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Improving Language and Reading Outcomes with A Systematic Technology-Based Approach: Two Cases

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ABSTRACT

Literacy Speaks! is a paper-based hierarchical approach to improving reading fluency and speech intelligibility. However, researchers have demonstrated that incorporating technology into activities improves outcomes for individuals with attention deficits or autism. The purpose of this study was to evaluate the effectiveness of a technology-based systematic approach to improving literacy and speech intelligibility for children with communication disorders. Two children (aged 10 and 13 years) with communication disorders attended twelve 30-minute intervention sessions delivered by a speech-language pathologist and two speech pathology students who all received training in the delivery of the *Literacy Speaks!* program. Observations, as well as changes in selected test performance, were used to measure intervention effectiveness. Although speech intelligibility decreased in both cases, both children improved various skills related to reading and language.Adapting Literacy Speaks! to a technology platform may be an effective language intervention for older children with communication disorders.

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INTRODUCTION

The aim of this investigation was to determine whether a systematic orthographic literacy approach would affect measureable change in speech-language skills of children with communication disorders when instruction and activities were paired with technology. Children with communication disorders have a higher incidence of reading disorders than the general population [1-3]. These problems are often related to poor phonological awareness (i.e., sensitivity to the sound structures of language), hyperlexia (i.e., advanced reading ability paired with poor reading comprehension), or speech sound issues (i.e., articulation errors or active phonological patterns) [1, 4-8]. Literacy Speaks! is a hierarchical program designed to improve reading skills as well as speech intelligibility in preschool and early elementary children with or without communication disorders. This evidence-based approach uses manipulatives (i.e., stimulus cards, books) with activities to systematically target: (1) alphabetic letter recognition, (2) sound-letter correspondence, (3) incorporation of target sounds into words, (4) exposure to sight words, (5) combination of target and sight words into phrases/sentences, (6) target and sight words in books, and (7) carryover of sound and literacy skills [9]..

Evidence suggests this approach increases phonological awareness which, along with rapid automatic naming, is a strong predictor of reading success [10-12]. *Literacy Speaks!* has affected a positive change in speech intelligibility (i.e., how much a listener understands of a child's message) in both research and clinical practice [10-12].

Children with deficits in multiple areas of communication (e.g., speech sounds, language) are often difficult to comprehend [10-13]. *Literacy Speaks!* has been shown to improve language and literacy skills [10-12].

Along with targeting an older population, this investigation replaced many of the technology-free materials used in Literacy Speaks! with targets and items displayed on an iPad. Children with autism or attention deficits demonstrate higher levels of concentration and task completion when technology is involved [14-16].

Before the current investigation, technology had not been paired with Literacy Speaks! in a clinical study. With technology–especially the tablet–becoming ubiquitous within the field of speech-language pathology, this adaptation may have significant ramifications for this particular reading approach.

MATERIALS AND METHODS

This research was approved by the Edinboro University Institutional Review Board. Both participants were recruited from the Governor George Leader Speech and Hearing Center. The children signed assent forms and their respective parents consented to their involvement. Neither children nor parents received compensation for participation.

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Baseline Testing

All testing was completed and analyzed by the first author, a licensed and certified speech-language pathologist. Testing assessed speech sounds (Clinician Assessment of Articulation and Phonology-2nd edition, CAAP-2; Secord & Donohue, 2014), language (Clinical Evaluation of Language Fundamentals-5th edition, CELF-5; Wiig, Semel, & Secord, 2013), reading ability (Gray Oral Reading Test-4th edition, GORT-4; Wiederholt & Bryant, 2001), phonological awareness and rapid naming ability (Comprehensive Test of Phonological Processing, CTOPP; Wagner, Torgesen, & Rashotte, 1999), the presence of childhood apraxia of speech (Screening Test for Developmental Apraxia of Speech, STDAS-2; Blakely, 2001), speech intelligibility, and hearing. Speech intelligibility was assessed informally using a single-word picture identification task since both participants have reading deficits and could not complete a more formal test. Each participant was audio-recorded identifying a series of 32 pictures and an unfamiliar listener—different for each recording—who was also naïve to the task attempted to guess what each child was saying. A ratio of words the listener understood to those he or she did not understand determined the speech intelligibility percentage. It is important to note that these tests do not have specific norms for children with either autism or attention deficits; these assessments were administered to identify the presence or absence of disordered aspects of communication. A summary of test results was given to the family of each participant.

Participant 1: Z, a 10-year-old boy, had diagnoses of attention deficit hyperactivity disorder (ADHD) and childhood apraxia of speech (CAS). CAS is a neurodevelopmental speech disorder in which motor planning is disrupted, resulting in speech production errors as well as in atypical speech rhythm [17]. Conversational speech intelligibility was estimated at less than 50% with unknown context. Z was placed in a special education classroom due to widespread academic difficulties. Pre-testing result descriptors are in Table 1.

Evaluation Tool	Qualitative Result
CELF-5	Severe language disorder
STDAS-2	Very likely
CTOPP: Phonological Awareness	Below average
CTOPP: Phonological Memory	Poor
CTOPP: Rapid Naming	Very poor
GORT-4	Very poor
Single Word Intelligibility	84%
Hearing Screen	Pass

Table 1: Baseline scores for Z.

Testing suggested that Z was a beginning reader with abilities well below those of his peers. The cognitive effort of reading negatively affected Z's comprehension. Phonological awareness (i.e., understanding of the sound structure of words and the ability to manipulate those sounds) was poor.

Speech intelligibility was decreased secondary to CAS. Receptive language (i.e., understanding) was significantly better than expressive language. Intervention goals were selected based on the results of the comprehensive assessment and focused on (1) increasing intelligible and accurate productions, (2) increasing sight word knowledge, (3) improving knowledge of letter-sound correspondence, and (4) decreasing impulsivity by focusing on applying new knowledge.

Participant 2: Q, a 13-year-old boy, had a diagnosis of autism with notable hyperlexia. He was placed in an autism classroom and received services during the school year for speech, language, and pragmatics. Pre-testing result descriptors are in Table 2. Speech intelligibility was significantly affected by active phonological patterns (i.e., predictable pronunciation errors that persist beyond a certain age; Table 3) and numerous sound substitutions and omissions (Table 4).

Evaluation Tool	Qualitative Result
CELF-5	Severe language disorder
STDAS-2	(could not complete)
CTOPP: Phonological Awareness	Very poor
CTOPP: Phonological Memory	Poor
CTOPP: Rapid Naming	Very poor
CAPP-2	Several active processes, sound errors
GORT-4	Very poor
Single Word Intelligibility	35%
Hearing Screen	Pass

Table 2: Baseline scores for Q.

Phonological Pattern	Example
Cluster reduction	*boom for broom*
Syllable reduction	*tephone for telephone*
Fronting	*tat for cat*
Deaffrication	*tew for chew*
Stopping	*doo for zoo*
Epenthesis	*bulack for black*
Postvocalic devoicing	*dok for dog*

Table 3: Active phonological patterns for Q.

Word Position	Error	Example
Initial	/k h/ → /t/	*tot for hot*
Initial	/g n z ʧ ʤ ʃ ð θ/ → /d/	*tdip for nip, ship*
Initial	/f v/ → /b/	*ban for van*
Final	/b f/ → /p/	*pup for puff*
Final	/t k g l n s ɚ ŋ/ → /ʃ/	*cash for cat, can*
Final	/d ʧ ð θ/ → /t/	*breat for breath, breathe*
Final	/z θ ð ʤ/ → /ʒ/	*teezh for teeth, teethe*
Final	/v/ → /b/	*brabe for brave*
Final	/g/ → Ø	*le for leg*

Table 4: Sound substitutions and omissions for Q

Testing confirmed Q's precocious reading ability but impaired reading comprehension. He skipped lines of text when reading and showed no evidence of awareness of this behavior. Q's limited speech sound inventory and multiple active phonological processes contributed to profoundly reduced speech intelligibility. The STDAS-2 could not be administered; Q did not understand the tasks. Goals for the experimental portion of the investigation were derived from test results. Q's intervention focused on (1) increasing vocabulary, (2) improving reading comprehension, and (3) intelligible and accurate productions of initial phonemes.

Intervention

The research team completed training in the delivery of the Literacy Speaks! program. A speech pathology student was assigned to work with each child under the direct supervision of the speech-language pathologist. The speech-language pathologist, who was known to both participants, delivered sessions in the assigned student's absence.

Each participant was seen for twelve 30-minute sessions over three weeks. Each session resumed where the previous one left off and systematically addressed selected phonemes. All letters, words, phrases, sentences and books were shown on an iPad running PowerPoint. Due to Q's complex speech sound issues, his intervention only addressed word-initial phonemes. Z, however, addressed sounds at the beginning as well as at the end of words. The procedure for each phoneme was as follows:respondents reported they would be more likely than not to attend to a seminar addressing special considerations

- ***Sound/letter in isolation:*** Showed the participant the printed representation (e.g., c C k K) of the phoneme (e.g., /k/). Once probes were >50% accurate on this or subsequent levels, the researchers moved on to the next level of complexity.

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• ***Target sounds in words:*** The participant was required to locate the target letter in a text (e.g., c ow). At this level, the participant practiced the phonological awareness skills of blending and segmenting. A picture representing the target word (e.g., color drawing of a cow) was introduced to ensure the participant's knowledge of the written word (e.g., cow) coincided with its phonological conception.

• ***Target word in phrases:*** Sight words (e.g., want, my) were introduced at this level and the participants practiced reading two-word combinations (e.g., want + cow).

• ***Target word in sentences***: Participants read sight words, words learned during different phoneme cycles, and punctuation that were combined to form short sentences (e.g., Would you like this cow?).

• ***Target word in short e-books:*** As multiple readings promote fluent reading, each participant read the phoneme-specific five-page booklet with the researcher, alone with support as needed, and then independently as possible.

Although intervention procedures were generally the same for each participant, there were some adjustments made to the protocol for each child in order to individualize application of the Literacy Speaks! program to maximize outcomes.

Participant 1 intervention: Although Z's single word speech intelligibility was relatively high, listener comprehension decreased when the child produced several words together. In order to target this as well as his inconsistent vowels, Z was required to produce each single word five times in succession and each two-word phrase twice in a row. The researcher gave Z feedback related to accuracy (i.e., knowledge of results) or articulator sequencing and production (i.e., knowledge of performance) and asked for additional productions.

Z guessed each time he read a sight word. After session four, the family was given a small notebook that contained 30 sight words. The family was asked to spend a few minutes each day reviewing these flashcards with Z.

To target improved letter-sound correspondence, Z was asked to sound out words at each level of the protocol. He also traced and then wrote the letters associated with a specific phoneme.

Premack's principle (i.e., perform a less desirable activity in order to get to a more desirable one) was applied to keep sessions productive. Z was highly motivated by a particular game downloaded on the iPad and worked through a level or two with a phoneme in order to earn the reward of approximately two minutes of play. When asked to read a phrase, sentence, or book, Z was reminded to wait and think before speaking in order to address impulsivity.

Participant 2 intervention: The researcher wrote out comprehension questions for each e-book; this cognitive strategy is one used for children with autism whose ability to decode is greater than their understanding [18, 19]. During early sessions, Q was given two answer choices. Later on, he was offered four choices. Q was asked to read the question and options aloud and then circle the correct answer with a pen. Some of the questions were concrete and could be answered based on a given picture or information in the sentence. This was used to ensure comprehension of new vocabulary (e.g., What is an iris? A leaf? A flower? A penguin?). Other questions were more abstract and required inference to answer correctly. The majority of questions were based on comprehension of a single page of text, but a few questions during the last two days of intervention asked about the story as a whole. Once it became clear that Q had difficulty with prepositions, many questions required recognition and then generation of an appropriate spatial term (e.g., beside).

Q was given placement cues (e.g., put your top teeth on your bottom lip) as well as visual models and asked to repeat inaccurate and unintelligible productions using this feedback. Due to Q's limited sound inventory, some phonemes were novel and required shaping from other phonemes or even direct manipulation of his articulators by the researchers.

It is also important to note that due to Q's high-level decoding ability, his family was not given sight words to review daily.

Post-experimental Testing

After the final 30-minute session, targeted informal testing was completed with each participant. Essentially, several test questions from a subtest or assessment tool were given in isolation to determine whether there was any change in performance on tasks. Whenever possible, tasks were given on the iPad in order to add visual support. Each participant circled answers manually.

Participant 1 post-testing: Reading fluency was identified as an area of need for Z so portions of the GORT-4 were readministered. Story 1 was completed without errors. Story 2, which Z did not attempt during pre-testing, was completed with the researcher helping read three words. Single-word intelligibility was reassessed and calculated to be 79%. Although this was a decrease from pre-testing, this was considered an improvement as Z actually attempted to read the words presented instead of relying on the accompanying pictures. Z was asked to complete several tasks aimed at assessing apraxia of speech. During the repetition of multisyllabic words, there were inconsistent vowels, but Z independently attempted to self-correct by slowing repeated productions. This resulted in more accurate utterances that were unnaturally slow. Finally, selected subtests of the CELF-5 were administered. Specifically, tasks required Z to understand relationships between words (e.g., make comparisons) and to build grammatically correct sentences given individual components. Z answered all of these questions accurately.

Participant 2 post-testing: The GORT-4 (two passages) was readministered to assess reading comprehension. Q skipped neither words nor lines of text. Comprehension scores on the two passages (40% and 60% correct, respectively) improved from baseline. Single-word speech intelligibility was determined to be 23%. Again this was a decline from initial measurement and attributed to an unidentified apraxia interfering with the known speech sound disorder. A series of tasks (e.g., nonspeech directives, word repetitions) were given to attempt to screen for the presence of an apraxia. Q had difficulty completing approximately 20% of the tasks. The specific challenges suggested a possible oral or ideomotor apraxia. Oral apraxia prevents an individual from moving one's face (e.g., pucker your lips) on demand. Ideomotor apraxia is the result of automatic-voluntary dissociation and prevents individuals from purposefully miming tool use (e.g., pretend to brush your hair). Neither oral nor ideomotor apraxia should have any effect on speech production. Parts of the CELF-5 were readministered. Q understood relationships among items with 88% accuracy and followed directions with 60% accuracy. Despite the visual support and rewriting test sentences to reflect material of high personal interest, Q could not complete the section on sentence repetition.

Despite the brief nature of this intervention using Literacy Speaks!, both participants demonstrated positive changes in speech and language skills. Although the comprehensive assessment was not repeated such that statistical analyses might compare pre- and post-testing quantitatively, targeted probes, as well as researcher observation, suggest a hierarchical intervention may be effective. At the conclusion of the intervention and testing, each family was given hard copies of the books read during individual sessions. Families were also provided with short summaries of intervention as well as observations about changes that resulted from participation in this study.

Participant 1 outcomes: Although his family was not compliant with reviewing sight words, practicing these difficult-to-decode words frequently during sessions resulted in a more fluent reading. By the end of the intervention, Z was attempting to sound out words instead of guessing and remaining guesses were more logical and based on context. Z was also self-correcting his reading at a high rate. He was still having trouble decoding words with similar-looking letters (i.e., p, b, d), but was using other strategies (i.e., self-correction, context) more effectively. Z was also expressing positive thoughts about reading in general.

Participant 2 outcomes: At the end of the investigation, Q was answering both concrete and abstract questions by selecting an answer from a field of four. He was also using new vocabulary words immediately after acquiring them. And although speech intelligibility did not measurably improve across the intervention, Q allowed researchers to attempt sound elicitation where he had not done so before. In isolation and with heavy support several phonemes were added to Q's sound inventory.

CONCLUSION

Literacy Speaks! systematically moves children from producing sounds to associating these with letters and then builds on reading skills from the bottom (e.g., blending sounds to form a word) to the top (i.e., decoding short paragraphs). Within this system, however, it remains possible for a speech-language pathologist, reading specialist, or special education teacher to target specific areas of need related to speech and language. For children with autism or behaviors associated with autism, the hierarchy of Literacy Speaks! provides a predictable structure that can still be tailored to contain highly interesting or motivating content for the individual. Technology can be successfully integrated into Literacy Speaks! to improve outcomes for children with autism or attention problems. These specific cases also suggest that this systematic approach is effective for late elementary and middle school children with communication disorders.

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REFERENCES

1. Anthony JL, Aghara RG, Dunkelberger MJ, Anthony TI, Williams JM, et al. What factors place children with speech sound disorders at risk for reading problems? Am J Speech Lang Pathol. 2011; 20: 146-160.

2. Ricketts J. Research review: reading comprehension in developmental disorders of language and communication. J Child Psychol Psychiatry. 2011; 52: 1111-1123.

3. Snowling MJ, Hulme C. Annual research review: the nature and classification of reading disorders–a commentary on proposals for DSM-5. J Child Psychol Psychiatry. 2011; 53: 593-607.

4. Brown HM, Oram-Cardy J, Johnson A. A meta-analysis of the reading comprehension skills of individuals on the autism spectrum. J Autism Dev Disord. 2013; 43: 932-955.

5. Cardoso-Martins C, Ribeiro da Silva J. Cognitive and language correlates of hyperlexia: evidence from children with autism spectrum disorders. Read Writ. 2010; 23: 129-145.

6. Lin CS. Early language learning profiles of young children with autism: hyperlexia and its subtypes. Res Autism Spectr Disord. 2014; 8: 168-177.

7. Rvachew S. Phonological processing and reading in children with speech sound disorders. Am J Speech Lang Pathol. 2007; 16: 260-270.

8. Saygin ZM, Norton ES, Osher DE, Beach SD, Cyr AB, et al. Tracking the roots of reading ability: white matter volume and integrity correlate with phonological awareness in prereading and early-reading kindergarten children. J Neurosci. 2013; 33: 13251-13258.

9. Richmond K. Literacy Speaks! 2009.

10. Richmond K. Autism spectrum disorders: building speech and literacy skills with orthographic instruction! Annual Conference of Pennsylvania Speech-Language-Hearing Association. 2014 April. Pittsburgh, PA.

11. Richmond K. Improve speech intelligibility and establish literacy skills simultaneously! Annual Conference of Pennsylvania Speech-Language-Hearing Association. 2014 April. Pittsburgh, PA.

Cite as: Raupp SL, Markley B. Improving Language and Reading Outcomes with A Systematic Technology- Based Approach: Two Cases. J Commun Disorder Assist Technol. 2017; 1: 1-10.

12. Spencer H. 5 year old with Lowe syndrome and Literacy Speaks! program [PowerPoint slides]. 2010.

13. Hustad KC. Speech intelligibility in children with speech disorders. Perspect Lang Learn Educ. 2001; 19: 7-11.

14. Lee A, Lang R, Davenport K, Moore M, Rispoli M, et al. Comparison of therapist implemented and iPad-assisted interventions for children with autism. Dev Neurorehabil. 2013; 18: 97-103.

15. McClanahan B, Williams K, Kennedy E, Tate S. A breakthrough for Josh: how use of an iPad facilitate reading improvement. TechTrends. 2012; 56: 20-28.

16. Neely L, Rispoli M, Camargo S, Davis H, Boles M. The effect of instructional use of an iPad on challenging behavior and academic engagement for two students with autism. Res Autism Spectr Disord. 2013; 7: 509-516.

17. American Speech-Language-Hearing Association. Childhood apraxia of speech [Technical report]. 2007; 1-74.

18. Senokossoff GW. Developing reading comprehension skills in high-functioning children with autism spectrum disorder: a review of the research, 1990-2012. Read Writ Quart. 2015; 32: 223-246.

19. Finnegan E, Mazin AL. Strategies for increasing reading comprehension skills in students with autism spectrum disorder: a review of the literature. Educ Treat Children. 2016; 39: 187-219.