerance Fading Memory

Standard scores from the Auditory Figure Ground subtest of the SCAN, percentage correct from the CID W-22 Speech-in-Noise test, scaled scores from the four auditory memory subtests of the TAPS-3 (Numbers Forward, Numbers Reversed, Word Memory, and Sentence Memory), and raw scores from the left competing measure of the SSW test were used as outcome measures.

The Auditory Figure Ground subtest of the SCAN was used because it assesses the participant's ability to understand words in the presence of background noise (multi-talker speech babble noise at +8 dB signal-to-noise ratio).

In this test, the participants listened to a list of words spoken in the presence of multi-talker background noise and were asked to repeat the words.

The CID W-22 Speech-in-Noise test was used because it assesses the participant's ability to understand words in the presence of static-like background noise.

In this test, the participants listened to a list of words spoken in presence of static-like background noise and were asked to repeat the words.

The four auditory memory subtests of the TAPS-3 (Numbers Forward, Numbers Reversed, Word Memory, and Sentence Memory) were used because they assess the participant's ability to remember and repeat auditory information presented without visual cues.

In these tests, the participants were read increasingly long lists of numbers and were asked to repeat the numbers, to repeat lists of numbers in reverse order, to repeat increasingly long lists of words, and increasingly long sentences. All these subtests were completed in an auditory only format with no visual cues.

The left competing measure of the SSW test was used because significant errors in this category is a strong indicator of difficulty holding auditory information in working memory. In this test, the participants were asked to repeat four words, two that were presented in the right ear and two that were presented in the left ear, with the middle two words presented simultaneously.

Results

SPSS was used to perform a Wilcoxon Signed Ranks Test (two-tailed) on all test measures to compare performance scores before and after intervention to determine whether a significant difference in the pre and post-test scores was present. P scores of less than 0.05 were considered to be statistically significant. This test was used because it was not reasonable to assume normality and equality of variances in the population under study (as would be necessary for parametric tests) due to the small number of subjects used. Median scores are accompanied by a range of average to be used as a frame of reference with all tests that use standard scores. A full listing of the data can be found in the Appendix.

Improvement for the three areas of auditory processing as described in the pie charts was determined if the participant improved his or her scores in at least three of the tests used to measure that area. The overall improvement charts show the improvement over the entire sample of ten participants, while the improvement among participants with deficits charts only displays improvements among participants who presented with deficits in that area of auditory processing.

Language Measures

Five tests were used to measure language, each taken from the TILLS: Vocabulary Awareness, Listening Comprehension, Reading Comprehension, Following Directions, and Social Communication. It was hypothesized that there should be an increase in the participants' language scores following therapy. The Reading Comprehension subtest was statistically significant, $N=10$, $z=-1.98$, $p=.048$. Median score was 4.5 at pretest and 6.5 at posttest, with the range of average being 7 to 13. The Social Communication subtest was statistically significant, $N=10$, $z=-2.11$, $p=.035$. Median score was 4 at pretest and 6 at posttest, with the range of average being 7 to 13. The following measures were not statistically significant: Vocabulary Awareness, Listening Comprehension, and Following Directions.

Literacy Measures

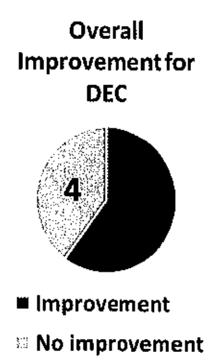
Two tests were used to measure literacy, the SIT and the Reading Comprehension subtest of the TILLS. It was hypothesized that there should be an increase in the participants' literacy scores following therapy. The SIT was statistically significant, $N=10$, $z=-2.10$, $p=.036$. Median score was 92.5 at pretest and 98.5 at posttest, with the range of average being 90 to 110. The Reading Comprehension subtest (described above) was also statistically significant.

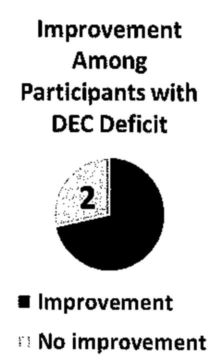
Phonological Awareness Measures

Six tests were used to measure phonological awareness, each taken from the LAC-3: Isolated Phonemes, Tracking Phonemes, Counting Syllables, Tracking Syllables (Multisyllable), Tracking Syllables and Phonemes (Multisyllable), and the Sum of the LAC-3 Standard Scores. It was hypothesized that there should be an increase in the participants' phonological awareness scores following therapy. The Tracking Phonemes subtest was statistically significant, $N=10$, $z=-2.38$, $p=.017$. Median score was 8.5 at pretest and 11 at posttest. The other five measures were not statistically significant.

Decoding (DEC) Measures

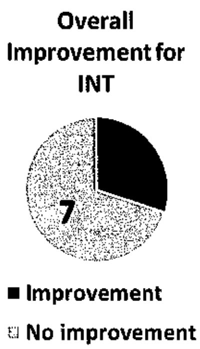
Four tests were used to measure decoding: two subtests of the SCAN (Competing Words and Filtered Words), the Phonemic Synthesis test, and the right competing measure of the SSW test. It was hypothesized that there should be an increase in the participants' decoding scores following therapy. All four tests were statistically significant. Competing Words, $N=10$, $z=-2.20$, $p=.028$. Median score was 4 at pretest and 7 at posttest, with the range of average being 7 to 13. Filtered Words, $N=10$, $z=-2.38$, $p=.017$. Median score was 4.5 at pretest and 7 at posttest with the range of average being 7 to 13. Phonemic Synthesis, $N=10$, $z=-2.69$, $p=.007$. Median score was 18 at pretest and 21.5 at posttest. SSW Test – Right Competing, $N=10$, $z=-2.15$, $p=.031$. Median error score was 6 at pretest and 3 at posttest.

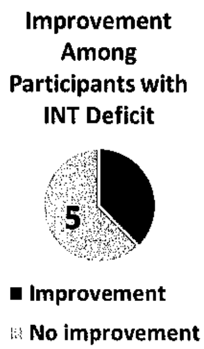




Integration (INT) Measures

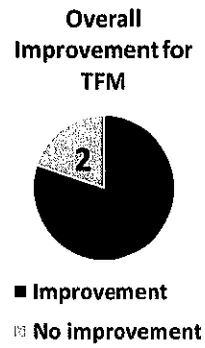
Four tests were used to measure integration: two subtests of the SCAN (Competing Words, and Competing Sentences), and the Dichotic Digits Test for the left and right ears. The Competing Words subtest (described above) was statistically significant. The other three tests were not statistically significant.





Tolerance Fading Memory (TFM) Measures

Eight tests were used to measure tolerance fading memory: the Auditory Figure Ground subtest of the SCAN, the CID W-22 Speech-in-Noise Test for the left and right ears, the four auditory memory subtests of the TAPS (Numbers Forward, Numbers Reversed, Word Memory, and Sentence Memory), and the left competing measure of the Staggered Spondaic Word test. It was hypothesized that there should be an increase in the participants' tolerance fading memory scores following therapy. The Auditory Figure Ground subtest was statistically significant, N=10, z=-1.97, p=.049. Median score was 4.5 at pretest and 6.5 at posttest with the range of average being 7 to 13. The Speech-in-Noise- Left Ear was statistically significant, N=10, z=-2.03, p=.042. Median score was 68% correct at pretest and 74% correct at posttest. The Speech-in-Noise- Right Ear was statistically significant, N=10, z=-2.66, p=.008. Median score was 62% correct at pretest and 76% at posttest. The SSW Test for Left Competing was statistically significant, N=10, z=-1.96, p=.050. Median error score was 12 at pretest and 8 at posttest. None of the TAPS subtests were statistically significant.



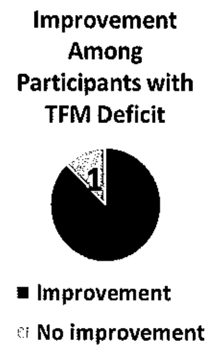


Table 2: Summary of the measures that were statistically significant

Test Measures	z	p
TILLS – Reading Comprehension	-1.980	0.048
TILLS – Social Communication	-2.108	0.035
LAC – Tracking Phonemes	-2.384	0.017
SIT – Sum of Standard Scores	-2.095	0.036
SCAN - Auditory Figure Ground	-1.970	0.049
SCAN – Competing Words	-2.200	0.028
SCAN – Filtered Words	-2.384	0.017
Phonemic Synthesis Test	-2.694	0.007
SSW – Left Competing	-1.963	0.050
SSW – Right Competing	-2.153	0.031
Speech-in-Noise – Left Ear	-2.030	0.042
Speech-in-Noise – Right Ear	-2.661	0.008

Discussion

The statistically significant findings of the present study suggest that the camp was effective in improving scores for children in four areas: literacy, decoding, right ear auditory processing ability, and social communication. The programs utilized during the three weeks of intervention that provide direct intervention in these areas are LiPS®, Visualizing and Verbalizing™, Differential Processing Training Program: Acoustic Tasks™, and Color My Conversation.

It was observed that the majority of test measures that saw statistically significant improvement were the measures for more foundational skills. A surprising number of the population in the study were well below age norms for the fundamental skills necessary for competence in the four areas addressed by the camp (those being decoding ability (specifically phonemic synthesis), tracking phonemes, and right ear auditory processing ability.)

The right ear matures at a faster rate in children than does the left ear. Considerable improvement was noted for right ear ability in the participants, and though improvement was seen in the left ear, it was not as pronounced as the improvement seen in the right. It is unclear as to the reason for this improvement, and further research into this question is needed.

The significant improvement seen in the area of decoding is thought to be from the LiPS therapy that the participants received. It is hypothesized that this improvement is connected to the increase in literacy scores, as decoding is a skill fundamental to the ability to read and write.

Significant improvement was not observed in the following areas: auditory memory, auditory organization, age-appropriate phonological awareness, and following directions. Retrospective analysis indicates little to no direct intervention in auditory memory and organization.

The level of therapy in following directions was not consistently systematic. The graduate students integrated following directions into the snack craft, science experiment, and craft stations. However, the method for having the participants follow directions was not uniform among the student clinicians nor was it systematic. It is proposed that in future camps a systematic method with more discreet shifts in difficulty be used for integrating following directions into therapy.

The phonological awareness skill levels of the participants were much lower than anticipated and did not meet age expectations. Phonological awareness was divided into five different categories during testing, with Tracking Phonemes being the most basic level, and the only place improvement was seen. The level that was addressed in therapy was well below age level. Fundamental skills improved but were not able to reach age-appropriate levels. It is proposed that reducing phonological awareness tasks to more rudimentary levels with more incrementally defined level shifts would improve therapeutic outcomes.

A total of twelve children participated in the summer program, but as there were only eight stations, eight were paired, and the remaining four rotated through the stations individually. These pairings were assigned based off of perceived compatibility at the beginning of the program. Observational data showed that the participants who received individual therapy rather than in pairs showed more improvement. Further research into this concept is needed, as well as a better protocol for determining pairing for the next year's program.

Two of the children, who participated in the camp but not in the study, were determined to be incompatible with the camp based on their needs and the level and purposes of the camp. It was concluded that a screening process should be developed so that children are better matched to the capabilities of the camp.

After reviewing the empirical and statistical data of the 2017 camp, the following changes have been considered for future camps: lowering the age range of participants, focusing on foundational skills, increasing time spent in stations, allowing for more individualized therapy, and elimination of On Cloud Nine®. This last change has been considered because On Cloud Nine® was developed to help children with math skills, and therefore it is recommended to be removed from a program focusing on language, literacy, phonological awareness, and auditory processing.

Audiologists and speech-language pathologists are normally restricted to their specific discipline in conducting research, but this study gave the opportunity most communication professionals are unable to take advantage of in the profession by combining both language and auditory processing testing to bring together a more complete picture of the patients and their needs. Collaboration in the field of communication disorders isn't common, the loss of which affects not only the client in the quality of treatment, but also the clinician in lacking valuable support in more completely addressing the client's needs. It is hoped that this research can encourage an increase in collaborative efforts in both research and treatment of children in speech and language disorders.

Limitations of the Study

Results of this study should be interpreted with caution due to the lack of participant randomization which reduces the study's internal validity. The small number of subjects coupled with the variance in skills and abilities preclude a causal relationship between intervention and participant progress.

The selection of participants was solely based on clients who came to the speech camp, and no control group was established. However, the study gives a realistic representation of the variance of clients in a speech-language pathologist's caseload.

This is a preliminary study, but it is hoped that the implications of this preliminary research can guide future research.

Future Research

This study suggests that there may be an advantage to individual therapy over therapy in pairs or groups. Further research is needed to investigate this concept.

Our study utilized a high intensity service delivery model for therapy which differs greatly from the typical service delivery model of one to two weekly thirty-minute sessions implemented in the school system. Further research is needed to investigate a possible correlation between intensity and frequency and participant improvement.

A unique feature of this study was the collaborative nature of its approach in involving an audiologist as well as speech-language pathologists. More research is needed to explore the benefits of collaborative work between audiologists and speech-language pathologists in treating children with language, literacy, phonological awareness and auditory processing disorders.

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APPENDIX

Table 1: Statistics for Language Measures

Language Measures	z	p
Vocabulary Awareness (VA)	-1.406	0.160
Listening Comprehension (LC)	-1.901	0.057
Reading Comprehension (RC)	-1.980	0.048
Following Directions (FD)	-0.566	0.572
Social Communication (SC)	-2.108	0.035

Table 2: Descriptive Statistics NPar Tests for Language Measures

		Percentiles		
Test	N	25th	50th	75th
Pre-VA	10	2.50	8.00	9.25
Pre-LC	10	0.75	5.50	9.75
Pre-RC	10	1.00	4.50	9.25
Pre-FD	10	3.75	6.00	9.25
Pre-SC	10	0.00	4.00	7.00
Post-VA	10	3.00	7.50	10.25
Post-LC	10	2.75	8.00	11.75
Post-RC	10	2.75	6.50	12.00
Post-FD	10	2.00	5.50	9.50
Post-SC	10	3.00	6.00	10.75

Table 3: Statistics for Literacy Measures

Literacy Measures	z	p
SIT	-2.095	0.036
Reading Comprehension	-1.980	0.048

Table 4: Descriptive Statistics NPar Tests for Literacy Measures

		Percentiles		
Test	N	25th	50th	75th
Pre-SIT	10	79.75	92.50	109.75
Pre-RC	10	1.00	4.50	9.25
Post-SIT	10	89.25	98.50	109.75
Post-RC	10	2.75	6.50	12.00

Table 5: Statistics for Phonological Awareness Measures

Phonological Awareness Measures	z	p
Isolated Phonemes (IP)	-0.954	0.340
Tracking Phonemes (TP)	-2.384	0.017
Counting Syllables (Csyll)	-0.073	0.942
Tracking Syllables (Multisyllable) (TS)	-0.531	0.595
Tracking Syllables and Phonemes (Multisyllable) (TS&P)	-0.378	0.705
Sum of LAC-3 Standard Scores (LAC-Sum)	-1.472	0.141

Table 6: Descriptive Statistics NPar Tests for Phonological Awareness Measures

		Percentiles		
Test	N	25th	50th	75th
Pre-IP	10	12.75	14.00	15.00
Pre-TP	10	8.00	8.50	10.25
Pre-Csyll	10	5.00	7.00	9.00
Pre-TS	10	3.00	4.00	5.75
Pre-TS&P	5	0.00	1.00	6.50
Pre-LAC-Sum	10	76.25	87.00	103.25
Post-IP	10	13.75	14.00	15.25
Post-TP	10	10.00	11.00	13.00
Post-Csyll	10	5.75	6.50	9.25
Post-TS	10	2.75	4.50	5.75
Post-TS&P	5	0.50	2.00	8.00
Post-LAC-Sum	10	82.50	85.50	108.25

The Tracking Syllables and Phonemes test measure has a sample size of five instead of ten because five participants reached a ceiling in testing and did not complete the test.

Table 7: Statistics for Decoding Measures

Decoding Measures	z	p
Competing Words (CW)	-2.200	0.028
Filtered Words (FW)	-2.384	0.017
Phonemic Synthesis (PS)	-2.694	0.007
SSW Test- Right Competing (SSW-RC)	-2.153	0.031

Table 8: Descriptive Statistics NPar Tests for Decoding Measures

		Percentiles		
Test	N	25th	50th	75th
Pre-CW	10	1.75	4.00	9.00
Pre-FW	10	1.00	4.50	8.00
Pre-PS	10	14.50	18.00	22.00
Pre-SSW-RC	10	3.75	6.00	9.00
Post-CW	10	3.25	7.00	10.00
Post-FW	10	4.25	7.00	11.25
Post-PS	10	19.00	21.50	23.50
Post-SSW-RC	10	2.75	3.00	4.25

Table 9: Statistics for Integration Measures

Integration Measures	z	p
Competing Words (CW)	-2.200	0.028
Competing Sentences (CS)	-1.781	0.075
Dichotic Digits- Left Ear (DD-L)	-1.365	0.172
Dichotic Digits- Right Ear (DD-R)	-1.483	0.138

Table 10: Descriptive Statistics NPar Tests for Integration Measures

		Percentiles		
Test	N	25th	50th	75th
Pre-CW	10	3.25	7.00	10.00
Pre-CS	10	4.00	5.50	9.00
Pre-DD-L	10	54.75	68.50	76.50
Pre-DD-R	10	65.75	81.00	89.25
Post-CW	10	1.75	4.00	9.00
Post-CS	10	1.00	3.00	7.25
Post-DD-L	10	58.00	63.50	89.00
Post-DD-R	10	72.75	88.50	90.50

Table 11: Statistics for Tolerance Fading Memory Measures

Tolerance Fading Memory Measures	z	p
Auditory Figure Ground (AFG)	-1.970	0.049
Speech-in-Noise- Left Ear (SN-L)	-2.030	0.042
Speech-in-Noise- Right Ear (SN-R)	-2.661	0.008
TAPS – Numbers Forward (NF)	-0.666	0.506
TAPS – Numbers Reversed (NR)	-1.098	0.272
TAPS – Word Memory (WM)	-0.586	0.558
TAPS – Sentence Memory (SM)	-1.310	0.190
SSW Test- Left Competing (SSW-LC)	-1.963	0.050

Table 12: Descriptive Statistics NPar Tests for Tolerance Fading Memory Measures

		Percentiles		
Test	N	25th	50th	75th
Pre-AFG	10	1.00	4.50	6.25
Pre-SN-L	10	57.00	68.00	74.00
Pre-SN-R	10	56.00	62.00	73.00
Pre-NF	10	4.00	6.50	9.00
Pre-NR	10	4.75	7.50	10.00
Pre-WM	10	5.00	7.00	8.50
Pre-SM	10	3.50	6.00	8.75
Pre-SSW-LC	10	8.75	12.00	15.25
Post-AFG	10	3.25	6.50	8.00
Post-SN-L	10	68.00	74.00	77.00
Post-SN-R	10	71.00	76.00	84.00
Post-NF	10	3.50	6.50	9.50
Post-NR	10	5.25	8.50	10.25
Post-WM	10	5.00	7.50	9.75
Post-SM	10	4.00	6.50	10.50
Post-SSW-LC	10	5.75	8.00	11.75