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# EFFECTS OF DYNAMIC TEXT AND SPEECH OUTPUT IN A GRAPHIC BASED AUGMENTATIVE AND ALTERNATIVE COMMUNICATION APP ON SUPPORTING THE TRANSITION TO LITERACY FOR INDIVIDUALS WITH AUTISM SPECTRUM DISORDER

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# ABSTRACT

The purpose of the study was to investigate the effects of the Transition to Literacy (T2L) software features within an augmentative and alternative communication (AAC) app on sight word reading abilities of individuals with Autism Spectrum Disorder (ASD) and complex communication needs. A single subject multiple probe design was used with one participant. After baseline was established, the participant was exposed to the intervention that introduced the AAC app with the T2L features in a structured task. The participant showed increased accuracy in identifying the twelve targeted, personally meaningful sight words. The results of this study show preliminary evidence that redesigning AAC apps to include dynamic text combined with speech output after selecting a graphic symbol on a grid-based AAC app can improve the sight word reading skills of the participants in a structured task. The T2L features on redesigned AAC apps should be used in conjunction with literacy instruction and serve as a potential way to infuse literacy development into daily communication.

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# Chapter 1

## Introduction

Communication is a right that all people should have the power to access. Humans communicate constantly simply through body language and gestures. For some people, a communication disability inhibits this natural right. Autism Spectrum Disorder (ASD) is a developmental disability that affects ones' ability to communicate and interact socially with others (Copeland, 2018).

ASD diagnosis divides behaviors into two classifications. One category of behaviors is restricted and repetitive behavior (American Psychiatric Association, 2013). Examples include circumscribed interests, unusual preoccupations and attachment to objects, and hypo or hyper sensitivity. The other category is social interaction and communication, which includes reduced production of social cues, reduced interest and engagement in social interactions, reduced performance of communication acts, reliance on formulas and unusual usage patterns, and reduced attention to voice. Reduced attention to voice is one of the earliest signs that a child may have ASD (American Psychiatric Association, 2013). Communication deficits impact both speech and nonverbal communication (Copeland, 2018). Regarding spoken communication, 30-50% of individuals with ASD do not develop functional speech (Shane et al., 2015). Nonverbal communication refers to gestures, eye contact, facial expressions, and body language. For people with ASD, there is a reduction in gesture use and eye contact, which are predictive of communication development and word use (American Psychiatric Association, 2013). These

challenges have negative implications on learning outcomes. As a result of delayed speech and language development, educational outcomes tend to differ. For example, educators tend to not focus on literacy development, with the view that this is not a functional life skill (Ruppar, 2017). All individuals, including individuals with ASD who have limited speech, should have a way to participate in a variety of educational and leisure activities. Yet, without appropriate supports, these individuals are at risk for reduced educational instruction, which inhibits future educational progress and opportunities in adulthood (Browder, Wakeman, Spooner, Ahlgrim-Delzell, & Algozzine, 2006).

**Augmentative and Alternative Communication and ASD**

Augmentative and alternative communication (AAC) can be used to support individuals with ASD; research demonstrates AAC has positively impacted communication (e.g. requesting), social interaction (e.g., turn tasking), and decreasing challenging behaviors (Ganz, 2015). AAC supports can range from low-tech (e.g., printed photographs of preferred items), mid-tech (e.g., simple digitized output devices), and high-tech (e.g., iPads with AAC applications) (Reichle, Ganz, Drager, & Parker-McGowan, 2016). High-tech AAC systems allow for certain benefits over low- and mid-tech counterparts that may be important to individuals with ASD (Ganz, 2015). For example, access to more vocabulary, use of on-board camera, and a range of organization options. Additionally, individuals with ASD who require AAC often select high-tech devices when offered choices among speech-generating devices, low-tech exchange-based systems, or manual sign language (Ganz, 2015).

The goal of AAC intervention is to assist individuals in maximizing their effective and efficient participation in a variety of activities (Reichle, Ganz, Drager, & Parker-McGowan, 2016). The main activity for young children in their formative years in engagement is education and educational related activities (e.g., playing with friend at or after school). Participation in the classroom is beneficial for instruction outcomes. The inability to produce intelligible speech negatively impacts participation in education including literacy instruction. The lack of functional speech results in lower engagement in the classroom and or a lack of adapted instruction (Caron, 2016). Changes in federal policy have created an emphasis on teaching academic content to all students, including those with severe disabilities, some of whom require AAC to communicate and participate (Whalon & Hart, 2011). Therefore, instruction must be adapted to these students so that they can be involved and progress in the general curriculum.

**Literacy for individuals with ASD who use AAC**

As the number of children with ASD continue to rise, and continue to be included within special education and inclusive environments, there is an urgent need to find ways to support the acquisition of literacy skills. Teaching literacy skills is the single most important thing we can do for individuals who use AAC (Lindsay, 1989). Yet for individuals with ASD and CCN, this skill is even more important. Access to literacy opens doors in terms of communication, allowing the individual to generate their own thoughts, as well as text-based AAC options (e.g., texting, social media, emailing, and orthographic-based AAC systems).

Unfortunately, over 90% of individuals who use AAC do not acquire functional literacy skills upon graduation from high school (Foley & Wolter, 2010). A number of factors could be

contributing to the poor outcomes including: (1) preconceived notions of readiness to succeed in learning literacy hinders individuals' progress from becoming literate (Browder & Xin, 1998); (2) lack of effective tools for learning (Koppenhaver, Evans, & Yoder, 1991), and (3) lack of teachers and related service providers trained to teach these individuals (Caron, Light, Holyfield, & McNaughton, 2018).

**Sight Words.**

A number of skills are required to become a reader and single word reading, or sight word reading, is a key early literacy skill (Caron, 2016; Mandak, Light, & McNaughton, 2018). If individuals fail at reading single words, they cannot comprehend or read connected text (Mandak et al., 2018); research indicates that individuals with ASD have poorly developed single word/sight word recognition skills (Nation, Clarke, Wright, & Williams, 2006).

Sight word instruction utilizes word recognition skills. Rather than learning the letters and sounds of a word, the student is taught to focus on the letters of the word and associate it with what it is referring to by sight. Through instruction, the text of the word now has meaning, and the individual can now read the word (Mandak et al., 2018). Sight word reading gives people the ability to complete functional tasks, and instills confidence in individuals around literacy that increases their motivation to learn (Caron et al., 2018). The initial sight words taught to individuals with ASD are predominantly functional words (e.g., safety words, food words) (Fossett & Mirenda, 2006). Other words taught include non-decodable words (i.e. the, has) that tend to be taught through memorization (Caron et al., 2018). There are different techniques to sight word instruction, some of which have been found to be more effective than

others. For example, stimulus fading and picture-to-text matching are two instructional practices that have been found effective (Baker, Rivera, Devine, & Mason, 2019; Fossett & Mirenda, 2006). Stimulus fading uses the unknown words with the familiar pictures. Slowly the pictures are removed to focus the learners' attention on the text only (Fossett & Mirenda, 2006). In one study, the students learned the words the fastest in the text-only condition, after the pictures were faded out (Richardson et al., 2017). Picture-to-text matching strategies enable learners to match new words with their pictures without requiring functional speech (Fossett & Mirenda, 2006). This form of instruction unpairs text from pictures and has learners actively use the pictures to match to the sight words. The active learning strategy involved in this technique can effectively teach sight words and has resulted in generalization skills to novel words (Fossett & Mirenda, 2006). In addition, some students have acquired sight words faster when presented with text and verbalizations of words (Richardson et al., 2017).

### AAC system and literacy.

AAC systems may allow for these various combinations of techniques and support literacy learning. The AAC systems have potential to support not only communication, but the literacy process as well, with minor design changes. Currently, AAC devices use graphic symbols, or photographs and line drawings, and pair them with text in a static way. Grid displays will commonly have the symbol and paired text in the same box, with a message bar at the top of the display. When a symbol is selected, the text is added to the message bar, which is apart from the symbol. Because of the static text pairing within the grid, or the text being displaced from the icon in the message bar, the majority of individuals who use AAC are not

learning these words in their orthographic form; the individual is focusing on the symbol rather than the text (Fossett & Mirenda, 2006).

Light, McNaughton, Jakobs, and Hershberger (2014) proposed incorporating transition to literacy (T2L) features into AAC technologies. The T2L feature draws upon theory and research to support language and literacy learning though the use of AAC and includes the following:

> (a) presentation of dynamic animated text upon selection of the graphic symbol using motion to draw visual attention to the text (cf. Jagaroo & Wilkinson, 2008) and to support orthographic processing; (b) origination of the text from the graphic symbol to support the association of the symbol and the text and thereby support understanding of the meaning of the text; (c) replacement of the graphic symbol by the text to make the word salient and mitigate the difficulties that may arise from static pairing of graphic symbols and text; (d) pairing of the speech output with the appearance of the written word on the screen to support phonological processing of the text; and, (e) targeting of sight words for the symbols within the learner's AAC system to ensure that concepts are known thus supporting the association of meaning with the text. The broad context provided by the AAC display and the communication situation may also support learning. The exposure to text is infused into the individual's AAC system, thus ensuring that literacy learning is driven by the individual's interests and needs (Light & McNaughton, 2013; Light et al., 2014).

In a study by Caron and colleagues (2018), five participants with ASD demonstrated increased accuracy reading twelve sight words through exposure to T2L software features (i.e., presentation of dynamic text and speech output upon symbol selection) during a structured matching task. These participants, who were described as minimally verbal with some literacy

skills (e.g., could not decode, yet were able to identify sight words), were also able to transition from a 15 location graphics-based grid display, to a 15 location text-only grid display during generalization tasks (Caron et al., 2018). Similarly, Mandak and colleagues (2018) found that young children with ASD were able to acquire ten sight words through book reading using T2L features within an AAC app that utilized visual scene displays.

This study extends previous research to a different population. The individuals in the larger study (including the participant that is the focus of this study) all have severe ASD, very limited literacy skills (less than 15 sight words), and complex communication needs requiring the use of AAC. More specifically, the research questions are: (1) what effect an AAC app with the T2L feature on sight word acquisition for individuals with ASD and CCN?; (2) are the effects of the application generalized to different graphic icons; (3) are the effects maintained after exposure to the app with the T2L feature is terminated? It was hypothesized that the dynamic text paired with speech output would effectively support the acquisition, generalization, and maintenance of sight word reading, of twelve sight words, by individuals with severe ASD and CCN.

# Chapter 2

# Method

## Research Design

This study implemented a single-subject multiple-probe, across-word set design. It is important to note that this paper reports on results from one participant from a larger study (Caron et al., 2018). The larger study included four participants with ASD. The independent variable for the study was the exposure to an AAC app with transition to literacy (T2L) software features (i.e., dynamic text and speech output upon selection of a graphic symbol). The dependent variable measured the student's accuracy of reading twelve personally relevant, high interest words (four words across three word sets). The dependent variable was the percentage correct during the sight word reading probes (i.e., the number of correctly identified sight words when presented with four graphic symbols, across eight trials - each word probed twice). The dependent variable was measured before, during, and after treatment to determine the changes in behavior. The study had four phases: (1) baseline, (2) intervention with the T2L feature on an AAC app, (3) generalization, and (4) maintenance.

## Participant

Individuals with ASD were recruited from schools in central Pennsylvania by accepting recommendations from teachers and speech language pathologists who worked with individuals

with ASD and complex communication needs. Eligibility criteria included: (1) had an ASD diagnosis based on the DSM-V criteria, confirmed through assessment with the Childhood Autism Rating Scale Second Edition, CARS-2 (Schopler, Van Bourgondien, Wellman, & Love 2010), (2) were 5-21 years old, (3) speech did not meet all daily communication needs, (4) followed one step directions, (5) communicated symbolically with a minimum of ten spoken words, signs, or graphic symbols, (6) lived in households which English was the primary language, (7) hearing and vision were unimpaired or corrected per teacher or parent report, (8) had limited literacy skills, including inability to decode**.**

The participant, Nick, was 19 years old and had an ASD diagnosis. Though being diagnosed with a cortical vision impairment, Nick had functional vision according to a vision specialist's report. He participated in a special-education classroom with a 1:1 aide throughout the day. Nick's communication consisted of predominantly physical communication and vocalizations of open vowel sounds. Per teacher report, he had knowledge of twelve letter sound correspondence and could read three sight words (i.e. see, blue, red). Nick had no decoding skills and was unable to read connected text. He had challenging behaviors which impacted his learning, according to his teacher.

**Table 1. Summary of demographic information for participant**

| **Participant** | |
|---|---|
| *Age* | 19 years old |
| *Gender* | Male |
| *Disability* | ASD |
| *Instruction Setting* | Substantially separate Autism Support classroom with a 1:1 aide |
| *Expressive Language* | No functional speech<br>Vocalizations |
| *Literacy* | 3 sight words<br>12 letter-sound correspondence<br>Not decoding<br>Not reading connected text |

## Materials

**Target Words.** The twelve target words used were chosen for their personal relevance to Nick and if they were common requests. The researcher interviewed the family and teacher, and together created a word list. The words chosen were high interest, meaningful, commonly said, and were in the participant's AAC device. The twelve target words were divided into three sets with four words per set. Each set was introduced separately, beginning with Set 1. All of the words introduced were presented in lowercase letters. The target words in each set are listed in Table 2.

**Table 2. Word Lists, for sight word instruction**

| Sight Word Set 1 | Sight Word Set 2 | Sight Word Set 3 |
|---|---|---|
| almonds | bird | scooter |
| crackers | read | help |
| swim | run | computer |
| stop | gym | horse |

**Probe Materials:** During all phases of the study, probes were conducted regularly to evaluate the participant's accuracy in reading the twelve words. The target words were individually printed on laminated text cards. A 2"X 2" graphic symbol for each of the words was provided from screenshots of the AAC app.

**Intervention Materials:** Materials used in the intervention included an app, AAC technology, and nine 12-page books created on Microsoft PowerPoint. Three books were created for each set of four words. Each book represented a target word three times. One book included the graphic representations (i.e. Symbolstix icons) found on the device with one symbol per page, acting as a direct match. The second book contained a photograph of the target sight word. The third book combined photographs with a character of interest to the participant.

**AAC Technology:** The T2L software was used on a 12.2 -inch LCD Samsung Galaxy Tablet®[4] on the NOVA Chat 12 device.

***AAC application with T2L software features.*** The T2L software features to support sight word learning was conceptualized by Light et al. (2014) to provide a first step in the transition to text from graphics-based AAC technologies/apps for individuals with complex communication needs with limited literacy skills. The T2L feature includes (Caron et al., 2018):

> Selection of a graphic symbol from the AAC grid display, enabling a dynamic presentation of text, resulting in the replacement of the graphic symbols on the screen with the written text for 3s and pairing of the text with speech output before the text shrunk back into the graphic symbol and disappeared (see Figure 1 and see a video demonstration at https://rerc-aac.psu.edu/research/r2-investigating-aac-technologies-to-support-the-transition-from-graphic-symbols-to-literacy/). The dynamic presentation took the traditionally static presentation of the written word and applied smooth movement (i.e., animation) in order to attract the learner's visual attention to the text (cf. Jagaroo & Wilkinson, 2008), thus potentially supporting orthographic processing of the written word. In addition, the text was paired with speech output upon selection of the graphic symbol, thus potentially supporting phonological processing of the word.


**Figure 1.** Example of the T2L feature. In the image on the left, the words are presented with a static text and graphic symbol pairing. In the middle, the T2L feature has been activated and the text is dynamically appearing on the screen. The image on the right depicts the replacement of

the grid display by the orthographic representation for the target word. The word appears on the screen for three seconds and then shrinks back into the graphic representation.

## Procedure

Each session occurred for 15-30 minutes, in Nick's classroom, and were conducted by the first author of the larger study (J. Caron). Three to five sessions occurred per week. Depending on Nick's schedule, two sessions could have occurred in the same day with a 30-minute break between sessions. The four phases of the study included baseline, intervention, generalization and maintenance.

**Prior to baseline: training the graphic icons**. Before baseline began, Nick was trained to recognize the graphic symbols that would be used in the study. The accuracy in identifying the symbols was assessed by prompting Nick to match the symbols in a book with the symbol on the AAC device. He needed to identify graphic symbols with a minimum of 90% accuracy over two consecutive sessions before beginning baseline.

**Baseline.** Three probes, one per word set, were conducted on the same day in order to establish the first baseline points of each set. Subsequently, a minimum of five baseline data points were collected per word set, prior to the introduction of intervention. Upon establishment of a stable baseline (i.e., two consecutive sessions with no increasing slope), intervention began with the set, starting with Set 1, while Set 2 and Set 3 remained in baseline (procedures then followed in the same manner for starting intervention with Set 2 and 3).

The probe included the presentation of four graphic symbols and one word (text card). The researcher instructed the participant to, "look at the pictures, read the word, give me the picture that matched the word." The researcher modeled the task for each word set two times by

using non-targeted words. No feedback was provided during the probe. Correct and incorrect responses were recorded on a data sheet, to get a session score out of 8.

**Intervention.** After establishing a baseline, Nick was introduced to the AAC device with T2L features. The device included a grid display of all twelve target sight words during intervention. The only words that had the T2L feature (i.e. dynamic text) activated were the four words within the set that they were working on. Each progressive set had four more words activated. In Set 1, four words were activated. In Set 2, eight words were activated. In Set 3, all twelve words were activated. Each intervention included two parts: (a) a probe to assess the student's accuracy reading the target words, and (b) using the T2L feature on the AAC app to support sight word learning.

*Probes.* Probes started each intervention session to measure the individual's accuracy reading the target words. The procedure for the probes in intervention were the same as the baseline procedure. Intervention ended once the criterion was attained. Criterion was met if the student got 6 out 8, or a minimum of 75%, trials correct over three consecutive sessions.

*T2L features in AAC App.* The AAC app with T2L features was introduced during the intervention session after the probe was completed. Two words that were not target words were first modeled by the researcher. The researcher would say a word and then touch the target word on the device. When the dynamic text appeared, the researcher would underline the word and read it out loud. After two models, the participant would act independently. Each target word had to be activated twice. If Nick took longer than three seconds to activate the appropriate target word, the researcher would activate it, but provided no feedback.

Nick matched the Symbolstix icon in the book with the graphic representation on the device. When he selected the graphic symbol from the AAC system, the T2L feature was

activated if the word was targeted within the set. Dynamic text appeared from the graphic icon, staying on the screen for three seconds, as the text was paired with speech output and then the text disappeared. The researcher instructed Nick to select the symbol from the grid display again to elicit the dynamic text and speech output for two sequential exposures. No feedback was provided to him. After selecting the graphic symbol twice, this process was repeated totaling to four exposures per each symbol or target word, three times for a combined twelve exposures to the dynamic text and speech output for each intervention session.

**Generalization.** Generalization data was collected concurrently during baseline and after the intervention phase. Generalization was determined by using different representations through photographs instead of graphic symbols. Data was collected by presenting the participant with four photographs and one text card, rather than four Symbolstix icons and one text card. The varied representations ensured that the participant was understanding the word and was not making a single direct match (i.e., not relying on memorization of the graphic symbols to read the sight words). Generalization was tested per each set upon meeting intervention criterion. Once intervention criterion was met in Set 1, the researcher performed generalization probes for the respective Set's target words. This procedure was repeated for the two other sets.

**Maintenance.** The probe procedure used in baseline and intervention was followed to measure maintenance. Maintenance probes were performed two weeks after exposure to all three sets in the intervention phase.

## Data Analysis

The level, trend, and slope of the data in the intervention condition were compared to those at baseline to determine the effectiveness and efficiency of the app with T2L software features. Non-overlap of all pairs (NAP), defined as the proportion of non-overlapping data between phases (Parker & Vannest, 2009), was also calculated. Parker and Vannest (2009) provided tentative NAP ranges for effect size: weak effect ranging from 0 to .31, medium effect ranging from .32 to .84, and large or strong effect ranging from .85 to 1.

# Chapter 3

## Results

Results for Nick's correct responses across the three-word sets are detailed below. The results are presented for each word set across the three phases of baseline, intervention, and maintenance. Within each set (Set 1, 2, 3), the participant established a stable and low baseline. During the intervention stage of each set, the participant's correct responses increased. Across each set, maintenance was seen. Pre-intervention and post-intervention generalizations increased in all three sets.

### Set 1 Performance

Figure 2 displays the percentage of four words for Set 1 identified correctly across baseline, intervention, and maintenance. Probes included eight trials per set of four words to identify the correct target word with each presented twice. Criterion for intervention was met with a minimum of 75% correct over three consecutive sessions. A stable baseline is defined by having no increasing slope. This stability was established at a low level of accuracy over six consecutive sessions. The mean percent accuracy for Set 1 baseline was 19% with a range of 12.5% to 25%. The mean percent accuracy for Set 1 intervention was 79% with a range of 75% to 87.5%. Set 1 had a positive gain of 60% correct after exposure to the dynamic text feature used in intervention. Set 1 criterion was met after five intervention sessions. This included 60

exposures per word, for a total of 3 minutes. For Set 1, Nick demonstrated a large immediate effect from baseline to intervention. The NAP for Set 1 is 1.00 (strong effect). Positive changes were also observed in generalization and maintenance phases. The average percent gain from pre-intervention generalizations to post-intervention generalizations is 69%. Maintenance is observed at criterion of 75%, but the mean percent accuracy was below criterion at 69%. The percent gain from baseline to maintenance is 50%.

**Set 2 Performance**

Figure 2 displays the percentage of four words for Set 2 identified correctly across baseline, intervention, and maintenance. A stable and low accuracy baseline was established over nine consecutive sessions. The mean percent accuracy for Set 2 baseline was 17% with a range of 0% to 25%. The mean percent accuracy for Set 2 intervention was 75% with a range of only 75%. Set 2 had a positive gain of 58% correct after exposure to the dynamic text feature used in intervention. Set 2 criterion was met after 14 intervention sessions. This included 168 exposures per word, for a total of 8 minutes and 24 seconds. The NAP for Set 2 is 1.00 (strong effect). Positive gains are seen with both generalization and maintenance measures for Set 2. The average percent gain from pre-intervention generalizations to post-intervention generalizations is 50%. There is a 58% positive gain between the baseline and maintenance phase. Maintenance was observed at criterion of 75% accuracy. The slope of the maintenance phase, which included three probes, was stable at 75%.

**Set 3 Performance**

Figure 2 displays the percentage of four words identified correctly across baseline, intervention, and maintenance. A stable baseline was established over twelve sessions. The mean percent accuracy for Set 3 baseline was 17% with a range of 0% to 25%. The mean percent accuracy for Set 3 intervention was 83% with a range of 75% to 87.5%. Set 3 had a positive gain of 66% correct after exposure to the dynamic text feature used in intervention. Set 3 criterion was met after 19 intervention sessions. This included 228 exposures per word, for a total of 11 minutes and 24 seconds. The NAP for Set 3 is 0.9890 (strong effect). The average percent gain from pre-intervention generalizations to post-intervention generalizations is 58%. Set 3 only had one probe for the post-intervention generalization and maintenance phase. Maintenance was observed at criterion of 75% accuracy, with a 58% positive gain between the baseline and maintenance phase.

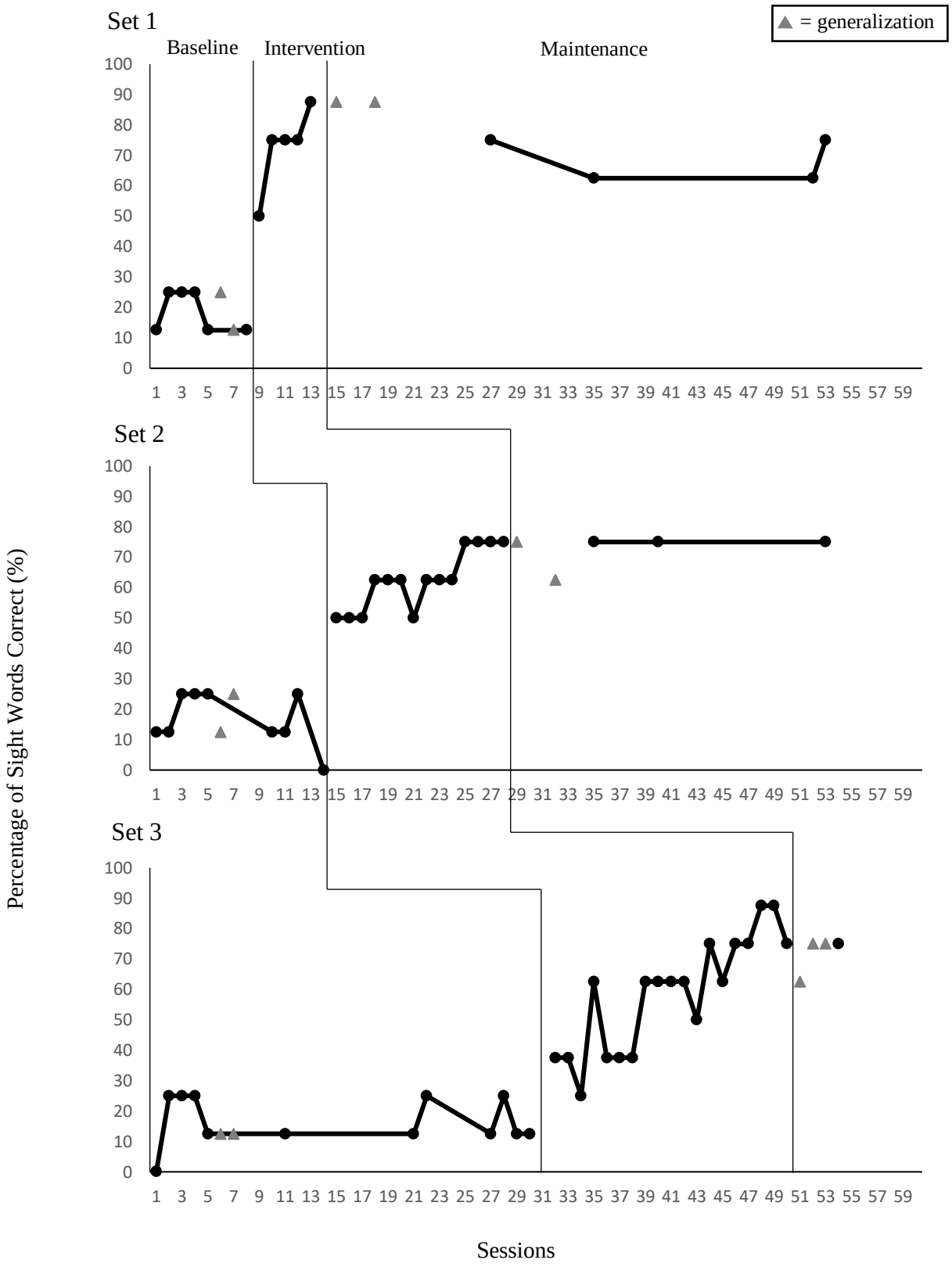


**Figure 2. Percentage of sight words read correctly, by Nick, out of 8 trials in the probes at baseline, intervention, generalization and maintenance.**

**Table 3. Results Summarized Across Sets from Baseline to Intervention**

| Word Set | Baseline Average | Average of Last 3 Intervention Sessions | Average Percent Gain |
|---|---|---|---|
| 1<br>almonds, crackers, swim, stop | 19% | 79% | 60% |
| 2<br>bird, read, run, gym | 17% | 75% | 58% |
| 3<br>scooter, help, computer, horse | 17% | 83% | 66% |

**Table 4. Results Summarized for Maintenance**

| Word Set | Baseline Average | Maintenance Average | Average Percent Gain |
|---|---|---|---|
| 1<br>almonds, crackers, swim, stop | 19% | 69% | 50% |
| 2<br>bird, read, run, gym | 17% | 75% | 58% |
| 3<br>scooter, help, computer, horse | 17% | 75%* | 58%* |

**Table 5. Results Summarized for Generalization**

| Word Set | Pre-Intervention Generalization | Post-Intervention Generalization | Average Percent Gain |
|---|---|---|---|
| 1<br>almonds, crackers, swim, stop | 19% | 88% | 69% |
| 2<br>bird, read, run, gym | 19% | 69% | 50% |
| 3<br>scooter, help, computer, horse | 13% | 71% | 58% |

**Table 6. Word Exposure Across Word Sets**

| Word Set | Total # of intervention sessions | Total # of exposures per word | Total exposure time per word |
|---|---|---|---|
| 1<br>almonds, crackers, swim, stop | 5 | 60 | 180s (3 min) |
| 2<br>bird, read, run, gym | 14 | 168 | 504s (8 min, 24 sec) |
| 3<br>scooter, help, computer, horse | 19 | 228 | 684s (11 min, 24 sec) |

# Chapter 4

## Discussion

Results from this case study, and the larger study, provide preliminary evidence that redesigning AAC apps with transition to literacy (T2L) features can positively impact the sight word learning of individuals with ASD who use AAC, despite having severely limited language and literacy skills. The participant in this study, Nick, demonstrated increased accuracy reading twelve personally relevant sight words, upon the introduction of an AAC app with T2L features. The exposure to the app resulted in strong effects, as indicated by a NAP scores (ranging from 0.98 – 1.00 across Sets) for the participant (Parker & Vannest, 2009). The participant experienced an average gain of 61% (range: 58%-66%) between baseline and intervention. Set 2 and Set 3 required three to four times as many intervention sessions as Set 1 to meet intervention criterion.

Findings are similar to the outcomes of recent research using the T2L features. Mandak and colleagues (2018) used the T2L feature in visual scene displays with younger children with ASD who had speech. Overall, the participants learned ten sight words for average gains of 73%, similar to this participant. The participant in this study attained higher NAP values per set, indicating a larger effect from the T2L intervention. The three participants in Mandak and colleagues (2018) research achieved higher maintenance accuracies (i.e., 90%) than the participant in this study. In a more similar comparison, Caron and colleagues (2018) used the same tablet and T2L software with participants with ASD and complex communication needs. The populations differ in literacy experiences; individuals in Caron and colleagues (2018) had previous literacy success with sight words, as each participant had a minimum of 150 sight

words prior to the start of the study. The participants learned twelve sight words, for average gains of 56%, demonstrating similar findings to this participant. The main difference in findings between the participants in Caron et al.'s study with this current study, was that this participant, Nick, needed more exposure time to each sight word. On average, participants from Caron and colleagues (2018) study needed 25 exposures and this participant needed and average of 152 exposures. In the Mandak and colleagues (2018) study, the three participants averaged 58 exposures per word. The typical learner can recognize a word after 35 exposures, while learners of varying abilities need 55 exposures to do so (Rasinski & Padak, 2008). When the AAC app with T2L features were used in Caron and colleagues (2018) study, the average was lower than the average number of exposures a typical learner requires. Overall, the similar gains amongst these three studies indicate the positive impact and potential of the T2L feature on sight word acquisition.

**Intrinsic Factors**

For the participant in this paper, different intrinsic factors may have contributed to his success. Though Nick has limited literacy skills, he participated in a literacy study with the same researcher and successfully learned to identify twelve letter-sound correspondences. The letter-sound correspondences he learned in the previous study may have been used to learn the sight words. Having knowledge of some letters and the sounds associated with them placed Nick in the partial alphabetic phase of literacy learning. In this phase, he is able to identify the sounds letters make and can use it to partially read words (Ehri, 2005). The phonemic awareness of some sounds may have helped him identify the sight words and their meaning.

**Extrinsic Factors**

In addition to intrinsic factors, several extrinsic factors potentially contributed to the effectiveness of the intervention. The main factors are related to the system design changes, or the T2L feature, including: dynamic text, paired speech output, and relevant words within the AAC system. The dynamic text used motion to attract the learner's attention initiating orthographic processing. Orthographic skills have been correlated with motion sensitivity thresholds of individuals and therefore, linked with the acquisition of reading skills (cf. Jagaroo & Wilkinson, 2008). Upon selecting the graphic symbol, the written word was paired with speech output and the auditory stimulation possibly supporting phonological processing. Phonological skills are used to predict future literacy skills because of the ability to associate a word's meaning with its acoustic characteristics, which is a supported and important skill in learning to read (Talcott et al., 2000). Another feature was that the text originated from the graphic symbols of the selected personally meaningful words. This association created between the symbol and the text supported the individual's understanding of the word displayed (Caron et al., 2018). Lastly, using vocabulary in familiar contexts, the device possibly helped to support meaning processing by using context clues. Comprehending target words requires activating background knowledge to gain an understanding of the word (Mirenda, 2003). The above components of the T2L feature may have supported Nick in learning to read the words associated with the symbols. Although it is not possible to evaluate the relative effects of any single feature or draw conclusions regarding the relative merit of this study to different approaches, the results from this study indicated the AAC app with T2L features does have a positive impact on the acquisition of sight words by one child with ASD who was minimally verbal and had severely limited literacy skills.

In addition to the T2L feature, using twelve personally meaningful words was an additional extrinsic factor that could have contributed to positive outcomes. Nick had low-tech AAC choice boards that contained similar words. The selection of these personally relevant words rather than articles such as "the" or "is" or community/ safety words was potentially an integral factor to this study. Selecting personally-relevant and highly motivating words was important to successful instruction, because meaningful words can foster intrinsic motivation and increase engagement in the literacy instruction (Light & McNaughton, 2013). The most motivating words, per teacher report, were included in Set 1. Nick required the least number of exposures to the words in Set 1, which was likely due to his interest, knowledge, and familiarity with these words.

Though people with ASD often receive limited literacy instruction, they do have the capabilities that allow them to acquire sight words – with very little intervention time, as indicated by this study, Mandak and colleagues (2018), and Caron and colleagues (2018) studies. AAC systems seem to have the potential to provide supplemental literacy instruction. Until individuals have stronger literacy skills, more intensive and adapted instruction needs to be provided. One way that it can potentially be provided is through the AAC system. Although the system was not used in the traditional sense (e.g., using the AAC system to communicate), the AAC system was used in a structured literacy task, which teachers and therapists could easily replicate. Matching, file folders, and worksheets are common ways that individuals are participating at school to acquire sight word knowledge. The structured matching task, with the T2L feature in an AAC system, seems to be another possible option for participation and learning.

**Limitations**

This study provides important data on the effects of an AAC app with T2L software features (i.e., dynamic text with speech output upon selection of a graphic symbol) on the sight word reading of one individual with severe ASD and complex communication needs. However, the study does have a number of limitations that should be considered when interpreting the results: (1) the paper only includes one child with ASD and complex communication needs; (2) the study established experimental control to determine the effect of the AAC app with T2L software features on the acquisition of the target words, however, baseline, generalization, and maintenance phases did not include five data points. The number of data points were limited to find a balance between methodological rigor and participant needs (Light & McNaughton, 2015). Findings, especially generalization, would have been strengthened if the probes had included a minimum of five data points per phase as recommended by Horner and colleagues (2005); (3) the study only focused on an isolated skill – sight word reading – with a small set of motivating target words, therefore we do not have a sense of how these finding would generalize with larger sets or different words; (4) the probe tasks for all phases used a closed set of choices, simplifying the reading task (Barker, Saunders, & Brady, 2012). It is possible that performance would vary if the probes included: an increased array size, more foils with the same initial letter as the target word, and foils that were not included in the intervention. Although the results for the generalization to the text-only grid display are promising, future research investigating these areas is warranted; (5) the individuals in this study received no literacy instruction on the selected words, thus isolating the AAC app with T2L features as the independent variable. This is not ideal practice, as the app should be used in conjunction with direct literacy instruction.

**Future research**

The T2L feature is designed to supplement, but not replace literacy instruction. Future research is required to investigate the effects of the AAC app with T2L features when paired with literacy instruction. The T2L feature provides the option of integrating literacy supports into meaningful communication, providing increased opportunities for functional learning, and potentially exposing individuals with ASD to relevant text throughout the day (Light & McNaughton, 2015). Yet it is possible that the T2L feature will be a distraction to either the individual with ASD or to the communication partner when used in daily interactions.

Future research is required to understand the full capabilities and effects of the T2L features on literacy skills. Sight word reading is one aspect of literacy that can lead to other emerging literacy skills. For instance, T2L may be used to teach decoding to users if the software can sound out different parts of the word. The decoding feature would bring each part of the word to the forefront of the screen and pair it with its respective speech output. Additional research is needed to see how T2L can be maximized for other literacy instruction.

Further research can explore the impacts of the T2L features with different participant populations beyond individuals with ASD. The studies should include more participants to gather more data for accurate averages. Also, probes in other studies should have larger sets of words and vary the types of words used.

Moreover, the software may be able to act as its own intervention system. Rather than the intervention being directed by a professional, the device could recognize an appropriate number of exposures per word and remove the graphic symbol when the user mastered that sight word. Instead of the software feature having to be directed by someone, the software could become integrated into an individual's daily communication. Research is needed to determine

the effectiveness of using the device in a more natural environment. Overall, more data is needed to optimize the T2L software.

## Conclusion

AAC aims to build communicative competence and has supported people of all abilities including those with ASD and CCN (Light & McNaughton, 2014). The traditional grid-based displays, with the static pairing of text, have contributed to communication development but are not yet optimized to support literacy learning. Literacy learning is the most powerful gift we can provide to an individual who uses AAC; supporting their generative abilities to fully express any thoughts. Yet due to poor literacy outcomes for individuals who use AAC, additional means to provide instruction and participation in these tasks is urgently needed. With minor design changes (e.g., the T2L feature in an AAC system), the use of current AAC systems have the potential to provide additional opportunities for literacy learning while supporting students who use AAC in developing vital literacy skills. Through this and the development of additional literacy skills, the T2L feature can be a starting point to potentially change educational engagement, outcomes, and opportunities.

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