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EFFECTS OF AN ASYNCHRONOUS, ONLINE TRAINING PROGRAM FOR PARENTS OF CHILDREN WITH AUTISM USING AUGMENTATIVE AND ALTERNATIVE COMMUNICATION

A Dissertation in

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Abstract

Objective: Individuals with autism who are minimally speaking often rely on augmentative and alternative communication (AAC). Communication partner training is an integral element of AAC intervention, and parents are ideal communication partners for supporting their child's language development skills. Asynchronous, online trainings may offer parents an accessible and flexible medium to learn to support their child's AAC communication. The primary goal of the current study was to evaluate the effects of an asynchronous, online training on the parent/caregiver's AAC strategy use in the context of shared book reading with their child.

Method: A total of five participant dyads participated in the study. A single-case randomized multiple-probe design was used. Parent/caregiver behaviors were observed prior to completing the online training and after completion of the training to determine if the training influenced parent/caregiver strategy use. Visual and statistical analyses were used to determine the presence and magnitude of effects.

Results: A functional relation was observed between the online training intervention and parent target strategy use in addition to use of individual components of the strategy. Tau-U nonoverlap calculations suggested medium to large effects of the intervention on parent strategy use during shared book reading with their child. An in-depth analysis of parent and child behaviors that influenced each other during the interactions is provided.

Conclusions: Asynchronous, online trainings may offer a valuable resource to parents of children who use AAC for communication, and parents prefer the flexibility and accessibility that is associated with asynchronous trainings. Future research should identify how online programs can be most effectively support widespread parent training and improve outcomes for children who require AAC.

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CHAPTER 1

INTRODUCTION

Participation in social interactions is critical for language acquisition. Individuals with autism spectrum disorder (ASD) experience social communication impairments, resulting in reduced opportunities for these individuals to engage in language-rich social interactions. Individuals with ASD with little to no functional speech (LNFS) who rely on augmentative and alternative communication (AAC) experience even fewer opportunities for engagement in meaningful interactions for language learning. The skills of communication partners interacting with individuals who use AAC play a critical role in fostering successful social interactions (Kent-Walsh & McNaughton, 2005) to support language learning. Evidence consistently demonstrates that training communication partners to implement AAC strategies is effective in enhancing the language and communication skills of individuals requiring AAC (Douglas et al., 2017). Therefore, communication partner training is an essential element of AAC intervention.

Parents are a primary communication partner, especially for younger children who require AAC, and they have the opportunity to engage in communication with their children across a variety of natural contexts. Research indicates that parents can be effectively trained to provide communicative supports to significantly enhance their child's communication (Douglas et al., 2017; Fey et al., 2006), particularly children with complex communication needs (CCN) (Branson & Demchak, 2009). However, barriers exist that prevent parents from participating in traditional AAC training (Douglas et al., 2017; Lakes et al., 2009). One potential solution to reduce these barriers and increase availability of information is the use of virtual, asynchronous trainings, allowing parents to access the information at a time and place that is most convenient for them (Wainer & Ingersoll 2014).

In the current study, established learning principles from the ImPAACT Program (Kent-Walsh & McNaughton, 2005) were applied to develop a virtual, asynchronous training for parents of children with autism spectrum disorders (ASD) who are communicating via AAC. The purpose of this study was to examine the efficacy of that training to teach caregivers a strategy to support their child's communication. Additionally, the impacts of caregiver strategy implementation on the communicative behaviors of their children with CCN were evaluated.

Autism and Social Communication

Autism spectrum disorder (ASD) is a developmental disorder characterized by deficits in social communication and restricted and/or repetitive interests and behaviors (American Psychiatric Association, 2013). Approximately 30% of individuals with a diagnosis of ASD do not develop speech functional enough to meet daily communication demands of everyday life (Tager-Flusberg & Kasari, 2013). As a result, these individuals require another modality of communication. Augmentative and alternative communication (AAC) is an evidence-based practice that is frequently used to provide a primary mode of communication to individuals with ASD with little to no functional speech (LNFS) (Kasari et al., 2014; Clarke & Williams, 2020). AAC allows these individuals to be active participants throughout life by providing a means of communication across meaningful contexts and for a variety of communicative purposes (Logan et al., 2017). Learning to independently and successfully communicate for multiple functions provides access to social and educational opportunities, thus improving outcomes and overall quality of life for these individuals. Therefore, it is critical that individuals who rely on AAC for communication learn to use the AAC system to communicate for a variety of different functions.

Communication Functions

Communication acts are characterized as serving various “communication functions” because children engaging in these communicative behaviors are doing so to serve a function or achieve an intentional goal within the context of their environment. Wetherby et al. (1988) identified three categories of communicative functions – behavior regulation, social interaction, and joint attention. According to Wetherby and colleagues, the function of communication acts in the behavior regulation category is to affect the behaviors of people within the environment. For example, the communication act of protesting an undesired object causes the communication partner to remove the undesired object from the child’s environment. Communication acts that fall within the social interaction and joint attention categories are socially motivated – as the goal of these communication acts is to engage with or share information with a communication partner. These communication acts include requesting a social routine, showing off (attracting attention to oneself), greeting, calling (gaining attention of a communicative partner), acknowledgement (indicating notice of a person’s previous statement or action), requesting permission, commenting, requesting information, and clarifying a previous utterance.

Social Communication and Language Development

Socially motivated communicative functions are foundational for language development and social interaction skills (Paul et al., 2018). Participation in social exchanges is critical to language acquisition and facilitates language learning by increasing exposure to language input and allowing the language learner to receive feedback on expressive communication behaviors (Casenhiser et al., 2015; Beukelman & Light, 2020). Impairments in social communication skills is a hallmark characteristic of individuals with ASD (American Psychiatric Association, 2013), and these impairments present as reduced initiation of communication, reduced responding to other’s communication, difficulties with joint attention, reduced eye contact, and limited use of gestures (Delehanty & Wetherby, 2021; Jaswal & Akhtar, 2019; Bottema-Beutel, 2016; Kasari et al., 2014). These reduced behaviors limit the initiation and extent of conversational exchanges, and communication partners often interpret these behaviors as signaling a lack of desire to engage socially with others (Jaswal & Akhtar, 2019). Consequently, individuals with ASD experience less engagement in these language-rich, reciprocal, social interactions with communication partners, resulting in reduced opportunities for language learning.

Gestures play a substantial role in language development (Delehanty & Wetherby, 2021), as they allow children to engage in meaningful and symbolic communicative exchanges with caregivers prior to the development of speech (Crais et al., 2004). Typically developing (TD) children begin to use intentional gestures for communication in the prelinguistic stage of development, allowing them to engage in social interactions with caregivers as young as 7-9 months of age (Crais et al., 2004; Delehanty & Wetherby, 2021). The intent behind some of the earliest observed gestures in TD children is to engage in a socially motivated communication act, such as “commenting,” by holding an object up to share with a caregiver (Crais et al., 2004). Individuals with ASD exhibit reduced rates of gestures use when compared to TD children (Delehanty & Wetherby, 2021). In addition, gestures are predictive of the development of spoken language (Delehanty & Wetherby, 2021; Ozcaliskan et al., 2016). Significant correlations have been found between language abilities and rates of gestures use, indicating that autistic individuals with more severely impaired language systems exhibit less gesture use compared to those with more intact language systems (Delehanty & Wetherby, 2021). Additionally, significant correlations between language abilities and overall use of communicative acts [i.e. gestures, nonword vocalizations, and spoken word(s) directed toward an adult and used as a communicative signal to serve a communicative function (Wetherby & Prizant, 2002)] have also been observed in children with ASD (Delehanty & Wetherby, 2021). Thus, children with ASD who demonstrate severe language impairments are engaging in significantly less communicative acts, such as gestures, vocalizations, and use of spoken language.

Engagement in communicative acts is essential because it gives caregivers the opportunities to respond and engage in meaningful social opportunities with the child to promote language acquisition. Thus, children with ASD with significant language impairments experience substantially less opportunities to participate in social interactions with caregivers, even further reducing language acquisition and social competence.

Social Communication as a Focus of Intervention

Given the impacts of engagement in social interactions on language learning, it is critical that interventions for individuals with ASD include a focus on teaching social communication skills. To accomplish this, interventionists need to be aware of the function of communication that is being taught in the communicative context of the intervention activity. According to Casenhiser et al. (2015, p. 847), "... the function of communication and self-expression is central to what makes language *language*." For example, a frequent and primary goal in autism intervention is labeling or identifying objects. However, during a structured labeling task, the intent behind the child's production of an object label is to engage in the expected behavior by accurately naming an item rather than to communicate about the item with a communication partner. The purpose of the interaction is to display semantic knowledge -- not to comment on or to request the object. Casenhiser and colleagues argue that if the child's intent while labeling an item is not to communicate about the object, this is not language.

The contrast in the behaviors of labeling versus commenting/requesting is important to consider when intervening with individuals with ASD who have reduced abilities in social communication. Because of the foundational deficits in social communication, children with autism may lack understanding of the purpose of language as a communication tool or have a limited understanding of the range of functions for which language is used (Casenhiser et al., 2015). Therefore, teaching object labeling is not addressing this underlying challenge. Interventions that are built on social communication facilitate language development because the language content drives the social interaction, allowing exposure to the range of functions for which language can be used (Casenhiser et al., 2015). Without the ability to learn through social interaction, a child is almost entirely dependent on a therapist/teacher teaching words in superficial contexts, which Casenhiser and colleagues compare to programming a computer (Casenhiser et al., 2015). Thus, to be effective in promoting the development of language, intervention should target challenges related specifically to social communication and support the use of language in genuine social interactions (Casenhiser et al., 2015).

Augmentative/Alternative Communication (AAC)

AAC is often introduced to provide a modality of communication for individuals with ASD who have LNFS (Kasari et al., 2014; Clarke & Williams, 2020). These individuals include very young children who are not developing adequate spoken language and older children who continue to demonstrate LNFS. These individuals cannot rely on speech to communicate and, as previously discussed, are likely not using gestures to initiate interactions (Delehanty & Wetherby, 2021). The AAC system provided is expected to act as the medium for these individuals to engage in these social communication acts essential for language development. Therefore, to promote language development, these individuals must learn to use AAC for social communication functions to participate in reciprocal, social exchanges. To accomplish this, interventionists must consider the function behind the language being taught when implementing AAC intervention with individuals with ASD.

Communication Partners and AAC

Communication partners play a critical role in facilitating the use of AAC during communicative exchanges. Engagement in successful interactions with an individual communicating via AAC is dependent upon the interaction skills of the communication partner (Kent-Walsh & McNaughton, 2005). While communication partner behaviors can have significant positive effects on communication outcomes for the individuals using AAC, evidence suggests that communication partners do not implement effective strategies without being trained (Biggs et al., 2018). In fact, communication partners often unintentionally limit communication development of their child with CCN by dominating interactions, asking primarily yes/no questions, frequently interrupting utterances, taking the majority of the turns, providing few opportunities for the child to initiate or respond, focusing on the communication technology rather than the individual, anticipating the needs of the child, and failing to recognize communicative attempts (Douglas et al., 2017; Kent-Walsh & McNaughton, 2005).

Training communication partners to implement strategies while engaging in interactions has been consistently reported to effectively enhance the language and communication skills of individuals requiring AAC (Douglas et al., 2017; Biggs et al., 2018). Therefore, communication partner training is an integral element of AAC. Thus, participation in a training program is critical to teach intervention strategies to communication partners to support communication and language development of AAC users.

Parents as Communication Partners

Parents are often the primary communication partners for a child who relies on AAC for communication. This is especially true for younger children who may not be attending a school program yet. Therefore, parent involvement in AAC intervention is considered best practice (National Research Council, 2001). Evidence consistently demonstrates the positive effects of including parents in AAC intervention, such as improved communication outcomes for children with complex communication needs (CCN; Branson & Demchak, 2009; Hardan, 2018; Koegel et al., 2020) and reduced device abandonment (Binger & Kent-Walsh, 2012; Johnson et al., 2006).

Parents can be ideal language teachers, as their proximity to the child allows for multiple, natural opportunities to identify, respond to, and expand communication attempts (Meaden et al., 2014). Moreover, parents engage in interactions with their child across a variety of contexts throughout the day, which can promote generalization of communication skills (Steiner et al., 2011). Generalization of communication skills from highly structured, experimental tasks to real-world, meaningful contexts is critical to improve outcomes for individuals with ASD relying on AAC (Holyfield et al., 2017).

Additionally, parent training has demonstrated positive effects for the parents including reduced parental stress, increased sense of self-efficacy, improved mental health outcomes (Steiner et al., 2011; Koegel et al., 2020), and increased optimism toward being able to positively influence their child's communication (Romski et al., 2011). Therefore, parent training in AAC intervention is critical to improve outcomes for the child who uses AAC and their families.

Parent Training for Children with ASD Using AAC

Children with ASD have inherent problems with social communication and generalization of skills related to their diagnosis (American Psychiatric Association, 2013).

Moreover, as previously discussed, individuals with ASD experience reduced opportunities to engage in social interactions due to their challenges with social communication. Therefore, training parents of children with ASD to help their children develop social communication is essential. Parents have frequent opportunities to implement strategies to engage their child in reciprocal social interactions in natural contexts to support the use of language for a variety of functions (Steiner et al., 2012), and the evidence consistently demonstrates effective outcomes when targeting social communication behaviors via parent education (Koegel et al., 2020). Further, parents can implement intervention in a variety of contexts to support generalization of communication skills across meaningful environments (Steiner et al., 2012). Lastly, numerous studies report that parents of children with ASD experience significantly high levels of stress when compared to parents of children with other developmental disabilities (Steiner et al., 2012). Parent training is associated with reduced parental stress (Steiner et al., 2012), and therefore may be important to improve quality of life for parents of children with ASD.

How to best support parents of children with ASD who require AAC needs to be investigated so that best practices are established. Prior research has shown that parents of children with ASD can learn strategies to effectively reduce problem behaviors, improve sleep habits, improve self-help skills, improve joint attention, and improve social skills and communication (Steiner et al., 2011). While parent education programs for parents of children with ASD have increased, relatively few studies are available that focus on children with ASD who demonstrate LNFS – the subgroup of individuals that requires the highest levels of support for learning (Koegel et al., 2020). Further, these individuals with LNFS rely on AAC to communicate, and as described above, parent training is an integral part of AAC intervention (National Research Council, 2001).

Furthermore, parents of children with ASD need to have access to educational materials during the early developmental years to improve outcomes for children and their families (Tager-Flusberg et al., 2017; Koegel et al., 2020). If not established early in development, communication intervention for individuals with ASD who have LNFS becomes more difficult as they age due to an increase in challenging behaviors used for communication, challenges with testing, and a pronounced increase in the refusal to engage socially (Tager-Flusberg et al., 2017). This suggests a critical need to explore how parents of young children with ASD who rely on AAC can be better supported.

Barriers to Parent Training

Despite evidence for the effectiveness of parent training, barriers exist that prevent parent attendance at traditional trainings (Lakes et al., 2009). These barriers include, but are not limited to, lack of childcare (Douglas et al., 2017; Preece et al., 2017), lack of time (Lakes et al., 2009), conflicting work schedules (Preece et al., 2017), geographic location (Applequist, 2009; Mandell et al., 2005), lack of transportation (Timpe et al., 2021), and/or delay in services (Carbone et al., 2010). These issues prevent parents from accessing critical information to support their child's communication and language to improve outcomes for the child and family members.

Research consistently demonstrates positive outcomes for children diagnosed with ASD who receive Early Intervention (EI) services (Roger & Vismara, 2008). However, families who experience those previously mentioned barriers, such as geographic location and/or delay in services due to long wait lists (Carbone et al., 2010), are not receiving the training required to support their child with ASD during early, critical developmental years (Suppo & Floyd, 2012). A persistent discrepancy between the need and availability of EI services exists for children diagnosed with ASD and their families (Suppo & Floyd, 2012). Therefore, alternative service delivery methods for parent training to ensure parents have access to essential information during instrumental developmental years to maximize the academic, behavioral, and social success of these children with ASD need to be explored (Suppo et al., 2012).

Scheduling conflicts act as a significant barrier for parents to attend traditional, in-person trainings (Koegel et al., 2020; Suppo & Floyd, 2012). Traditional parent training models, especially for children who are receiving services in a school setting, require the parent to meet with the speech-language pathologist (SLP) during school hours. Preece & colleagues (2017) surveyed 148 parents of children with ASD in three different countries to inform the development of parent training programs. More than half of the participants expressed a preference for training on the weekend, and 50% of participants from Macedonia requested training in the evening. While weekends and evenings might be ideal for parents, service provider schedules pose an obstacle to accommodating these requests. The professional working with the child is generally not available for training parents during weekends and evenings. A solution that meets the scheduling needs of parents with demanding work schedules and family obligations that prevent them from attending in-person training(s) with their child's SLP needs to be found.

Multiple studies have evaluated and reported the positive effects of parent training programs (Koegel et al., 2020; Suppo & Floyd, 2012). Despite these positive effects, these parent training programs/models may not be easily transferrable outside the context of the research program. Persistent conflicts outside of experimental contexts may prevent many families from participating in trainings (Suppo & Floyd 2012). Within the context of a research study, training schedules are often adjusted to meet the needs of the participants or only include families who experience little to no barriers to training participation (Suppo & Floyd, 2012). For example, facility-based parent training programs would be difficult for parents who have limited financial resources and challenges with transportation and childcare (Anan et al., 2008; Ingersoll & Dvortcsak, 2006; Laugeson et al., 2009). However transportation and childcare may be provided for the duration of participation in the research study.

Similarly, time-intensive programs would not be feasible for parents with demanding work schedules and lack of access to childcare (e.g. 25-hour long training for 5 consecutive days; Koegel &Koegel 2002). Parents need to possess adequate time and energy for parent training programs to be successful. Parents experiencing clinically significant levels of stress do not benefit from intensive parent training programs (Singer, 2002; Webster-Stratton & Reid, 2003; Steiner et al., 2011), as they may only increase parental stress and potentially impede the child's progress (Osborne 2008; Steiner et al., 2011). Therefore, parents with those types of time demands and stressors may not be represented within the participant group for some studies nor be appropriate for some parent training paradigms.

Available parent training programs/models that have arisen from prior research programs may not be feasible for families who experience significant barriers to access. Researchers recommend consulting with families to ensure they have the time and energy to devote to an education program (Kaiser & Hancock, 2003). Each family's lifestyle, needs, and resources need to be considered to determine the setting and intensity that would most benefit that particular family (Steiner et al., 2011).

Consideration for the needs of each family can allow for the provision of a training method that serves as a "best fit." For example, some parents prefer to be involved in every at-home speech session, while others prefer more infrequent participation (Steiner et al., 2011). Some parents might possess ample time, finance, and energy resources and prefer intensive, in-person trainings. Some parents might require less intensive, self-paced training options that can be accessed at times that are convenient for them. Given the importance of training communication partners to promote communication and language development, researchers need to evaluate the effectiveness of alternative service delivery models to support more parents and allow access to information that will positively impact their child with CCN (Suppo & Floyd, 2012; Koegel et al., 2020).

Online Training

The provision of services through digital platforms, or online training, has the potential to remove external barriers that may prevent families from participating in services and training (Hansen, 2019; Suppo & Floyd, 2012). Online training may offer a feasible option for parents with less resources available to them. Issues related to transportation, child-care, scheduling, and limited availability of services could all be lessened by digital platform interventions (Hansen, 2019). Online training approaches have also been suggested to be especially beneficial for parents of children with CCN (Wainer & Ingersoll, 2014). Another consideration in the use of online training for parents is the growing interest in and use of virtual therapy methods due to the onset of the COVID-19 pandemic. Many programs were adapted and delivered virtually to meet the needs of clients (Timpe et al., 2021). As virtual learning continues to grow, the evidence-base supporting it must also grow (Timpe et al., 2021).

Asynchronous, self-paced trainings have also been found to be beneficial to support parents in learning communication strategies. In addition to reducing the previously described barriers (e.g. lack of childcare, lack of time), asynchronous online trainings allow parents to access materials at times and places that are convenient for them (Delaney et al., 2012). Further, parents have the opportunity to work at their own pace, allowing for the individualization of engagement in the instruction (Suppo & Floyd, 2012). Additionally, the provision of synchronous, individual coaching during intervention requires extensive resources and personnel, which limits the implementation of a program with a large number of families (Meaden et al., 2014). Therefore, further exploration of a technology delivered intervention has long been recommended (Meaden et al., 2014). Intervention delivery through technology could allow information to be distributed more broadly to families of children with CCN, regardless of geographical location (Heitzman-Powell et al., 2014). In addition, families who may not have access to speech therapy services due to delay in services (Carbone et al., 2010) could obtain critical information to enhance their child's communication.

Studies that have evaluated the effects of asynchronous, online trainings for the communication partners of individuals using AAC have consistently reported positive outcomes – for both the communication partner and the individual using AAC – across a variety of ages, diagnoses, and AAC modalities (Caron et al., 2016; Caron et al., 2021; Catania et al., 2009; Collins 2012; Douglas et al., 2013; Douglas et al., 2017; Gormley, 2019; Hajjar et al., 2020; Martocchio & Rosales 2017; Mccody & McNaughton, 2020; McCulloch & Noonan 2013; Nefdt et al., 2010; Nosik & Williams, 2011; Pollard et al., 2014; Rosales et al., 2018; Vladescu et al., 2012; Walker, 2019). Effective online trainings have included elements such as video models, strategy description(s), comprehension checks, self-reflections, and opportunities to plan strategy use. Combining these online intervention elements with systematic learning principles may be particularly effective to teach parents important AAC intervention strategies and to provide a cost-effective and time-effective service delivery model (Akamoglu et al., 2018) for parents with less availability and resources.

ImPAACT Program

Improving Partner Applications of Augmentative Communication Techniques (ImPAACT; Kent-Walsh et al., 2010) is an evidence-based communication partner program that employs explicit, systematic instructional principles (Ellis et al., 1991) that aid in the acquisition and generalization of communication strategies. ImPAACT has been shown to be effective when teaching strategies to communication partners of children using AAC across a variety of diagnoses, language levels, ages, and types of AAC systems (Binger et al., 2008; Binger et al., 2010; Kent-Walsh et al., 2010; Rosa-Lugo et al., 2008; Kent-Walsh et al., 2003; Kent-Walsh, Binger, & Hasham, 2010). The ImPAACT program consists of 8 steps: (1) Pre-test and commitment to instructional program, (2) Strategy description, (3) Strategy demonstration, (4) Verbal practice of strategy steps, (5) Controlled practice and feedback, (6) Advanced practice and feedback, (7) Post-test and commitment to strategy use, and (8) Generalization. Goals of each step in the ImPAACT program are as follows:

Step 1: Pretest and commitment to the instructional program. The goals of step 1 in the ImPAACT program include (a) discussing the benefits of target strategy use, and (b) ensuring communication partners are motivated to learn the strategy (Kent-Walsh & McNaughton, 2005; Tempe et al., 2021).

Step 2: Strategy Description. The goals of step 2 in the ImPAACT program include (a) providing a clear description of the component skills necessary to implement the target strategy and (b) discussing the positive effects of component skills (Kent-Walsh & McNaughton, 2005; Timpe et al., 2021).

Step 3: Strategy Demonstration**.** The goals of step 3 in the ImPAACT program include (a) a review and demonstration of each step in the strategy, and (b) increasing communication partners' metacognitive thinking by discussing the thought process involved in making implementation decisions (Kent-Walsh & McNaughton 2005; Timpe et al., 2021).

Step 4: Verbal practice of strategy steps. The goal of step 4 within the ImPAACT program is for communication partners to memorize the strategy steps to promote automaticity (Kent-Walsh & McNaughton, 2005; Timpe et al., 2021). Communication partners engage in rote verbal rehearsal of strategy steps and are asked to describe and explain the importance of each strategy step.

***Step 5: Controlled Practice & Feedback*.** The goals of step 5 within the ImPAACT program are to (a) build communication partner skills through highly controlled role play trials, (b) build confidence and fluency of strategy implementation, and (c) gradually allow communication partners to assume control of monitoring their effective use of the strategy (Kent-Walsh & McNaughton, 2005; Timpe et al., 2021).

***Step 6: Advanced Practice and Feedback*.** The goal of step 6 is for communication partners to learn how to apply the strategy to natural contexts and allow them to self-regulate their behaviors to evaluate their success (Kent-Walsh & McNaughton, 2005; Timpe et al., 2021).

***Step 7: Posttest and commitment to strategy use*.** The goals for step 7 in the ImPAACT program include (a) tracking partner skill acquisition, and (b) encouraging partners to commit to long-term use (Kent-Walsh & McNaughton, 2005; Timpe et al., 2021).

***Step 8: Generalization*.** Step eight was created with the purpose of determining if the partner and child can use the skills in new contexts (Kent-Walsh & McNaughton, 2005; Timpe et al., 2021).

Elements included in the virtual instruction intervention for this study were derived from these eight steps and the goals of each step within the ImPAACT program (Kent-Walsh & McNaughton, 2005). Table 1 outlines steps and procedures from the original, in-person ImPAACT training program and the modifications for the current study.

Studies employing the ImPAACT program have taught communication partners the following two strategies to use in the context of shared storybook reading: (1) *Read, Ask, Answer* (Binger et al., 2008; Rosa-Lugo et al., 2008; Kent-Walsh 2003; Kent-Walsh, Binger, & Hasham, 2010; Timpe et al., 2021), and (2) *Read, Ask, Answer, Prompt* (Kent-Walsh, Binger, & Malani 2010; Binger et al., 2010). Figures 1 and 2 provide visual representations of the *Read, Ask, Answer* (RAA!) and the *Read, Ask, Answer, Prompt* (RAAP!) strategies, respectively. The skills included in the RAA! And RAAP! strategies to promote communication of the AAC user are aided AAC modeling → expectant delay → (WH question ask/answer prompt or verbal prompt if child does not communicate) → contingent response. During RAA!, communication partners are instructed to *read* a page of the storybook and provide an aided AAC model of a keyword followed by an expectant delay to allow an opportunity for the child to communicate. If the child does not communicate, the communication partner then *asks* a "WH" question and provides an aided AAC model of a keyword followed by another expectant delay. If the child still does not communicate, the communication partner *answers* the question and provides another aided AAC model of a keyword followed by an expectant delay. A contingent response is provided following each communicative turn taken by the child. The RAAP! strategy follows the same protocol as RAA!, however if the child still does not communicate after the communication partner answers the question and provides the aided AAC model + expectant delay, a verbal prompt is provided (e.g. Your turn) to elicit communication from the child.

Table 1. In-Person ImPAACT Program & ImPAACT Applied to Online Training

Step	Original ImPAACT Program	Current Study Procedures (Online Training)
1. Pretest and commitment to instructional program	• Provide examples of storybook reading sessions with and without use of the target strategy and • Sign contract outlining instructional activities	• Describe known benefits of using target strategy • Outline instructional activities in training • Participants select button indicating their commitment to the program
2. Strategy Description	• Provide partners with visual aid outlining entire strategy	• Provide visual representation of SOAR strategy • Review implementation and positive effects of each skill in the SOAR strategy individually
3. Strategy Demonstration	• Role-play strategy use with communication partner acting as child • Use "think aloud" statements during strategy implementation to explain thought process	• Strategy is demonstrated via video model • "Think aloud" statements are included in video model
4. Verbal practice of strategy steps	• CPs describe and explain the importance of each step in the strategy • Rote verbal rehearsal of strategy steps • Use of mnemonic device	• CPs complete matching task to match strategy steps to explained importance • Visual representation of pneumonic SOAR is provided and reviewed • Communication partners instructed to read strategy steps aloud at least three times ("Show, Opportunity, Assist, Respond") until memorized with visual supports provided.
5. Controlled practice and feedback	• Role play strategy use; partner plays themselves, researcher plays child • Coaching and feedback gradually faded	• Parents encouraged to practice strategy by themselves using the child's AAC device and the corresponding storybook • Parents view videos of strategy implementation to identify errors
6. Advanced practice and feedback	• Communication partner read stories with child and implements target strategy • Researcher provides coaching as needed, and fades over time	• Parents practice strategy with child • Parents complete self-evaluation form describing how well they felt they implemented the strategy, areas of strength, and areas needing more practice
7. Posttest and commitment to long-term strategy use	• Review "pre" and "post" instruction videos • Discuss differences in child behaviors and other noted effects of instruction • Generate action plan to encourage long-term strategy use	• Parents provided with examples of additional activities the SO(A)R strategy could be applied to • Post-Intervention data is collected
8. Generalization of targeted strategy use	• Partner and child read novel storybooks together or engage in novel activity (e.g. craft) • Coaching provided as needed	• Post-training generalization data is collected by investigator (baseline generalization data collected prior to Step 1

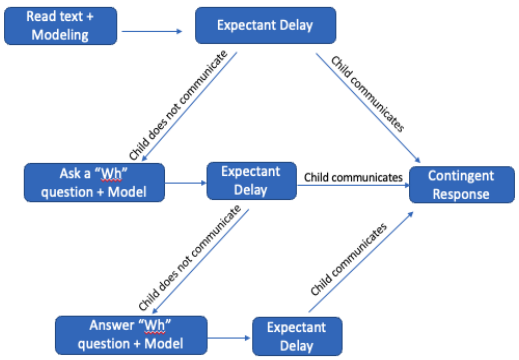

Figure **1:** Visual Representation of the RAA! Strategy

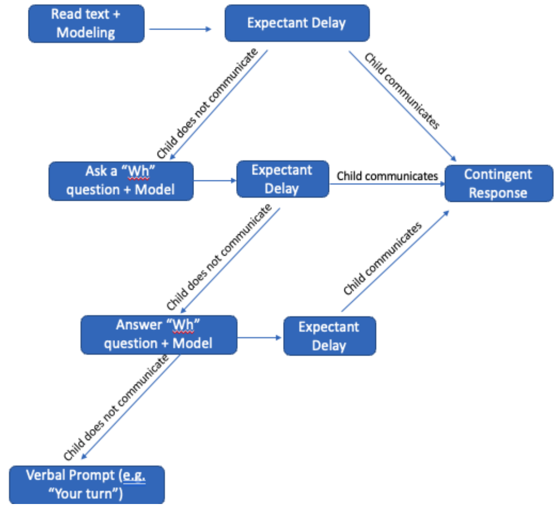

Figure **2:** Visual Representation of the RAAP! Strategy

All studies that taught the RAA! and RAAP! strategies reported positive results for communication partner behaviors and communication behaviors of the individual with CCN.

All but one study employing the ImPAACT program have used in-person instruction. Timpe and colleagues (2021) modified the well-established ImPAACT program to incorporate a virtual component to respond to the growing use of virtual services. Specifically, the first portion of the training program (steps 1-5) took place in-person, while the latter portion that included advanced coaching and feedback, generalization to a novel task, and communication partner commitment to strategy use (steps 6-8), took place via telepractice, during which the researchers engaged in synchronous, live communication with the families. Results indicated that the principles from the ImPAACT program—when delivered virtually—continued to positively affect communication partner behaviors and children with CCN.

The ImPAACT program is well-established and the use of telehealth is emerging as a viable service delivery method. The first four steps of the ImPAACT program are primarily information sharing (e.g. strategy description) and demonstration of strategies, which can be easily accomplished via video modeling. However, steps 5 and 6 (i.e. controlled practice and feedback) of the ImPAACT program traditionally require in-person interaction with the investigator to allow for real-time and immediate feedback on strategy use. It is unknown if the lack of in-person feedback from the investigator will still result in the successful implementation of strategies to support individuals using AAC by the communication partner. The current study will investigate whether the goals of each step in the ImPAACT program can be successfully translated to an asynchronous platform while maintaining effective teaching of strategies.

SO(A)R Strategy

The current study applies systematic teaching principles from the ImPAACT approach to an asynchronous, online program to teach parents of children with ASD with LNFS the SO(A)R strategy. The SO(A)R strategy was developed for this study to promote social communication by engaging the parent and child in reciprocal interactions through provision of multiple opportunities for the child and/or parent to initiate communicate and respond. The SO(A)R strategy also aims to promote the use of language for social communication functions to target the social communication impairments for children with ASD. The current study teaches communication partners the following skills: aided AAC modeling ("*Show* the child use of the device") → expectant delay ("*Opportunity* for the child to communicate") → prompting ("*Assist* the child to use the device if no response") → contingent response ("*Respond* to the child's communication"). The acronym *SO(A)R* (Show, Opportunity, Assist, Respond) will be used to represent the skills included in the strategy. The *(A)* is represented in parentheses because this skill will only be performed if the child does not independently communicate. A visual representation of the SO(A)R strategy is shown in Figure 3.

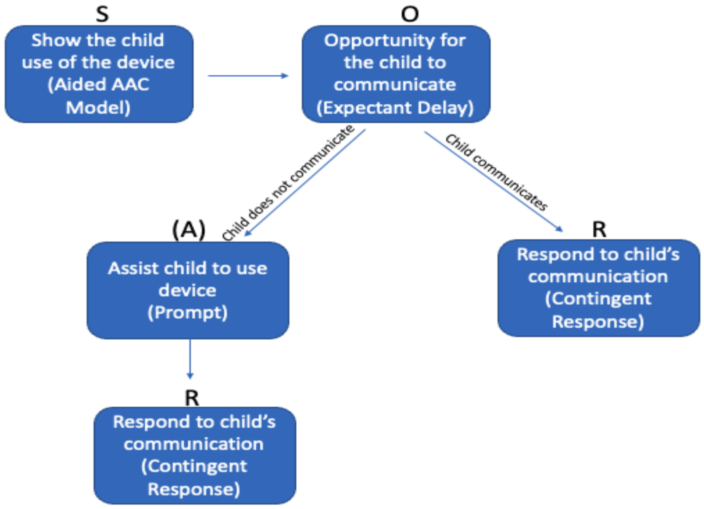

Figure **3**: Visual Representation of the SO(A)R Strategy

SO(A)R is similar to the previously described RAA! and RAAP! strategies, however some modifications are included. The "WH" prompts will be removed to promote the communicative function of spontaneous commenting and avoid a repetitive, responsive labeling task. For example, if the parent asks questions such as, "Who is that?" or "What is that?" while pointing to a picture in the book, the child's communication function becomes a responsive label, and the interaction is complete. The child may learn to wait for the adult-directed "WH" question on each page to determine what they are supposed to communicate. The "WH" prompts will be replaced with gestural (i.e. pointing) or manual (i.e. guiding child's hand) prompts to elicit AAC output from the child. The removal of the adult-directed "WH" questions will also foster responsive interactions from the parent—a critical element of Enhanced Milieu Teaching (EMT)—during which the parent can follow the interests of the child and avoid direct elicitation of a child's response from assessment-like questions (Dunn Davison et al., 2021). A prompt for expressive output via the AAC system is included in the strategy because evidence indicates that the child is more likely to acquire vocabulary when prompted to use the AAC symbols expressively during interactions rather than simply observing others using the symbols (Romski et al., 2010).

The positive effects of interventions including the elements of the SO(A)R strategy (i.e. modeling, expectant delay, prompting, responding) are well-documented. O'Neill and colleagues (2018) conducted a meta-analysis evaluating the effects of interventions that included aided AAC input for individuals with complex communication needs, providing additional evidence for the use of modeling, expectant delay, prompting, and contingent responding to support the communication of individuals using AAC. Three studies (Johnson, McDonnell, Nelson, & Magnavito, 2003; Johnston, Nelson, Evans, & Palazolo, 2003; Kent-Walsh, 2015) used interventions with the same skill sequence as the *SO(A)R* strategy – modeling → expectant delay →prompting → contingent response. All of these studies reported positive effects on the communication of the child with CCN. Kasari et al. (2014) also incorporated a similar sequence while implementing a combination of Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER) and Enhanced Milieu Teaching (EMT) interventions with minimally speaking children with ASD. The investigators provided aided AAC models, prompts to elicit the child's communication such as expectant delays, verbal prompts, and gestures, and contingent responses to the child's communication. The children with ASD showed significant increases in spontaneous communication following the intervention. Finally, it is recommended that communication partners who are providing aided AAC models or input should be trained to use prompt hierarchies and language response strategies in conjunction with the use of aided language models (Van Tatenhove, 2009). Thus, evidence indicates that teaching parents to use these specific skills will support the communication of their child who uses AAC to communicate.

Summary and Current Study

In summary, social communication skills allow for participation in reciprocal social interactions, within natural, meaningful contexts, which are critical to language acquisition. Communication partners, particularly parents, are necessary to facilitate these conversational exchanges for individuals who rely on AAC. Parents have frequent opportunities to implement AAC intervention strategies within naturally occurring contexts, which is ideal for language learning. Additionally, parent training is an integral piece of AAC intervention. Research indicates that parents require training to learn the skills necessary to support the communication of their child who uses AAC. However, barriers exist that prevent many parents from being able to participate in traditional, in-person parent training sessions. New methods of sharing critical information with parents of children who require AAC need to be explored because of the barriers to access for training. Asynchronous, online parent training programs may eliminate these barriers and offer a feasible training method for parents who require trainings that offer flexibility, easy accessibility, and place less demands on parent resources. Asynchronous trainings also eliminate the need for personnel and can result in more widespread distribution of essential information to families of children with ASD who rely on AAC.

Asynchronous trainings for communication partners of individuals who use AAC result in positive outcomes both for the communication partner and the individuals using AAC. The current study applies evidence-based teaching principles from ImPAACT to an asynchronous online training program incorporating online intervention elements from previous studies (e.g strategy description, video demonstration) to teach parents of children with ASD the SO(A)R strategy. SO(A)R is derived from evidence-based practices, and previous research supports that parents can successfully learn the skills included (e.g. modeling, expectant delay, responding).

All previous studies using ImPAACT taught communication partners strategies during shared book reading. Therefore, parents were taught to use SO(A)R in the context of a shared book reading activity for the current study.

The learning principles of the ImPAACT program are effective to teach communication partners strategies to implement during interactions with individuals who require AAC. However, ImPAACT has been mainly applied to in-person trainings. One study applied ImPAACT to a partially in-person training supplemented with a synchronous telepractice portion (Timpe et al., 2021). The application of ImPAACT learning principles to an asynchronous, online training platform needs to be evaluated. This can help determine if online training programs can serve as a valuable resource for families to improve outcomes for children with ASD. Research evaluating online training programs is needed to determine the effects on parent behaviors and communication behaviors of the child using AAC. Furthermore, investigation of parent education programs for children with ASD who are minimally speaking and learning to become symbolic communicators via AAC is highly needed (Koegel et al., 2020). The current study can contribute to determining how to develop and distribute efficacious training for parents of this population.

To evaluate the effects of an asynchronous, online training program for parents of children with ASD using AAC, the following research questions will be addressed:

1) What are the effects of an asynchronous, self-paced, virtual training program on parent/caregiver's ability to implement the *SO(A)R* strategy accurately when interacting with their child with ASD who uses AAC in the context of shared book reading?

2) What are the effects of an asynchronous, self-paced, virtual training program on parent/caregiver’s ability to implement AAC intervention techniques including aided AAC modeling, provision of an expectant delay, prompting, and responding when interacting with their child with ASD who uses AAC in the context of shared book reading?
3) What are the effects of an asynchronous, self-paced, virtual training program on parent/caregiver’s ability to generalize the SO(A)R strategy and AAC intervention techniques including aided AAC modeling, provision of an expectant delay, prompting, and responding when interacting with their child with ASD who uses AAC in an activity other than shared book reading?
4) What are parent/caregiver perceptions of an asynchronous, self-paced, virtual training program to teach use of the SO(A)R strategy to their child with ASD?

CHAPTER 2

METHODS

Participants

Approval for the study was obtained from the Pennsylvania State University Institutional Review Board prior to commencement of the study. Participants were recruited through personal contacts and flyers that were posted on online social media platforms (e.g. Facebook, Instagram). Parents who expressed interest in the study completed an eligibility screening. The following inclusion criteria were applied to parents: (a) caregiver to a child with an ASD diagnosis, (b) access to technology that allowed for the participation in a virtual, online training (e.g. computer, smart phone), (c) no known speech, language, or hearing impairments, (d) obtained at least a high school diploma or equivalent, and (e) having English as their primary language. The following inclusion criteria was applied to the children in the dyads: (a) received an official diagnosis of ASD from a medical professional (e.g. psychiatrist, neurologist), (b) absence of comorbid visual impairments, hearing impairments, or genetic disorders, (c) demonstrated little to no functional speech characterized by less than 20 words, (d) motor abilities allowed for independent symbol selection on an AAC device, (e) at were least 3 years of age at the time of the study, and (f) were able to attend to a shared reading activity for 10 minutes. Six parent-child dyads were initially recruited to participate in the study. One parent withdrew from the study due to unexpected health issues, resulting in a total of five parent-child dyads. Tables 2 and 3 provide descriptions of parents and children in the dyads, respectively. Pseudonyms are used when describing dyads to protect participant identity. Test scores reported below were provided by the parent/caregiver. No formal language testing was completed as part of the current study.

Table 2. Parent/Caregiver Participant Demographics

Participant	Age	Ethnicity	Location	Caregiver Role	Previous AAC Training	Employment Status	Highest Education Achieved
Dyad 1 (Margaret)	49 years	White	South Carolina	Grandmother	None	Unemployed	Associate's degree
Dyad 2 (John)	30 years	White	Virginia	Father	None	Full-time (≥40 hrs/wk)	Master's degree
Dyad 3 (Veronica)	39 years	White	Virginia	Mother	Some information received from SLP & ABA provider	Worked 3 jobs (≥50-55 hrs/wk)	Master's degree
Dyad 4 (Natalie)	41 years	Black	New York	Mother	None	Full-time (>40 hrs/wk)	Master's degree
Dyad 5 (Katie)	38 years	White	New York	Mother	None	Part-time (25-30 hrs/wk) + Enrolled as part-time nursing student (7 credits)	Associate's degree

Dyad 1 (Margaret & Alex)

Margaret and Alex live in the state of South Carolina. Margaret is 49 years of age, and she is Alex's grandmother. She reported her ethnicity as White, and her highest degree of education achieved was an associate's degree. Margaret was not employed during this study and stayed home to help care for Alex. Margaret reported that she had received no AAC training prior to this study. Alex (age 4;10) recently began learning how to communicate using the Picture Exchange Communication System (PECS; Frosty & Bondy, 2002) upon study commencement. Margaret reported that Alex was learning how to exchange one picture symbol to communicate a want/need, indicating that he was likely at Phase I or II of PECS. Alex communicated by pulling adults to items that he wanted but did not engage in social communication with people in his environment. Alex was diagnosed with ASD by a psychologist. Alex received a raw score of 47 on the Childhood Autism Rating Scale – 2nd Edition (CARS-II; Schopler et al., 1988), indicating severe symptoms of ASD. On the Preschool Language Scale – 5th Edition (PLS-5; Zimmerman et al., 2011), Alex received the following standard scores: 50 (Auditory Comprehension), 52 (Expressive Communication), 50 (Total Communication).

Dyad 2 (John & Matthew)

John and Matthew lived in in the state of Virginia. John (age 30 years) is Matthew's father. John ethnicity is white, and his highest degree of education achieved was a bachelor's degree. He worked a full-time job requiring at least 40 hours per week. John indicated that Matthew's SLP will sometimes provide him with teaching strategies for AAC via Zoom, but no formal AAC training was completed prior to this study. Matthew (age 5;9) was described as a nonverbal communicator who used LAMP Words For Life (grid size approximately 20-30 buttons). Matthew used LAMP on his device for requesting only and reported that Matthew was very good at requesting preferred things. Matthew usually used one button to communicate a want/need while using LAMP, but he was observed to use a two-button combination on a couple of occasions. Matthew was good at getting needs across by pointing or bringing people to things he wants, especially if he could not reach it. Matthew was diagnosed with ASD by a developmental pediatrician, and he received a score of 4 on the Standardized Test of Autism in Two Year Olds (STAT; Stone & Ousley, 2004), which is highly suggestive of ASD. Matthew also completed a BRIGANCE Screening – 3rd Edition (Brigance & French, 2013) at age 1;9. In the language development domain, he received a score of 1.0 with an age equivalent of <9 months, indicating below average skills. In the adaptive behavior domain, he received a score of 7.0 with an age equivalent of < 5 months, indicating below average skills.

Dyad 3 (Veronica & Frank)

Veronica and Frank lived in the state of Virginia. Veronica (age 39 years) is Frank's mother. Her ethnicity is white, and her highest level of education achieved was a master's degree. Veronica worked three jobs, consuming at least 50-55 hours per week. Veronica received some parent training from Frank's SLP for how to use his AAC device at home. She also received some training from the Applied Behavior Analysis (ABA) therapist during co-treatments with the SLP. Frank (age 8;2) used LAMP Words for Life to communicate on an iPad with a grid size of approximately 20-25 buttons. Frank communicated at home primarily using 1–3-word phrases to communicate wants/needs. Frank usually produced 1-word utterances when requesting something, and he pulled someone to the item he wants if his speech was unintelligible. Frank sometimes commented via speech during book reading with his mother with a lot of prompting. Frank used his AAC device more so at school when they are unable to understand him. Frank received a diagnosis of ASD from a neuropsychologist. Frank's mother shared a variety of paperwork with the primary investigator related to his ASD diagnosis, however it did not contain diagnostic test scores. Veronica is waiting to obtain a copy of his evaluation report from the neuropsychologist, which she will then share with the primary investigator. Accordingly, no ASD diagnostic scores are currently included for Frank. An attempt was made to administer the Clinical Evaluation of Language Fundamentals – 5th Edition (CELF-5; Wiig et al., 2013) to assess Frank's language abilities by a speech-language pathologist. Per the CELF-5 protocol, all subtests were discontinued due to Frank consistently scoring zero.

Table 3. Child Participant Demographics

Participant	Age	Language Assessment Scores	ASD Assessment Scores	AAC System
Dyad 1 (Alex)	4;10	PLS-5 Auditory Comprehension (SS=50) Expressive Communication (SS=50) Total Communication (SS=50) **December 2020*	CARS-II: Raw score: 47 **November 2021*	PECS Phase I/II
Dyad 2 (Matthew)	5;9	BRIGANCE Screening-III Lang. Dev. Score: 1.0 AE: <9 mos. **April 2017* Capute Scales Comm. Skills 6-8 month range **June 2017*	STAT: Score of 4 **June 2017*	LAMP Words for Life (~20-25 button grid)
Dyad 3 (Frank)	8;2	CELF-5 administered; all subtests discontinued due to consistently scoring 0 **June 2018*	*Obtainment of test scores in progress*	LAMP Words for Life (~25 button grid)
Dyad 4 (Tim)	11;6	TECEL Raw score: 55 AE: 21 mos, 30 days **March 2019* ROWPVT SS: <55 PR: <1 **February 2019*	CARS-2 T-score: 41 PR: 19 **October 2019*	TouchChat (~25 button grid)
Dyad 5 (James)	11;4	OWLS-II SS: 40 AE: 3;1 PR: <0.1 **February 2020* PPVT-5 SS: 40 AE: 2;6 PR: <0.1 **January 2020*	CARS-2 T-score: 66 PR: 95 **January 2020*	TouchChat (~25 button grid)

**Date the test was administered*

Dyad 4 (Natalie & Tim)

Natalie and Tim lived in the state of New York. Natalie (age 41 years) is Tim's mother. Her ethnicity is black, and her highest level of education achieved was a master's degree. Natalie worked a full-time job, consuming at least 40 hours a week. Natalie completed no parent training activities to teach AAC skills prior to this study. Tim (age 11;6) communicated using an AAC device with the TouchChat application (grid size approximately 25 buttons). Tim communicated primarily by requesting. He only communicated using TouchChat at home when he wants food, but nothing else. If Tim communicated for something other than food, he used hand gestures. Tim was diagnosed with ASD by a neurologist. He received a T score of 41 on the Childhood Autism Rating Scale – 2nd Edition, placing him in the 19th percentile. Tim received a standard score of <55 on the Receptive One Word Picture Vocabulary Test – 4th Edition (ROWPVT-4; Brownell, 2010), placing him in the <1 percentile. Tim was also administered the Test of Early Communication and Emerging Language (TECEL; Huer & Miller, 2011). He received a raw score of 55 and an age equivalent of 21 months, 30 days.

Dyad 5 (Katie & James)

Katie and James lived in the state of New York. Katie (age 38) is James's mother. Her ethnicity is white. Her highest education degree obtained was an associate's degree, and she held her Licensed Practical Nurse (LPN) license and was working on becoming a registered nurse. She worked part -time job (25-30 hour/week) and was enrolled as a part-time nursing student. Katie completed no AAC parent training prior to this study. James (age 11;4) used an AAC device with the TouchChat application to communicate (grid size approximately 25 buttons). James used is AAC device to communicate mainly to ask for what he wants. Mom reported that sometimes they used it when asking him a question. He also communicated wants and needs by bringing someone to an item or bringing a preferred item over to someone to ask for permission to access the item. James received an official diagnosis of ASD from a psychologist. He received a T-score of 66 on the CARS-II (Schopler et al., 1988). Standardized language assessments indicated severe language impairments. James was administered the Peabody Picture Vocabulary Test – 5th Edition (PPVT-5; Dunn & Dunn, 2007), and he received a standard score of 40 placing him in the <1 percentile. James was also administered the Oral and Written Language Scales – 2nd Edition (OWLS-II; Carrow-Woolfolk, 2011), and he received a standard score of 40 placing him below the 1st percentile.

Research Design

This study included the following phases: (a) baseline, (b) intervention, (c) post-intervention. During the baseline phase, parents engaged in reading a book with their child prior to completing the online training. When participants completed the baseline phase parents were sent the link to the online training to complete the intervention phase that consisted of the parent/caregiver completing the training. Parent/caregivers completed the training at their own pace. The post-intervention phase began once the online training was completed. During the post-intervention phase, parents engaged in book reading sessions with their child; they were instructed to use the SO(A)R strategy while reading with their child.

Generalization data was collected for two of the five participant dyads. Three participants dyads did not complete generalization measures due to unforeseen schedule conflicts that interfered with data collection (e.g. unplanned work trip). For generalization, parent/caregivers were asked to choose between two activities – either snack or play – to engage with their child. During baseline, one generalization video was obtained during which caregivers were instructed to engage in the predetermined activity with their child for 8 minutes with the AAC device available and open to the corresponding pre-programmed vocabulary page. One generalization video was then obtained during the post-intervention phase. During the post-intervention generalization activity, parents/caregivers were provided with instructions to follow procedures similar to baseline, but to use the SO(A)R strategy throughout the activity.

A single-case randomized multiple-probe across participants design was used to evaluate the effects of the online training on parent/caregiver's ability to implement strategies with their child with ASD who communicated via AAC. Randomized multiple-baseline across participants single-case design (SCD) represents the most rigorous inference design and may be the strongest design in the entire class of SCD due to its analogous structure with traditional group experiments in which participants are randomly assigned to experimental conditions (Kratochwill & Levin, 2014). It is also considered to have greater population external validity because it provides multiple independent sources of intervention-efficacy evidence (Kratochwill & Levin, 2014). Randomization can be similarly applied in multiple-probe designs (MPD) across participants (Ledford, 2018), which was determined to be the most appropriate approach for this study to control for the likelihood of testing threats and to make the baseline condition less aversive for the parents participating in the study (Ledford & Gast, 2018).

Randomization was applied to the current study via randomized phase-order, which includes randomly assigning participants to predetermined, staggered intervention start points (Kratochwill & Levin, 2014; Ledford & Gast, 2018). Consistent with procedures for using randomization in SCD, the investigator determined baseline lengths (i.e. number of data points to collect and when) and staggered intervention start points for each of the three tiers prior to the study beginning (Kratochwill & Levin, 2014; Ledord & Zimmerman, 2022). Baseline lengths and data points were determined using the following What Works Clearinghouse Standards: (a) the first three baseline sessions must overlap vertically, (b) three consecutive probe points should be included prior to introduction of intervention, (c) cases not receiving the intervention must have a probe point where another case first receives intervention, and (d) at least five data points per phase.

A randomized multiple-probe design requires replication across participants with repetition of the intervention sequentially introduced across phases of the design (Kratochwill & Levin, 2014). The current study met these replication requirements by introducing intervention sequentially to participants across three tiers. Participants were randomly assigned to the pre-determined staggered intervention start points, placing them in either Tier 1, 2, or 3. Two participants were originally included in each tier of the study. As previously mentioned, attrition occurred for one participant who was assigned to Tier 3 during baseline data collection. As a result, Tier 1 included two participants, Tier 2 included two participants, and Tier 3 included one participant.

The limitation of using randomly assigned and predetermined baseline lengths is the removal of response-guided decision making, which could result in increased difficulty identifying a functional relation if baseline patterns are problematic (e.g. highly variable, increasing trend) (Ledford & Gast, 2018; Ledford & Zimmerman, 2022). In traditional SCD, a functional relation is considered to exist between the dependent variable and the intervention "… when the design documents three demonstrations of the experimental effect at three different points in time with a single participant or across different participants" (Horner et al., 2005, p. 168). Therefore, response-guided decisions are often made to increase to chances of identifying a functional relation based on data patterns. While Horner's recommendation of three demonstrations of experimental effect is considered a conceptual norm among published papers, there is no empirical basis for this recommendation (Kratochwill & Levin, 2010).

The use of predetermined baseline lengths creates a response-independent design as intervention is introduced at the predetermined start points regardless of baseline performance.

First, predetermined baseline lengths were selected for the current study to improve ethical treatment access. The use of response-guided designs can cause significant delays in access to potentially effective treatments for participants assigned to later tiers (Gregori et al., 2021), and results in participants assigned to later tiers going a considerable amount of time without any intervention (Ledford & Zimmerman, 2022). The current study aimed to enroll children with ASD who are minimally speaking, suggesting severe language impairments and likely challenging behaviors. Due to the unpredictability of child behaviors, there was a high risk of variable data resulting in extended baseline phases and ultimately, participants in later tiers waiting a substantial amount of time before receiving intervention. Therefore, it was decided to use a design with predictable baseline lengths. In addition, predictable baseline lengths allowed the investigator to give the participants a more accurate estimate of the length of enrollment in the study, making participation a more positive experience for parents/caregivers (Ledord & Zimmerman, 2022).

Second, predetermined baseline lengths with response-independent methods may more accurately identify intervention efficacy or lack thereof (Ledford & Zimmerman, 2022). Researchers often modify an intervention if participants fail to meet some criterion during the intervention condition before introducing the original intervention to the following participant(s). However, reporting of non-effects observed from interventions is critical to informing high-quality future studies (Tincani & Travers, 2018; Ledford & Zimmerman, 2022). A response-independent method was selected for this study in order to accurately identify the sole efficacy of the online training on communication behaviors without the requirement of an additional intervention from the investigator. The effects of the online training on each parent/caregiver informs important future research for evaluating and developing parent training programs for this population. Moreover, the attention of the participants to the information included in the online training may have been skewed if they were aware that they would be provided with direct coaching and/or feedback from the investigator after the training.

Finally, predetermined and randomly-assigned baseline lengths were used to reduce bias. When using a response-guided design, tier assignment decisions may be impacted by the fact that studies demonstrating effects are more likely to be published (Ledford, 2018). For example, researchers may assign the participant(s) who are most likely to demonstrate maturation effects to the first and shortest baseline condition. Therefore, randomization strengthens the study by helping to control for threats to internal validity.

Independent Variable (Virtual Training)

The SO(A)R strategy was taught to caregivers using the online training platform Articulate 360. Techniques taught to parent/caregivers during the virtual training to support communication from their child using AAC included (a) modeling, (b) expectant delay/wait time, (c) prompting a response, and (d) contingent responding. The mnemonic SO(A)R was created to enhance memorization and fluency of strategy implementation. The letters within the mnemonic represent the following strategies: *S* - *"Show"* (parents show the child how to use the device by modeling selection of a message); *O* - *"Opportunity"* (parents provide an expectant delay of 5 seconds so the child has an opportunity to access the AAC system); (*A)* - *"Assist"* (parents assist or prompt the child to use the device if the child does not access the AAC system independently following the expectant delay); *R* - *"Respond"* (parents respond contingently to the child's communication). The following sections provide in-depth descriptions of the online training.

Lesson 1: Introduction & Commitment. The first portion of the virtual training provided information about known benefits of the skills incorporated in the strategy when communicating with individuals using AAC. This was accomplished via written text and visuals on the screen accompanied with audio narration. Lastly, participants actively committed to the instructional program by selecting a response from a multiple-choice question in order to make a conscious commitment to learning the strategy by selecting a button indicating, "Yes, let's get started! Participants were only permitted to move forward in the training if they selected the "Yes" button.

Lesson 2: SO(A)R Description. Participants were provided with a visual representation of the SO(A)R strategy. Each skill in the SO(A)R strategy and the known benefits was described individually. Participants were provided with images depicting use of each skill in addition to the known benefits of using each skill. For example, the skill associated with "S" (Show use of the device or aided modeling) was described followed by a description of the positive effects of modeling on an AAC device (e.g. can increase vocabulary learning). The strategy was then reviewed again in its entirety. Participants were required to complete a matching activity to match each skill in the SO(A)R strategy with its described action. For example, "Opportunity" was accurately paired with the description to "Wait quietly for 5 seconds." Once participants accurately matched each skill in the strategy with the appropriate definition, they were permitted to move to the next phase in the training.

Lesson 3: SO(A)R Demonstration. Participants watched video models of each step in the SO(A)R strategy individually in the order in which they should occur. Participants could replay the video for each step as many times as they liked and chose when to move onto the video for the following step. Two video models for each skill were included in the training. Next, participants watched video models of the steps of the strategy combined. Think aloud statements were included and paired with each strategy step. For example, when demonstrating how to "show use of the device," the following think aloud statement might be included, "I chose to model the vocabulary word for Elsa because I know that is the child's favorite Disney character." Participants could rewind, fast forward, and rewatch video models as many times as desired.

After observing the video models, participants then watched videos and responded to multiple choice questions to further promote metacognitive thinking for strategy implementation. Questions required participants to make decisions about what they would do next and why based on the video provided. For example, the video may have shown that the communication partner completed step 1 ("S" - show how to use the device) and step 2 ("O" - opportunity for the child to respond), however the child still did not respond after the five second wait time. A potential multiple-choice question inserted at this point would be:

What would you do next?

A) Show use of the device

B) Assist the child in using the device (correct)

C) Continue to wait

Participants were provided feedback for both correct and incorrect responses immediately after answering the question. For example, if the participant chose "B" above as their response, the feedback said "That's right! The child has not communicated independently during the given opportunity, so now it's time to Assist the child to use the device – first by pointing, and then by guiding the child's hand to the button if needed." If the participant responded incorrectly and chose "C" above as their response, the feedback would say, "Incorrect. The parent has waited 5 seconds and given the child an opportunity to respond. Now, it's time to assist the child to use the device by first pointing, and then guiding the child's hand to the button if needed." Participants needed to answer 100% of questions correctly in order to move onto the next portion of the training.

Lesson 4: Let's Memorize! Participants engaged in rote verbal rehearsal of strategy steps and were asked to describe and explain the importance of each strategy step. The mnemonic device SO(A)R was used to promote memorization. Participants completed a flashcard task to review the importance of each strategy step. They were instructed to click on the flashcard with the skill label on it. After clicking on the flashcard, it would flip over and list the benefits of using each skill in the SO(A)R Strategy. Following this, there were three flashcards on the screen with "SO(A)R" on the front. Participants were instructed to flip each flashcard and read the listed strategy steps on the back of the flashcard aloud. Participants were encouraged to continue this activity as many times as they desired until they felt they had verbally memorized the steps in the strategy.

***Lesson 5: Let's Practice*.** To monitor accurate use of the SO(A)R strategy, participants engaged in another multiple choice activity called "Was SO(A)R Used Correctly?" Participants viewed videos of strategy implementation and responded to questions to determine if SO(A)R was used correctly or incorrectly. Feedback was provided for both correct and incorrect responses. If SO(A)R was used incorrectly in the video, participants responded to a follow up question to identify which strategy step was in error. For example, a video might include a communication partner showing how to use the device (S), providing an opportunity to respond (O), assisting the child in accessing the device (A), and then turning the page of the book. The error in this scenario is the communication partner did not respond to the child's communication (R). Feedback on responses to questions was provided along with explanations as to why the error was made. For example, feedback would indicate, "You're right! The communication partner failed to respond to the child's communication. Rather, they turned the page." Participants needed to answer 100% of questions correctly in order to move onto the next portion of the training.

One key element of this phase of the intervention is that communication partners begin to get hands on practice. Therefore, communication partners were asked to retrieve the AAC device, a book, and the visual handout provided with the SO(A)R strategy pictured to engage in hands on practice. This allowed for practice in a highly controlled context without the child present. Parents were asked to practice SO(A)R with at least one full book before moving onto the next portion of the training. Parents were reminded they were able to practice with as many books as they would like.

Lesson 6: Practice With Your Child. Parents were instructed to practice implementing the *SO(A)R* strategy while reading with their child. After practicing, parents were provided with a self-evaluation to identify what skills they felt confident using and what skills they wanted to improve. Parents were encouraged to practice as many books as they liked and to complete the self-evaluation to monitor their strategy use.

Lesson 7: Complete! Additional examples of activities in which the SO(A)R strategy could be used were provided (e.g. snack, play) via visual images and text on the screen. Parents were provided with a certificate of completion and instructed to send a screenshot of the certificate to the investigator to indicate the training was complete.

Materials

Visual Representation of SO(A)R

When the intervention phase began, participants were mailed a laminated page including a visual representation of the SO(A)R strategy. Parents were told it could be used as a visual support and to have it available while they were reading with their child to remind them of steps in the procedure

Books

Participants were each provided with ten personalized books based on the interests of the child. The investigator gathered information from the parents about topics the child would want to communicate about (e.g. ice cream, the pool, family members). This was done in an effort to increase the child's motivation to participate in the activity and promote learning of meaningful, functional vocabulary that could be used outside of the book reading activity. All books were created electronically via the Pictello application (AssistiveWare B.V.). Pictello is an iPad educational application that allows for the easy creation of electronic books using personalized photographs and text. In addition, hard copies of books were mailed to participants. All participants were provided with funding to purchase the Pictello application, and participants were given the option to read the books using the Pictello app on an iPad or to use the hard copies provided. All participants chose to use the hard copies of books while reading with their child and indicated that reading on the iPad would be too distracting to the child. The creation of the books incorporated guidelines from Kent-Walsh et al. (2003) and Yorke et al., (2018). Books (a) had illustrations, specifically large, colorful photos of target vocabulary items (b) included text within the child's zone of proximal development for overall comprehension, (c) incorporated vocabulary that was of high interest to the child and appropriate to the child's development, and (d) used simple language. Each book page contained large, colorful photos of vocabulary items that were of high interest to the child in addition to 2 to 3 simple phrases (e.g. “I see a clownfish. The clownfish is orange and white.”). Appendix A includes the book topics for each participant.

AAC technology

All participants were provided with an iPad with the TouchChat application pre-programmed by the investigator. The investigator programmed one vocabulary page (25-button grid size) to correspond with each book. The vocabulary pages included vocabulary relevant to the story including people, objects, places, adjectives, and actions. All participants were provided with 10 vocabulary pages containing 25 buttons each to keep the grid displays consistent across participants. Four of the five children participating in the study used a grid display on their current AAC system (e.g. TouchChat, LAMP), so a grid display was deemed most appropriate. The youngest participant, Alex had just begun to learn to use picture symbols to communicate via PECS and had not yet begun discriminating picture symbols prior to this study. However, keeping vocabulary displays consistent across the parents was important to ensure that a more complex or simple display did not impact a parent’s ability to implement target skills.

Procedure

Baseline Phase

Baseline measures were collected via video recording. Parent/caregivers were instructed to read one of the provided books with their child with the AAC device within reach and opened to the vocabulary page corresponding with the selected book. Parent/caregivers were instructed to interact with their child as they typically would during the reading activity. Parent/caregivers either sent data videos to the investigator via email or text or the investigator recorded the data sessions on Zoom. No feedback or instructions were provided during the Zoom recording sessions. The primary investigator determined a priori that five data points would be collected during baseline for participants in Tier 1, 7 data points would be collected during baseline for participants in Tier 2, and 8 data points would be collected during baseline for participants in Tier 3. Figure 4 illustrates the predetermined baseline measures.

Intervention Phase

Once the appropriate number of baseline measures had been collected, the investigator sent the parent/caregiver a link for the online training via email and via text. Participants were instructed that they could complete the online training from their computer, iPad, or Smart Phone. Adult participants were asked to complete the training within the week, but if more time was needed, it would be provided. Upon completion of the training, the participants sent the investigator a screenshot of the completion certificate located in the last training module to verify that they had completed all modules within the training.

Post-Intervention Phase

Similar to baseline, post-intervention measures were collected via video recording. Parent/caregivers were instructed to read one of the provided books with their child with the AAC device within reach and opened to the vocabulary page corresponding with the selected book. Parent/caregivers were instructed to use the SO(A)R strategy while reading with their child. Parent/caregivers either sent data videos to the investigator via email or text or the investigator recorded the data sessions on Zoom. No feedback or instructions were provided during the Zoom recording sessions. The investigator determined a priori that 8 data points would be collected during post intervention for participants in Tier 1, 7 data points would be collected during baseline for participants in Tier 2, and 5 data points would be collected during baseline for participants in Tier 3. The intervention was not introduced to a sequential tier until 5 post intervention videos were collected from participants in the previous tier. Figure 4 illustrates the predetermined post-intervention measures.

		PHASE I					PHASE II				PHASE III					PHASE IV				PHASE V					PHASE VI			PHASE VII				
TIER 1	Dyad 1	BL1	BL2	BL3	BL4	BL5	INTERVENTION				PIV 1	PIV2	PIV3	PIV4	PIV5							PIV6		PIV7						PIV8		
				BL-GEN									PIV - GEN																			
	Dyad 2	BL1	BL2	BL3	BL4	BL5	INTERVENTION				PIV1	PIV2	PIV3	PIV4	PIV5							PIV6		PIV7		P1IV7*				PIV8		
						BL GEN							PIV -GEN																			
TIER 2	Dyad 3	BL1	BL2	BL3			BL4						BL5	BL6	BL7	INTERVENTION				PIV1	PIV2	PIV3	PIV4	PIV5						PIV6		
													BL-GEN										PIV-GEN									
	Dyad 4	BL1	BL2	BL3			BL4						BL5	BL6	BL7	INTERVENTION				PIV1	PIV2	PIV3	PIV4	PIV5						PIV6		
														BL - GEN									PIV - GEN									
TIER 3	Dyad 5	BL1	BL2	BL3			BL4									BL5						BL6	BL7	BL8	INTERVENTION			PIV1	PIV2	PIV3	PIV4	PIV5
																							BL - GEN								PIV - GEN	

Note. BL=Baseline; PIV=Post-Intervention; GEN=Generalization. All boxes highlighted in yellow represent predetermined baseline measures that were obtained from participants. All boxes highlighted in green represent predetermined post-intervention measures that were obtained from participants. All boxes highlighted in gray were planned data points to include, however the data was not obtained due to unpredictable conflicts (e.g. work trip, COVID).

PIV7* Received the data point, but not during the predetermined phase.

Figure **4**: Predetermined phase measures and staggered intervention start points.

Generalization

Generalization data was collected from three of the five participant dyads. For generalization, parent/caregivers were asked to choose an additional activity to engage in with their child during the study – either snack or play. The investigator gathered information from the parent/caregivers about the generalization activity to determine appropriate vocabulary to program for the generalization activity (e.g. child's preferred snacks or preferred toys). One vocabulary page for the generalization activity was programmed for each participant. Generalization vocabulary pages included sentence starters (e.g. "I want, I see, I like") in addition to attributes, verbs, nouns, and phrases (e.g. "My turn!" for play time).

One generalization video was obtained during baseline and one generalization video was obtained during the post-training phase. During baseline, parent/caregivers were instructed to interact with their child as they naturally would for eight minutes while engaging in the predetermined activity (i.e. snack or play) with the AAC device within reach. During post-intervention, parent/caregivers were instructed to interact with their child during the same activity for eight minutes with the AAC device within reach while using the SO(A)R strategy. All generalization videos were recorded by a third party in the household and sent electronically to the investigator via email.

Social Validity

Social validity (Schlosser, 1999) measures were included to evaluate parent perspectives of perceived intervention outcomes, ease of use of the instructional techniques, generalizability, and overall benefit to their children. Social validity measures were modified from Timpe et al. (2021). Parent/caregivers were provided with a survey via Penn State Qualtrics including a 5-point Likert Scale (*1 = Strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 – agree, 5 = Strongly agree*) in addition to open-ended questions. Table 8 provides the means and ranges for responses to survey questions that included the Likert Scale. Appendix B includes the social validity survey and open-ended questions sent to participants.

Data Collection

Video Recordings

All data sessions (i.e. baseline, post-intervention, generalization) were video recorded. One parent/caregiver recorded the sessions himself by setting up a camera in a stationary location throughout the session. Other parent/caregivers used a third party (e.g. child’s aunt, dad) to record the parent/caregiver and child engaging in the book reading activity. Videos were sent electronically to the investigator via email or text message or uploaded to a secure Google Drive, as requested by the parent/caregiver. One parent/caregiver participated in the book reading sessions while on Zoom with the investigator. These Zoom sessions were recorded and saved as data videos. The investigator only provided feedback during the Zoom sessions if the camera angle needed to be adjusted. Parent/caregivers were instructed to include themselves, the child, the book, and the AAC device screen in the camera frame. All participants completed the reading sessions and generalization sessions in their home.

Data Analysis

Dependent Variables

The primary dependent variables examined in this study were fidelity of implementation of the SO(A)R strategy by the parents and use of individual skills (e.g. modeling, prompting) within the SO(A)R strategy. The frequency or number of times the SO(A)R strategy was used correctly in addition to the number of times the parent/caregivers used aided AAC modeling, expectant delays, prompts (i.e. pointing prompts and manual prompts), and provided responses to their child's communication (i.e. confirming and expanding responses) were counted for each book reading session. The secondary dependent variables examined in this study were child communication acts, including the frequency of independent AAC selections, and prompted AAC selections. Operational definitions for dependent variables are provided in the Data Coding section.

Transcription

All data videos were transcribed by the primary investigator to capture spoken language and communicative acts. Videos were repeatedly viewed by the investigator and content was transcribed onto a Microsoft Excel (Microsoft Corporation, 2018) spreadsheet. Parent/caregiver behaviors that were transcribed included speech, AAC selections, pointing to the device and the book, providing manual prompts to the child, and turning the page in the book. Child behaviors that were transcribed included intelligible speech or speech approximations, AAC selections, and pointing to the device and the book.

Data Coding

The transcripts were then coded for dependent variables for the parent/caregivers and children in each dyad. Parent/caregiver behaviors coded in the transcripts included modeling, providing an expectant delay, prompting (pointing, manual), and responding (confirming, expanding) to their child's communication. The primary dependent variable was procedural fidelity of the SO(A)R strategy. The SO(A)R strategy was used accurately if parents exhibited the skills in the strategy in the correct order. Specifically, parents used SO(A)R accurately if behaviors were exhibited in the following sequence: modeling, expectant delay, pointing prompt, manual prompt, respond to child's communication.

The goal of the SO(A)R strategy is to have the child communicate independently and spontaneously using the AAC device. Therefore, if the child communicated at any point during the book reading or during the sequence of the SO(A)R strategy and the parent responded to their child's communication by either confirming or expanding the message, the SO(A)R strategy was coded as accurate.

Individual skills from the SO(A)R strategy (i.e. modeling, expectant delay, prompting, responding) were coded as dependent variables. Each dependent variable was operationally defined and assigned a color code in the transcript to indicate when a specific behavior occurred in the interaction. Modeling, coded as yellow, was operationally defined as the parent/caregiver making an AAC selection for a vocabulary term from the book. Further, to be coded as modeling, an AAC selection by the parent/caregiver could not be in direct response to the child communicating a message. The latter would be considered a response and responses were coded separately. Each individual button on the AAC device representing a vocabulary item that was selected by the parent/caregiver was counted as one model. For example, if the parent/caregiver was reading a book about Goodnight Moon and they selected two buttons to model "Goodnight" + "Moon," it was counted as two occurrences of modeling.

Provision of an expectant delay, coded as orange, it was operationally defined as the parent waiting quietly for at least three seconds without prompting the child. In order for a behavior to be counted as provision of an expectant delay, parents/caregivers could not be engaging in other behaviors (e.g. turning the book page).

Prompts provided by the parent were coded as either a pointing prompt or a manual prompt. A pointing prompt, coded as pink, was operationally defined as the parent pointing to a specific button on the AAC device to cue their child to press that button. Each button pointed to by the parent/caregiver was counted as one occurrence of pointing. For example, if the parent/caregiver pointed to the two buttons for "pop" + "bubbles" for the child to communicate "pop bubbles," it was counted as two occurrences of a pointing prompt. A manual prompt, coded as red, was operationally defined as the parent/caregiver making physical contact with the child's hand or arm to guide it to press a button on the device. Similar to the pointing prompt, each button that the parent manually prompted the child to press was counted as one occurrence of manual prompting.

Responding behaviors were coded as either confirming the child's message or expanding the child's message. Responding to the child's communicated message by confirming, coded as light green, was operationally defined as the parent repeating the child's message, either in isolation or in a phrase, within the next utterance. For example, if the child communicated "SpongeBob," the parent could respond by saying "SpongeBob!" in isolation or using it in a phrase such as, “Yes, that’s right, it’s SpongeBob!” Finally, responding to the child’s communicated message by expanding the message, coded as dark green, was operationally defined as the parent expanding their child’s message by selecting an additional button on the AAC device. For example, if the child communicated a 1-button message (e.g. “swim”), the parent could respond by expanding the message to a 2-button message (e.g. “go” + “swim”).

Additional secondary dependent variables included child communication, specifically AAC selections and speech and/or speech approximations. Child communication via AAC was coded as independent, independent with a spoken cue, or prompted. Independent communication from the child included speech or any AAC selection that was not performed as the result of the parent pointing to the target button or making physical contact with the child’s hand or arm to guide it to the button. Child communication that was independent with a spoken cue included any AAC selections or speech that was in response to a spoken cue from the parent/caregiver. Spoken cues included “WH” questions (e.g. “Where is the blowfish?”), spoken directives from the parents (e.g. “Tell me on the iPad”), or cloze sentence cues (e.g. “I watch Dora on _____”). Child communication that was prompted included AAC selections that were made as the result of the parent/caregiver pointing to a button on the device or the parent/caregiver providing the child with a manual prompt to select a button.

The number of different words (NDW) was also calculated for each transcription. The NDW for the parents included the number of different vocabulary selections the parent made throughout the activity. These included vocabulary selections with the purpose of modeling on the device and vocabulary selections that parents might have made when responding to the child’s communication, either by confirming it or expanding it. The number of different words for children included the number of different AAC vocabulary selections made throughout the activity. The number of different words was calculated for the child's independent communication, prompted communication, and overall communication (independent and prompted communication combined).

Inter-Observer Agreement

Prior to this study beginning, two research assistants trained with the primary investigator to complete inter-observer agreement checks. During training, the research assistants met with the primary investigator to learn about the SO(A)R strategy and the operational definitions for each behavior in the SO(A)R strategy. In addition, the research assistants completed the online training intervention that was completed by the parent/caregiver participants. The research assistants then viewed 48 videos of the primary investigator using the SO(A)R strategy with typically developing kids during a reading activity. The videos were created by the primary investigator to include in the training as video models of SO(A)R being used both correctly and incorrectly (e.g. the parent fails to provide an expectant delay). The order of the 48 videos was randomized to ensure that correct models of the SO(A)R strategy and various incorrect models of the SO(A)R strategy randomly occurred. Research assistants watched each video and coded the behaviors they observed. Initial agreement between the primary investigator and research assistants for coded behaviors was 98%. Agreement for training videos reached 100% consensus after discussion among study team members.

After completing the coding training, the same two research assistants completed inter-observer agreement checks for transcription content and coding of parent/caregiver and child behaviors for the current study. Transcription content was checked for accurate recording of communication from both the parent/caregiver and the child. Parent/caregiver communication and behaviors included in transcriptions were speech, AAC selections, pointing to the device, and guiding the child's hand to the device in addition to activity relevant actions (e.g. turning the page, pointing to book picture). Child communication and behaviors included in transcriptions were intelligible speech approximations, AAC selections, symbolic gestures and/or signs, and activity relevant actions (e.g. pointing to book pictures). No child used gestures for communication during the interactions. One child used the manual sign for "yes" on two occasions throughout the study, however this was not included in the data coding. Reliability checks for transcription content were completed for ~21% of transcriptions. Transcriptions were randomly selected from each dyad and each phase (Douglas et al., 2017). Agreement between the primary investigator and research assistants was 99.7 %.

The same two trained research assistants completed inter-observer agreement checks for coding of dependent variables for ~21% of video transcripts that were randomly selected from each dyad and each phase (Douglas et al., 2017). Video transcripts were recorded on Excel (Microsoft, 2010) spreadsheets, with each row containing communication (speech and AAC selections) and behaviors (e.g. pointing) in the order that they occurred throughout the interaction. Trained research assistants assigned appropriate color codes to video transcripts while watching participant data videos. The research assistants were masked to the phases the participants were in. Transcripts color coded by the primary investigator and the research assistants were compared. Initial agreement was 97.7%. IOA reached 100% after discussion among the study team members.

Visual Analyses

Visual analyses of the data were conducted to determine (a) if there is a relationship between the independent variable (i.e. online training program) and the dependent variables and (b) the strength or magnitude of that relationship (WWC, 2020). Visual analysis of level, trend, and variability was conducted within each phase and each participant. Immediacy of change, variability, and consistency were visually analyzed across phases (WWC Standards; Ledford & Gast, 2018).

Visual analysis was used to determine the presence of an intervention effect. Changes in level and trend of data patterns across two adjacent conditions indicate the presence of an intervention effect (Ledford & Gast, 2018). Participants did not receive ongoing intervention following baseline due to the intervention being provided *prior to* and *not during* the post-intervention phase. Therefore, it was not expected that data patterns would demonstrate an increasing trend during the post-intervention phase. However, a change in the level of data patterns from baseline to post-intervention would be critical to demonstrate an intervention effect. A clear change in level demonstrates a basic effect, and three basic effects demonstrates a functional relation (Cooper et al.,2021). Immediacy of change was analyzed to determine magnitude of effect, as an abrupt change in level provides a clear indication of behavior change and suggests a "powerful" intervention (Ledford & Gast, 2018).

Statistical Analyses

It is recommended that SCD research studies include an effect size estimate to evaluate the magnitude of effects and non-overlapping data. Visual analyses were supplemented with standardized mean difference (SMD) and non-overlap (i.e. Tau-U) effect sizes to satisfy these recommendations. Between-case standardized mean difference (SMD) or *HPS d* (Hedges, Pustejovsky, & Shadish, 2012; 2013) is recommended as a parametric effect size measure in SCD (Ledford & Gast, 2018). *HPS d* is a statistical model in which the effect size parameter corresponds to the standardized mean difference (Cohen's *d*), allowing for the demonstration of treatment effect in SCD on the same metric often used in between-subject design. This results in an effect size measure that takes between-participant variability into account, apart from within-participant variability (Ledord & Gast, 2018), and describes the average magnitude of effects across all participants in the study. This measure was calculated using a web-based calculator at https://jepusto.shinyapps.io/scdhlm (Pustejovsky, 2021).

It is recommended that more than one effect size be used based on the lack of consensus for best effect size metric in SCD (Manolov & Moeyaert, 2017). Tau-*U* measures were included as a measure of effect size to evaluate magnitude of effect for each participant individually. In addition, a weighted Tau-*U* was calculated for each dependent variable. Tau-*U* calculates non-overlapping of all pairs (NAP) with consideration for trends in the data over time (Parker et al., 2011). Tau-U measures were calculated using the online Tau-U calculator (Vannest et al., 2016). Tau-U effect sizes range from 0 to 1 and are interpreted as small (< 0.65), medium to large (.66-.92), or large (.93-1.0) (Vannest & Ninci, 2015). Tau-U values for dependent variables can be found in Tables 4 and 5 for adults and children, respectively.

Procedural Reliability

Procedural reliability was unable to be directly observed due to the asynchronous nature of the intervention in this study. However, features were included in the online training in an attempt to ensure participants completed each module. To move onto the next module in the training, participants selected a "Continue" button on the bottom of the screen. This "Continue" button was locked until the participants completed all activities within the current module. For example, if a module required participants to click on virtual cards for information to be revealed, the "Continue" button was not active until all the virtual cards had been clicked on. In addition, participants were not permitted to select the "Continue" button until all comprehension questions (e.g. multiple choice, matching) within a module were answered correctly. If participants did scroll to the bottom of a module and try to click the "Continue" button before the module content was complete, they were given a prompt such as, "Please answer all the questions above correctly to move on."

When participants reached the final module, a completion certificate was on the screen. Participants were instructed to send a screenshot of the completion certificate to the primary investigator. Post-intervention data collection did not begin until the primary investigator received the image of the completion certificate.

CHAPTER 3

RESULTS

The majority of participants completed the online training on their Smart Phone (n=3), and the remainder completed it on their laptop (n= 2). The duration range for completion of the entire training was 1-2 hours. The mean, median, and range values were calculated for each dependent variable and each phase (i.e. baseline, post-intervention) and are represented in Table 6 and Table 7 for the adults and children, respectively. Median values were included in addition to mean values as they are recommended to represent level because SCD studies contain relatively small numbers of data points, and median values are less susceptible to influence from outliers (Cooper et al., 2021; Ledford & Gast, 2018). Results for each individual caregiver/child dyad, including visual interpretation of graphs and Tau-*U* nonoverlap calculations, are reported below. See Tables 4 and 5 for a comprehensive report of Tau-*U* calculations for each dependent variable for caregivers/parents and children, respectively.

The goal of the current study was to evaluate the effects of a completely asynchronous, online training to teach parents/caregivers the SO(A)R strategy during shared book reading with their child to support their child's communication via AAC. Visual analyses of the graphs revealed four basic effects from baseline to intervention (i.e. Dyad 1, Dyad 2, Dyad 4, and Dyad 5), demonstrating a functional relation between the online training and parent use of the SO(A)R strategy. Tau-*U* nonoverlap calculations of 0.85 (Dyad 1), 1.00 (Dyad 2), 1.00 (Dyad 4), and 1.00 (Dyad 5) revealed medium to large effects for the caregivers' strategy use. The between case standardized mean difference (SMD) was calculated to describe the average magnitude of effects of the intervention on parents' use of the SO(A)R strategy across all participants in the study. The between cases standardized effect size for parent strategy use was 1.838, *SE* = 0.444, 95% CI [0.890, 2.785]. This standardized effect size corresponds with Cohen's *d*, and thus, this indicated a large effect size (Cohen, 1988).

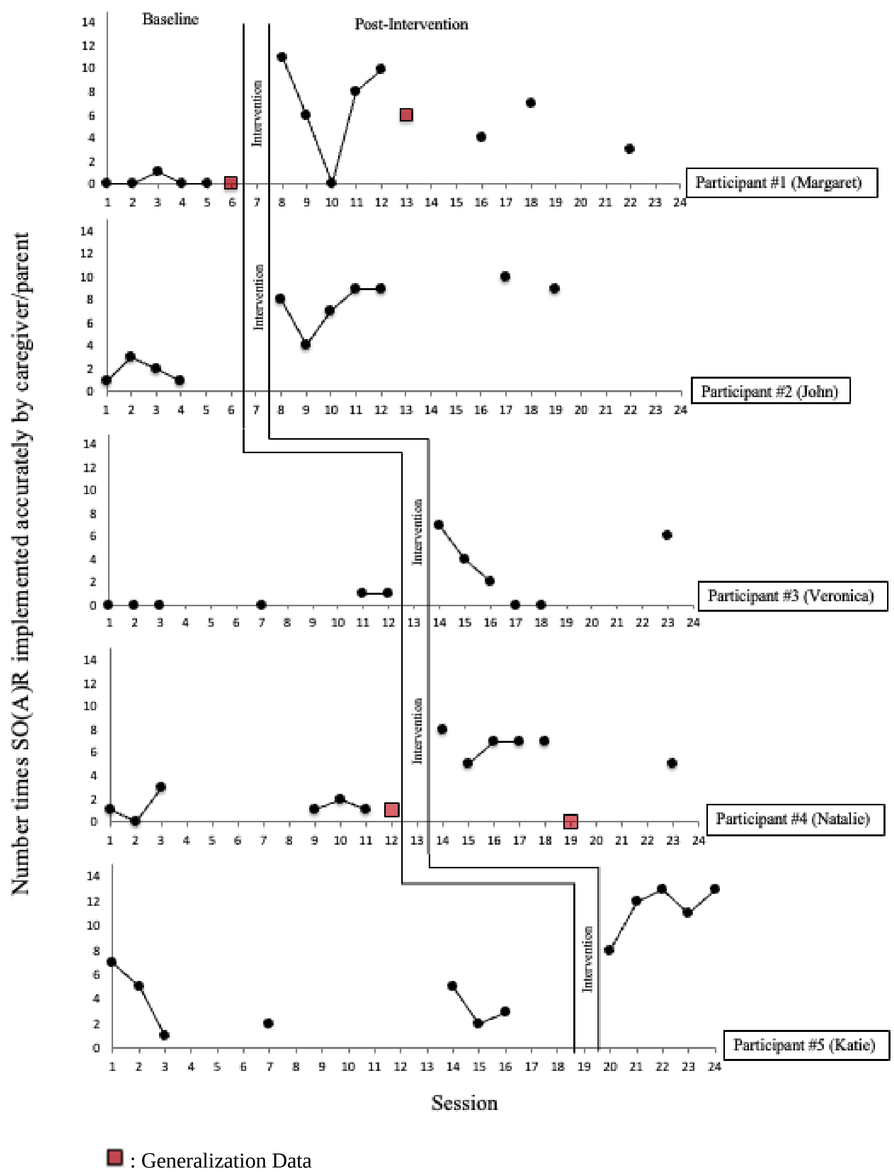

Figure **5**: Number of times caregivers accurately implemented the SO(A)R strategy.

Additionally, this study evaluated the impacts of the online training on parent/caregiver use of individual skills (i.e. modeling, providing an expectant delay, prompting, and responding) within the context of the interaction with their child. A functional relation was observed between the online training and the provision expectant delays while caregivers/parents interacted with their child. Visual analyses of the graphs revealed four basic effects from baseline to intervention (i.e. Dyad 1, Dyad 2, Dyad 3, and Dyad 5), demonstrating a functional relation. Tau-*U* nonoverlap calculations were 0.88 (Dyad 1), 1.00 (Dyad 2), 1.00 (Dyad 3), and 1.00 (Dyad 5) for each baseline to post-intervention phase comparison, suggesting medium to large effects across individual parent/caregiver participants. The between case (SMD) was calculated to describe the average magnitude of effects of the intervention on the use of expectant delays across all participants in the study. The between cases standardized effect size for the expectant delay variable was 1.686, SE = 0.352, 95% CI [0.975, 2.396] indicating a large overall effect size (Cohen, 1988).

Finally, this study also assessed the impacts of the parent/caregiver completing the online training on the communication behaviors of the child during the shared book reading activity. Functional relations were observed for prompted child communication, the NDW communicated by the child when prompted, and independent communication in response to a spoken prompt. Visual analyses of the graphs indicated a functional relation for prompted child communication as intervention effects were observed for Dyads 1, 3, and 5. Tau-*U* was calculated to be 1.00 (Dyad 1), 1.00 (Dyad 3), and 0.97 (Dyad 5), suggesting large effects of the intervention on child prompted communication for each of these individual dyads. The between case standardized mean difference (SMD) was calculated to describe the average magnitude of effects of the intervention on child prompted communication across all participants in the study. The between cases standardized effect size for prompted child communication was 0.799, *SE* = 0.398, 95% CI [-0.020, 1.617] indicating a medium to large overall effect of the online training intervention on child's communication when given a prompt (Cohen, 1988). Tau-*U* nonoverlap calculations were 1.00 (Dyad 1), 1.00 (Dyad 3), and 0.97 (Dyad 5) for each baseline to post-intervention phase comparison, suggesting large effects for individual child participants.

Visual analyses indicated a functional relation for the NDW communicated by the child when prompted (i.e. Dyad 1, Dyad 3, and Dyad 5). Tau-*U* nonoverlap calculations were 1.00 (Dyad 1), 1.00 (Dyad 3), and 1.00 (Dyad 5) for each baseline to post-intervention phase comparison, suggesting large effects of the online training intervention on individual child participants. The between case standardized mean difference (SMD) was calculated to describe the average magnitude of effects of the intervention on the number of different vocabulary words the children communicated when prompted across all participants in the study. The between cases standardized effect size was 1.140, *SE* = 0.416, 95% CI [0.284, 1.995] indicating an overall large effect of the online intervention on children's use of different vocabulary words when given a prompt (Cohen, 1988).

Visual analyses indicated a functional relation for independent communication in response to a spoken prompt (i.e. Dyad 2, Dyad 4, and Dyad 5). However, in contrast to previously discussed variables, the online intervention decreased this behavior. This suggests that the SO(A)R strategy may have been effective to reduce parent use of spoken prompts during shared book reading. Tau-*U* nonoverlap calculations were -0.89 (Dyad 2), -0.67 (Dyad 4), and -0.57 (Dyad 5) for each baseline to post-intervention phase comparison, suggesting small to medium effects of the online training intervention on children's communication in response to a spoken prompt. The between case SMD was calculated to describe the average magnitude of effects of the intervention on child independent communication in response to a spoken prompt across all participants in the study. The between cases standardized effect size was -0.484, *SE* =

0.224, 95% CI [-0.985, 0.017] indicating an overall small to medium effect of the online training on children's responsive communication during shared book reading (Cohen, 1988).

While basic effects were observed for additional dependent variables, a functional relation was not established as a behavior change was not observed at three different points in time. The influence of the parent and child behaviors on one another throughout the interactions impacted outcomes for individual components of the SO(A)R strategy and child communicative behaviors. In-depth descriptions of interactions and results for each member of the five dyads for each dependent variable are provided in the following sections**.** Data is represented visually on line graphs for each caregiver/parent dependent variable in the following figures: Figure 5 (SO(A)R Procedural Fidelity, Figure 6 (Modeling), Figure 7 (Expectant Delay), Figure 8 (Prompting), Figure 9 (Responding), and Figure 10 (NDW). Data is represented visually within graphs for each secondary dependent variable in the following figures: Figure 11 (Independent Child Communication), Figure 12 (Child Prompted Communication), Figure 13 (Child Overall Communication), and Figure 14 (NDW).

Dyad 1 (Grandmother; Margaret)

SO(A)R Procedural Fidelity

According to the operational definition of SO(A)R, if the child communicated independently and the parent responded by either confirming or expanding the message, SO(A)R was considered to be used accurately. Prior to completing the intervention, Margaret implemented the SO(A)R strategy on one occasion throughout the entire baseline phase (*M*=0.2; Median = 0; Range = 0-1). The use of SO(A)R was used once during baseline entailed the child independently selecting a button on the AAC device and the caregiver responding by confirming the child's message. Visual analysis of strategy use revealed a stable baseline pattern with a low level and no trend. After completing the online training and entering the post-intervention phase, Margaret implemented the SO(A)R strategy accurately on an average of 6.5 occasions per book reading session (Range 0-11; Median = 6.5). Visual analysis of strategy use during the post-intervention phase revealed an immediate change in level that sustained at moderate (with the exception of the outlier Session 11), demonstrating an intervention effect. A high level of variability and no trend was observed. Variability was influenced by the outlier in Session 11, during which the child would not sit to read the book, resulting in Margaret being unable to implement the SO(A)R strategy. The child also demonstrated behaviors during session 27 (e.g. throwing the book) which made it challenging for the caregiver to complete SO(A)R. Tau-*U* calculations suggest medium to large effects (Tau-*U* = 0.85) on caregiver strategy use.

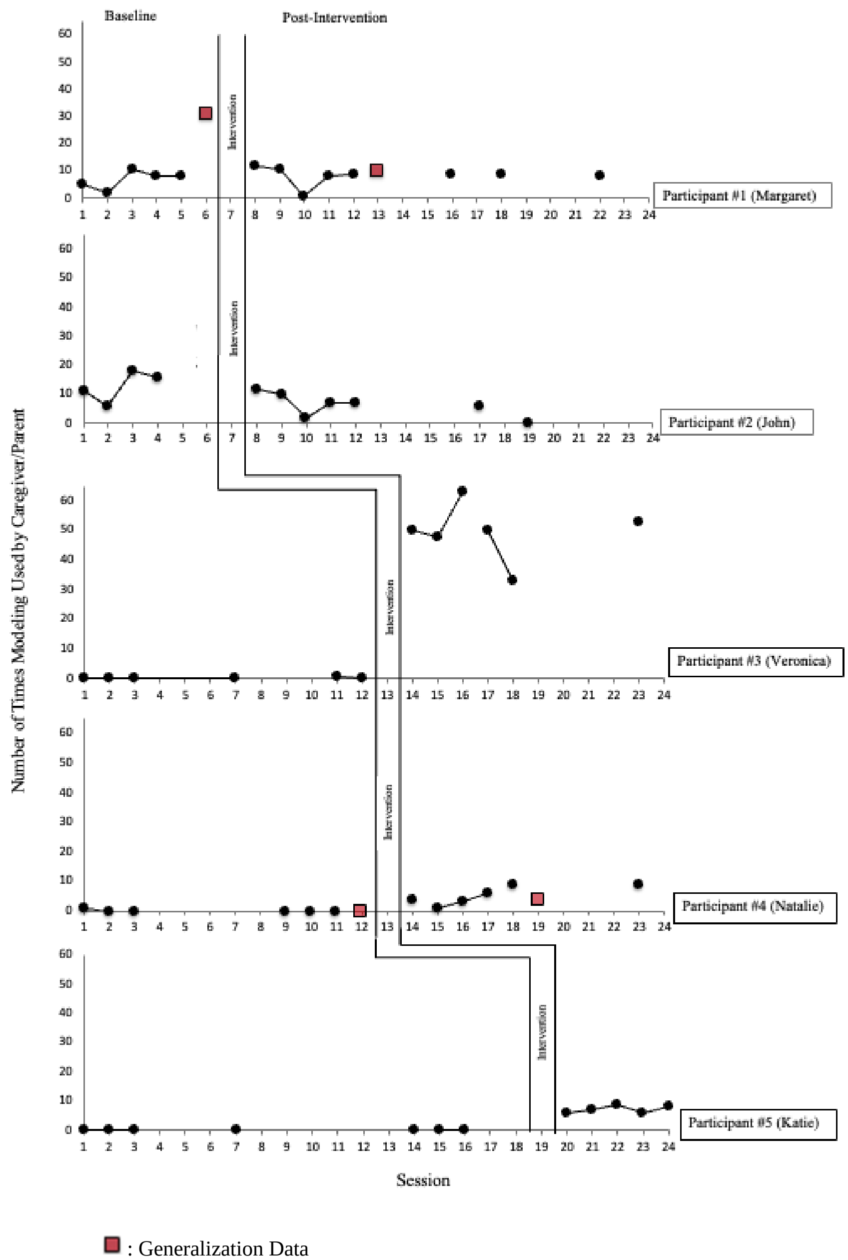

Figure **6**: Number of times caregivers used modeling.

Modeling

Prior to completing the online training, Margaret modeled vocabulary on the AAC device an average of 6.8 times per book reading session (Range 2-11; Median = 8). Visual analysis revealed a low to moderate level with some variability and no trend. After completing the online training, Margaret modeled vocabulary on the AAC device at an average frequency of 8.4 occasions per book reading session (Range 1-12; Median = 9). Visual analysis of data patterns demonstrated that the level sustained at moderate with little to no change (with the exception of the outlier in Session 11), indicating no intervention effect. Tau-*U* calculations indicated small effects (Tau-*U*=0.38) on Margaret's modeling behavior.

Expectant Delay

Prior to completing the online training, Margaret did not provide any expectant delays during book reading sessions (*M*=0; Median = 0; Range = 0-0). Visual analysis of the graph revealed a consistently low level with no variability or trend. During the post-intervention phase, Margaret provided an average of 5.4 expectant delays during shared book reading (Range 1-10; Median = 6). Margaret exhibited an immediate increase in level with mild to moderate variability (influenced by the outlier in session 11) demonstrating a basic effect. Due to challenging behaviors, Margaret did not have the opportunity to provide expectant delays in Session 11. An initially decreasing trend followed by an increasing trend that sustained was observed. Tau-*U* was calculated to be 0.88 indicating medium to large effects on Margaret's behavior.

Prompting

During the baseline phase, Margaret provided one total pointing prompt across all five baseline sessions (*M*=0.4; Median = 0; Range = 0-1). Visual analysis of the data demonstrated a low, stable baseline with zero trend. During the post-intervention phase, Margaret provided a pointing prompt to Alex an average of 6.9 times (Range 2-10; Median = 7) per book reading session. When Margaret began the post-intervention phase, an immediate change in level with minimal variability (with the exception of outlier Session 11) and zero trend was observed demonstrating a basic effect. Tau-*U* was calculated to be 0.98 indicating a large effect on Margaret's pointing prompt behavior.

Margaret provided no manual prompts during the baseline phase (*M*=0; Median = 0; Range = 0-0). Visual analysis of data revealed a stable baseline with low level and zero trend. After completing the online training intervention, Margaret provided a manual prompt during book reading an average of 7 times (Range 1-11; Median = 7) per session. An immediate change in level with minimal variability (with the exception of outlier Session 11) and zero trend was observed demonstrating a basic effect. Similarly to previously reported variables, Session 11 continued to be an outlier. Tau-*U* calculations suggest very large effects (Tau-*U* = 1.00) on Margaret's manual prompting behavior during the interaction.

Responding

Prior to completing the online training, Margaret responded to Alex's communication by confirming his message at an average rate of 0.6 across all 5 baseline sessions (*M*=0.6; Median= 0; Range= 0-4). Visual interpretation of the graph indicated a stable baseline with a low level and zero trend. During the post-intervention phase, Margaret responded to Alex's communication via confirmation on an average of 8 occasions (Range 1-12; Median = 8.5) per book reading session. A basic effect was demonstrated as an immediate increase in level with moderate variability and zero trend was observed upon entering the post-intervention phase. Tau-*U* calculations suggest large effects (Tau-*U* = 0.95) on Margaret's responding to Alex's communication by confirming his message.

Margaret did not respond to Alex's communication by expanding his communication messages on any occasion during baseline or post-intervention phases. Data remained stable at zero for baseline and post-intervention phases. No effect was observed.

NDW

The number of different words (NDW) included the total number of different vocabulary items communicated by Margaret on the AAC device, and it included any vocabulary selections that were counted as aided AAC modeling and AAC selections that were used to expand the child's communication message. Margaret used the AAC device to communicate an average of 6.4 different words (Range 2-10; Median = 7) per shared book reading session prior to completing the online training. Visual analysis revealed moderate variability with zero trend. Upon completing the online training and entering the post-intervention phase, Margaret used an average of 7.4 different words (Range 1-11; Median = 8). Visual interpretation of the graph revealed no change in level and mild variability with the exception of the outlier session 11. Margaret did not access the AAC device to expand Alex's communication messages throughout the study. Therefore, all vocabulary selections made on the AAC device by Margaret were considered AAC modeling behaviors both during the baseline and post-intervention phases. Tau-*U* calculations suggest a small effect (Tau-*U* = 0.25) on the number of different words used by Margaret.

Dyad 1 (Child; Alex)

Child Independent Communication

Based on the previously described operational definition of independent communication from the child, all AAC button selections made by the child that were not the result of a pointing prompt or a manual prompt from the adult in the dyad were counted as independent communication. Each button selection made by Alex during the session was counted as one occurrence of independent communication. Prior to Margaret completing the online training, Alex independently communicated approximately 7.8 times (Range 0-33; Median = 0) during shared book reading sessions. Visual analysis of the data revealed initial stability (i.e. first three data points) followed by high variability and zero trend. Variability was influenced by an outlier in Session 4, during which Alex repeatedly selected buttons on the AAC system within one communication turn (e.g. “beach” button pressed 13 times rapidly). During the post-intervention phase, Alex independently communicated at an average rate of 11 button selections (Range 0-36; Median = 4.5) per book reading session. No change in level was observed and data patterns continued to demonstrate a high level of variability with zero trend. Tau-*U* calculations suggest a small effect (Tau-*U* = 0.38) on Alex’s independent communication via AAC.

As previously discussed, independent communication was operationally defined as the child accessing the AAC device without a pointing prompt or a manual prompt. Therefore, if the child accessed an AAC button without the caregiver/parent pointing to a button or providing hand over hand assistance, the child’s communication was counted as independent. Caregivers/parents often provided spoken prompts/cues (e.g. “Where’s the octopus?” “Tell me with the iPad”). Therefore, the child’s independent communication in response to a spoken prompt was calculated as well. Alex did not communicate in response to a spoken cue on any occasion during the baseline or post-intervention phases of the study.

Child Prompted Communication

Prior to his grandmother completing the online training, Alex engaged in no prompted communication acts (M=0; Median = 0; Range 0-0). A stable baseline was observed with zero trend at a low level. After his caregiver completed the online training, Alex engaged in prompted communication acts at an average rate of 7.4 occasions (Range 1-11; Median = 8) during the 8 shared book reading sessions. There was an immediate increase in level with moderate variability and zero trend indicating a basic effect. Variability was influenced by the data outlier in Session 11. No overlap of data points was observed. Tau-*U* calculations suggest very large effects (Tau-*U* = 1.00) on Alex's communication via AAC when provided with a prompt.

Child Communication Overall

The frequency of Alex's communication overall (i.e. independent and prompted communication combined) with the AAC device was calculated. Prior to his grandmother completing the online training, Alex communicated on an average of 7.8 occasions using the AAC device (Range 0-33) per shared book reading session. Baseline was initially stable (i.e. first three data points) followed by a data outlier in Session 4, making the data pattern highly variable with zero trend. After Alex's grandmother completed the online training program, Alex communicated on an average of 18.1 occasions using the AAC device (Range 0-46; Median = 14.5) per book reading session. Visual interpretation of the graph indicated an immediate change in level, high variability (influenced by data outlier in session 11), and zero trend, suggesting a basic effect. Tau-*U* calculations suggest small effects (Tau-*U* = 0.65) on Alex's overall communication via AAC.

NDW

The number of different words for children included the total number of different AAC vocabulary selections made throughout the activity. Each unique vocabulary selection was counted as 1 different word. The NDW was calculated for Alex's independent communication, prompted communication, and overall communication (i.e. independent and prompted communication combined). Prior to his grandmother receiving the online training, the average NDW independently communicated by Alex was 1.8 words (Range = 0-5; Median = 0) per reading session. The graph reveals an initially stable baseline (i.e. first three data points) followed by an increasing trend. After his caregiver completed the online training, the average

NDW independently communicated by Alex was 3.1 words (Range 0-8; Median = 2.5) per reading session. Visual interpretation of the graph revealed no change in level with moderate variability and zero trend. Tau-*U* calculations suggest small effects (Tau-*U* = 0.33) on the NDW independently communicated by Alex via AAC.

During baseline, Alex communicated no words that were elicited by prompted communication. Baseline data patterns were stable with zero trend. After his grandmother completed the online training, Alex communicated an average of 6.1 different words (range 1-11; Median = 5.5) that were elicited by a prompt during shared book reading sessions. There was an immediate change in level with moderate variability and zero trend indicating a basic effect. Again, variability was influenced by the data outlier in session 11. Tau-*U* calculations suggest very large effects (Tau-*U* = 1.00) on the NDW Alex communicated when provided with a prompt.

Analyses were also conducted for the NDW overall (i.e. independent and prompted communication). Prior to Margaret receiving the online training, the average NDW communicated overall by Alex was 1.8 words (Range = 0-5; Median = 0) per book reading session. Visual interpretation of the graph indicates an initially stable baseline (i.e. first three data points) followed by a gradually increasing trend. After Alex's grandmother completed the online training, the average NDW communicated overall by Alex was 8.1 (Range 1-11; Median = 9) per book reading session. The graph revealed an immediate change in level with moderate variability and zero trend indicating a basic effect. Tau-*U* calculations suggest large effects (Tau-*U* = 0.90) on the NDW overall Alex is communicated via AAC.

Dyad 1 Summary

Visual analyses revealed intervention effects on Margaret's behavior for the following dependent variables: (a) accurate implementation of SO(A)R, (b) expectant delay, (c) pointing prompts, (d) manual prompts, and (e) responding by confirmation. Immediate changes in level observed suggest the intervention was "powerful" and/or immediately effective on Margaret's behavior (Ledford & Gast, 2018). In addition, Tau-U calculations suggest large effects of intervention on all dependent variables for which an effect was observed.

No intervention effects were observed for modeling or the NDW used by Margaret. Margaret engaged in modeling on the AAC device during the baseline phase. Thus, there was no observed change in this behavior after completing the online training. Given the inherent relationship between modeling on the device and the NDW communicated on the device by the adult, similar data patterns were observed for these variables. As Margaret increased the number of models provided in a session, the NDW used in that session increased as well. Margaret accessed the device throughout the study only to provide models of vocabulary. She did not access the device to expand Alex's communication messages from a one-button selection to a two-button selection when responding.

Visual analysis revealed effects on Alex's communication for the following dependent variables: (a) overall communication, (b) NDW overall, (c) prompted communication, and (d) NDW prompted. Immediate changes in level were present for all dependent variables for which an effect was observed suggesting the intervention was "powerful" and/or had an immediate effect on these communication behaviors (Ledford & Gast, 2018). In addition, Tau-*U* calculations indicate large to very large effects for prompted communication, NDW prompted, and NDW overall. Small effects (Tau-*U* = 0.65) are suggested for overall communication.

With regards to Alex's communication, no effects were observed for independent communication or the NDW communicated independently. The inherent relationship between these two variables explains why no effects were observed for both of them. Alex was the youngest child enrolled in the study and the only child participant who did not use an AAC device for communication prior to beginning the study. He recently began PECS upon the study commencing, but he had not yet learned to discriminate picture symbols. Further, although Margaret reported Alex would be able to sit for a shared book reading activity prior to the study beginning, initial shared book reading sessions revealed that Alex had difficulty attending to the task and may have lacked readiness skills (e.g. attention, following simple directions). The cognitive demands of attending to the task paired with the presentation of an unfamiliar, 25-button grid high-tech AAC display likely placed additional burdens on Alex which influenced his ability to use the AAC device independently to communicate.

In conclusion, the online training intervention was highly effective to teach Margaret how to implement the SO(A)R strategy accurately in addition to AAC communication partner skills such as providing wait time (expectant delay), providing prompts in a hierarchy format (pointing → manual) to encourage AAC output from the child, and responding to the child's communication message. Margaret's completion of the online training also has a positive impact on Alex's communication by increasing his overall communication acts and increasing the number of different vocabulary words he communicated on the AAC device during shared book reading.

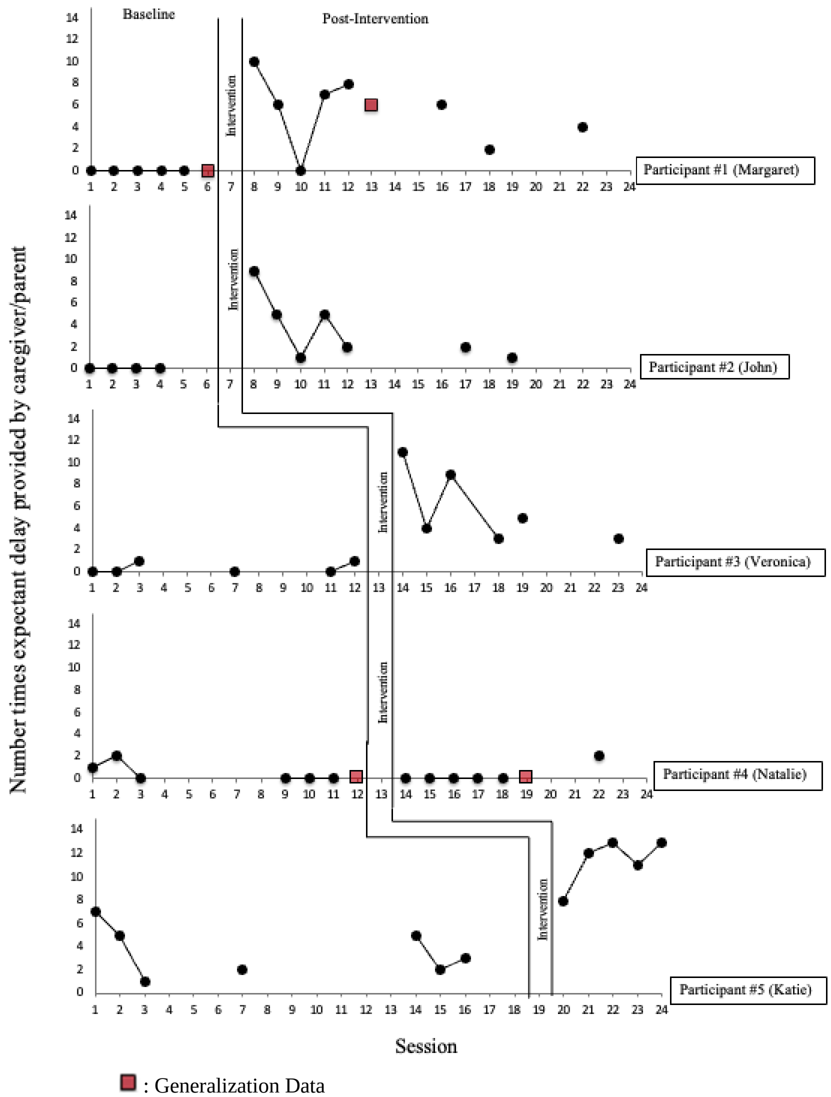

Figure **7**: Number of times an expectant delay was provided by the parent/caregiver.

Dyad 2 (Father; John)

SO(A)R Procedural Fidelity

Prior to completing the intervention, John implemented the SO(A)R strategy accurately on an average of 1.75 occasions (Range = 0-3; Median = 1.5) per book reading session with his child. Visual analysis of strategy use during baseline revealed a low level with little variability and a decreasing trend. After completing the online training and entering the post-intervention phase, John implemented the SO(A)R strategy accurately at an average rate of 8 times per session (Range = 4-10; Median = 9). Visual analysis of strategy use during the post-intervention phase revealed an immediate change in level (i.e., demonstration of a basic effect) with moderate variability toward the beginning of the phase and stability toward the end of the phase (i.e. last three data points). No data overlap was observed. Tau-*U* calculations suggest very large effects (Tau-*U* = 1.00) on parent strategy use.

Modeling

John modeled vocabulary on the AAC device during shared book reading at an average rate of 12.75 times (Range 6-18; Median = 13.5) during baseline. Visual analysis revealed moderate variability and no clear trend. After completing the online training, John modeled vocabulary on the AAC device at an average rate of 6.3 models (Range 0-12; Median = 7) per book reading session. Visual interpretation of the graph revealed low to moderate variability with a gradual decrease in trend and no change in level (i.e. no demonstration of basic effect). Tau-*U* calculations suggest a small effect (Tau-*U* = -0.61) on John's use of AAC modeling.

Expectant Delay

Prior to completing the online training, John provided no expectant delays during shared book reading with Matthew. The graph exhibited a stable baseline with a low level and zero trend. After completing the online training, John provided an average of 4.2 expectant delays (range 1-9; Median = 2) during shared book reading sessions with Matthew. Visual analysis revealed an immediate change in level with mild to moderate variability and no trend, indicating a basic effect. Tau-*U* calculations suggest a very large effect (Tau-*U* = 1.00) on John's provision of expectant delays during shared book reading.

Prompting

Prior to completing the online training, John provided a pointing prompt to Matthew on an average of 4.5 occasions (Range 2-7; Median = 4.5) per book reading session. Visual analysis of the graph revealed mild variability with a slightly increasing trend. After completing the online training, John provided a pointing prompt to his child at an average rate of 5 times (Range 0-10; Median = 5) per shared book reading session. The graph revealed a very slight change in level was observed followed by a decreasing trend with mild variability indicating no basic effect. Tau-*U* was calculated to be 0.04, suggesting a very small effect.

The provision of manual prompts was also measured. In the baseline phase, John provided manual prompts to Matthew at an average frequency of 13 occurrences per session (Range = 6-20; Median = 13). Data patterns during baseline were highly variable with zero trend. The high variability was attributed to the increased amount of manual prompting John provided to Matthew during sessions 2 and 4, as he guided Matthew's hand to select AAC buttons while he was reading aloud. After completing the online training intervention, John provided Matthew with a manual prompt an average of 2 occasions per session (range 1-4; Median = 2). An immediate change in level (decrease) with little to no variability and zero trend was observed, indicating a basic effect. Tau-U was calculated to be -1.00, suggesting a very large effect on decreasing John's use of manual prompting during shared book reading.

Responding

John responded to Matthew's communication by confirming his message at an average rate of 9 (Range 6-15; Median = 7.5) per baseline session prior to completing the online training. Visual analysis of the graph revealed moderate variability (influenced by an outlier in session 2) and zero trend. During session 2, John frequently repeated messages aloud after manually prompting Matthew to select the AAC buttons. After completing the online training intervention, John responded to Matthew's communication by confirming his message at an average rate of 6.6 times per session (range 3-8; Median = 8). Visual analysis of the graph indicated no change in level (i.e. no demonstration of a basic effect) with little variability and zero trend. Tau-*U* calculations (Tau-*U*= -0.25) suggest a very small effect on John's responding to Matthew's communication by confirming the message.

Data was also analyzed for changes in John's responding behavior by expanding Matthew's message. During baseline, John expanded Matthew's message on zero occasions. After completing the online training, John expanded Matthew's communication message at an average rate of 3.7 times (Range 1-6; Median = 4) per book reading session. Visual analysis of the data showed an immediate change in level with mild variability and zero trend indicating a basic effect. No data overlap was observed. Tau-*U* calculations suggest a very large effect (Tau-*U* = 1.00) on John's behavior of expanding his child's communication.

NDW

John accessed the AAC device to communicate an average of 8.3 (Range 4-12; Median = 9) different words per book reading session during the baseline phase. Visual analysis revealed the data to be slightly variable with an increasing trend observed in the final three data points. During the post-intervention phase, John used the AAC device to communicate an average of 7.7 (Range 4-13; Median = 7) different words. There was no change in level and variability was mild with zero trend indicating no basic effect. Tau-*U* calculations suggested a small effect (Tau-*U* = -0.08) on John's use of different vocabulary words throughout shared book reading.

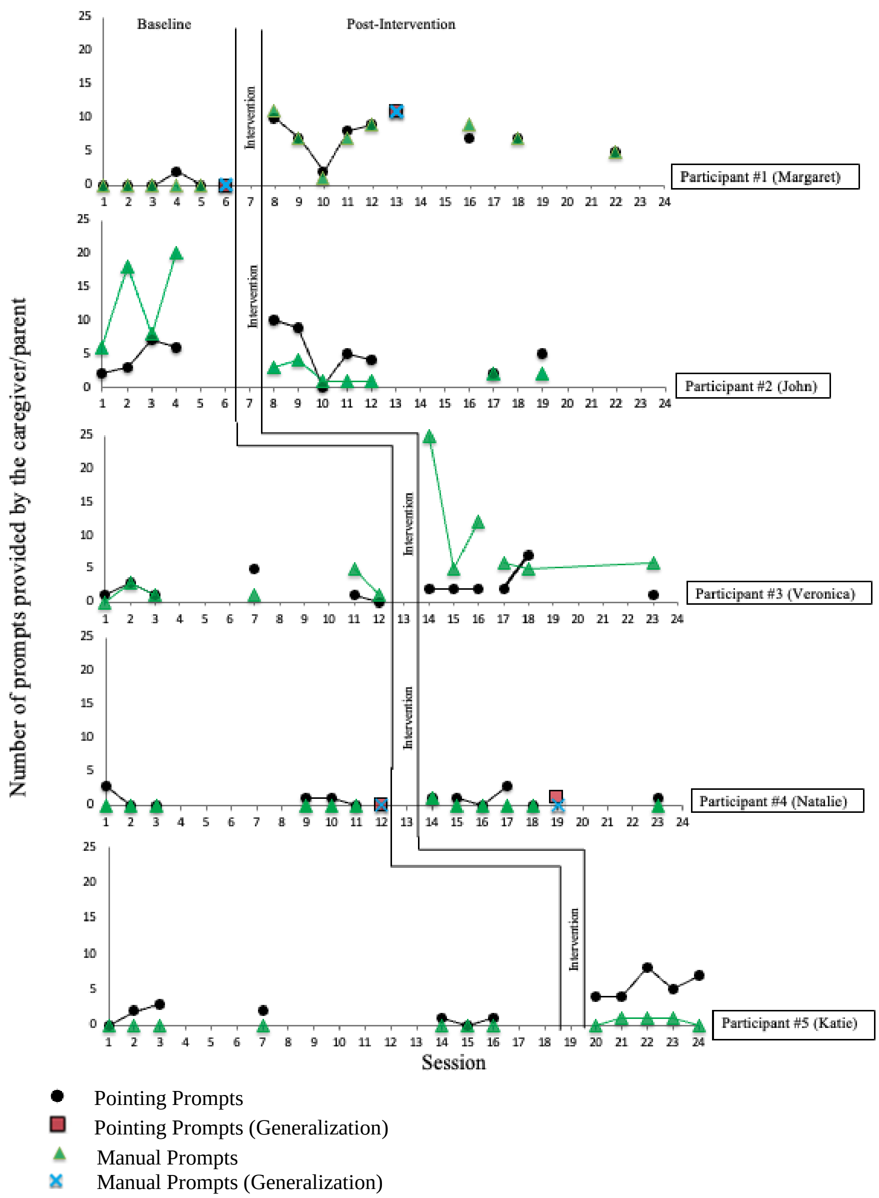

Figure **8**: Number of prompts provided to the child by the caregiver/parent.

Dyad 2 (Child; Matthew)

Child Independent Communication

Prior to his father receiving the online training, Matthew communicated independently on an average of 8.3 occasions (range 0-14; Median = 9.5) per book reading session. Visual interpretation of the graph indicated mild variability with a decreasing trend toward the end of the phase. After his father completed the online training, Matthew communicated independently on an average of 11.4 occasions (range 1-19; Median = 12) per book reading session. The graph displayed no change in level (i.e. no demonstration of basic effect) with initial variability and an overall increasing trend. Tau-*U* calculations suggest small effects (Tau-*U* = 0.29) on Matthew's independent communication.

Independent communication from the child in response to a spoken prompt was also calculated. Prior to Matthew's father completing the online training, Matthew communicated independently in response to a spoken prompt at an average rate of 3.25 button selections (Range 1-5; Median = 3.5) per book reading session. Visual analysis of data in the baseline phase revealed mild variability and zero trend. After his father completed the online training, Matthew communicated independently in response to a spoken prompt on an average of <1 occasion (*M*=0.4; range 0-1; Median = 0) per book reading session. A change in level was observed (decrease) with little to no variability and zero trend indicating a basic effect. Tau-*U* calculations suggest a medium to large effect (Tau-*U* = -0.89) on Matthew's communication in response to a spoken prompt.

Child Prompted Communication

Prompted communication from the child was defined as any AAC selection made as the result of a pointing prompt or manual prompt from the caregiver/parent. Prior to Matthew's father completing the online training, Matthew communicated after being provided with a prompt on an average of 17.5 occasions (Range = 6-22; Median = 20.5). Visual interpretation of the graph indicated moderate variability with zero trend. After Matthew's father completed the online training, he demonstrated prompted communication an average of 5.7 times per session

(Range 1-9; Median = 6). There was an immediate change in level and a gradually decreasing trend with mild to moderate variability indicating a basic effect. No overlap was observed. Tau-*U* calculations suggest a medium to large effect (Tau-*U* = - 0.75) on Matthew's prompted communication. The substantial reduction in manual prompting from his father contributed to the decrease in Matthew's prompted communication.

Child Communication Overall

The frequency of Matthew's communication overall (i.e. independent and prompted communication combined) with the AAC device was calculated. Prior to his father completing the online training, Matthew communicated on an average of 29 occasions using the AAC device (Range 23-39; Median = 27). Baseline was moderately variable with a gradually decreasing trend toward the end. After Matthew's father completed the online training program, Matthew communicated on an average of 17.6 occasions using the AAC device (Range 10-29; Median = 17) per book reading session. Visual interpretation of the graph indicated an immediate change in level with moderate variability and zero trend indicating a basic effect. Tau-*U* calculations suggest medium to large effects (Tau-*U* = -0.71) on Matthew's overall communication via AAC. Again, the reduced amount of manual prompting provided by Matthew's father contributed to this observed decrease in communication.

NDW

The NDW communicated by the child was calculated for the child's independent communication, prompted communication, and overall communication (independent + prompted combined). The average NDW communicated independently by Matthew during the baseline phase was 4.25 (range 1-8; Median = 4), and visual analysis revealed mild variability with a decreasing trend observed in the last three data points. During the post-intervention phase, Matthew communicated an average of 5.6 different words (range 1-10; Median = 6) independently per book reading session. Visual interpretation of the graph revealed no change in level and moderate variability toward the beginning of the phase followed by stability and no clear trend indicating no basic effect. Tau-*U* calculations (Tau-*U* = 0.32) suggest small effects on the NDW Matthew communicated independently.

Prior to Matthew's father completing the online training, the average NDW communicated by Matthew when engaging in prompted communication was 11 (range 4-15; Median = 11) per book reading session. Visual interpretation of the graph reveals mild to moderate variability and zero trend. After his father completed the online training, the average NDW communicated by Matthew when engaging in prompted communication was 5.3 (range 1-9; Median = 5). Visual analysis indicated a change in level with a gradually decreasing trend and mild variability indicating a basic effect. Tau-*U* calculations (Tau-*U* = -0.67) suggest medium effects on Matthew's communication. This decrease is consistent with the decrease in Matthew's prompted communication discussed above due to the reduced amount of manual prompting he was receiving after his father completed the online training.

The average NDW communicated by Matthew for overall communication in the baseline phase was 13.8 words (Range 8-19; Median = 14). Baseline data revealed moderate variability followed by a decreasing trend. After his father completed the online training, the average NDW communicated by Matthew for overall communication was 9.6 (range 8-12; Median = 10). Visual analysis of the graph revealed no change in level with mild variability and no trend, indicating no basic effect. Tau-*U* calculations suggest a small effect (Tau-*U* = -0.63) on the number of different words communicated by Matthew. Again, this decrease is consistent with the decrease in Matthew's communication overall discussed above due to the reduced amount of manual prompting he was receiving after his father completed the online training.

Dyad 2 Summary

Visual analyses revealed intervention effects on John's behavior for the following dependent variables: (a) accurate implementation of the SO(A)R strategy, (b) expectant delay, (c) manual prompting, and (d) responding to his child's communication using expansion. Immediate changes in level observed for these variables suggest the intervention was "powerful" and/or immediately effective on John's behavior (Ledford & Gast, 2018). In addition, Tau-U calculations suggest very large effects of intervention on all dependent variables for which an effect was observed. Tau-U values were 1.00, 1.00, and 1.00 for accurate implementation of SO(A)R, expectant delay, and responding (expand), respectively, indicating a strong increase in those behaviors. In contrast, a Tau-U value of -1.00 for manual prompting was observed, indicating a strong decrease in that behavior. Prior to receiving the online training, John provided little to no wait time to give Matthew an opportunity to communicate. Rather, he frequently picked up Matthew's hand either while reading aloud or immediately after reading aloud to have him select AAC buttons. After completing the online training, John's increased use of expectant delays and pointing prompts resulted in reduced frequent manual prompting throughout the shared book reading activity.

Similar to the caregiver in Dyad 1, no intervention effects were observed for modeling or the NDW used by John. John engaged in modeling on the AAC device during the baseline phase. Thus, there was no observed change in this behavior after completing the online training. Given the inherent relationship between modeling on the device and the NDW communicated on the device by the adult, similar data patterns were observed for these variables. After completing the intervention, John did demonstrate an effect for increasing his use of the device to expand Matthew's communication from a 1-button message to a 2-button message. However, this did not seem to significantly impact the NDW communicated via AAC by John. No intervention effects were observed for pointing prompts or responding (confirm) because John was exhibiting these behaviors during the baseline phase.

Visual analysis revealed intervention effects on Matthew's communication behaviors for the following dependent variables: (a) overall communication, (b) independent communication in response to a spoken prompt, (c) prompted communication, and (d) NDW prompted. Immediate changes in level were present for all dependent variables for which an effect was observed suggesting the intervention was "powerful" and/or had an immediate effect on these communication behaviors (Ledford & Gast, 2018). Tau-*U* calculations indicate medium to large (prompted communication, NDW prompted, overall communication) and large (independent communication with spoken prompt) effects for the observed variables. Visual and statistical analyses indicate a decrease in these communication behaviors. A decrease in communication in response to a spoken prompt would be expected, as the increase in use of the SO(A)R strategy would result in John reducing spoken prompts. The decrease in Matthew's prompted communication and overall communication is likely due to John's reduced manual prompting. John provided a high level of manual prompting during the baseline phase, particularly during sessions 2 and 4. While reading aloud during these sessions, John manually prompted Mason to select multiple buttons per page. For example, while reading, "Little bunny wants to be a rock," John manually prompted Matthew to select AAC buttons for "little" + "bunny" + "rock," which counted as three manual prompts on one page. This resulted in Matthew demonstrating high levels of prompted communication during baseline, and therefore a decrease was observed in the post-intervention phase for both prompted communication and the NDW prompted.

While there was no basic effect observed from the visual analysis of the graph for independent communication, the mean and median values for Matthew's independent communication increased. Further, the nature of Matthew's independent communication from baseline to post-intervention should be considered. During baseline sessions 1 and 2, he often repeatedly selected buttons on the AAC device (e.g. selected "dentist" button 8 times consecutively) during one communication turn. Based on the operational definition of independent communication, each button selection was counted as 1 occurrence of independent communication. During the post-intervention phase, Matthew was attentive to the book pictures and appeared more intentional about his AAC button selections.

In conclusion, the online training intervention was highly effective to teach John implementation of the SO(A)R strategy in addition to AAC communication partner skills such as providing wait time (expectant delay) and responding to his child's communication message by using expansion. John also reduced his provision of spoken prompts and manual prompts during the shared book reading while using the SO(A)R strategy, which can provide Matthew with more opportunities to engage in spontaneous, independent communication. The decrease in Matthew's prompted communication and overall communication is likely attributable to the reduction in John's frequent manual prompting from baseline to post-intervention. However, the reduction in manual prompts may also be beneficial for Matthew, as it allows him to be more of an independent communicator during interactions.

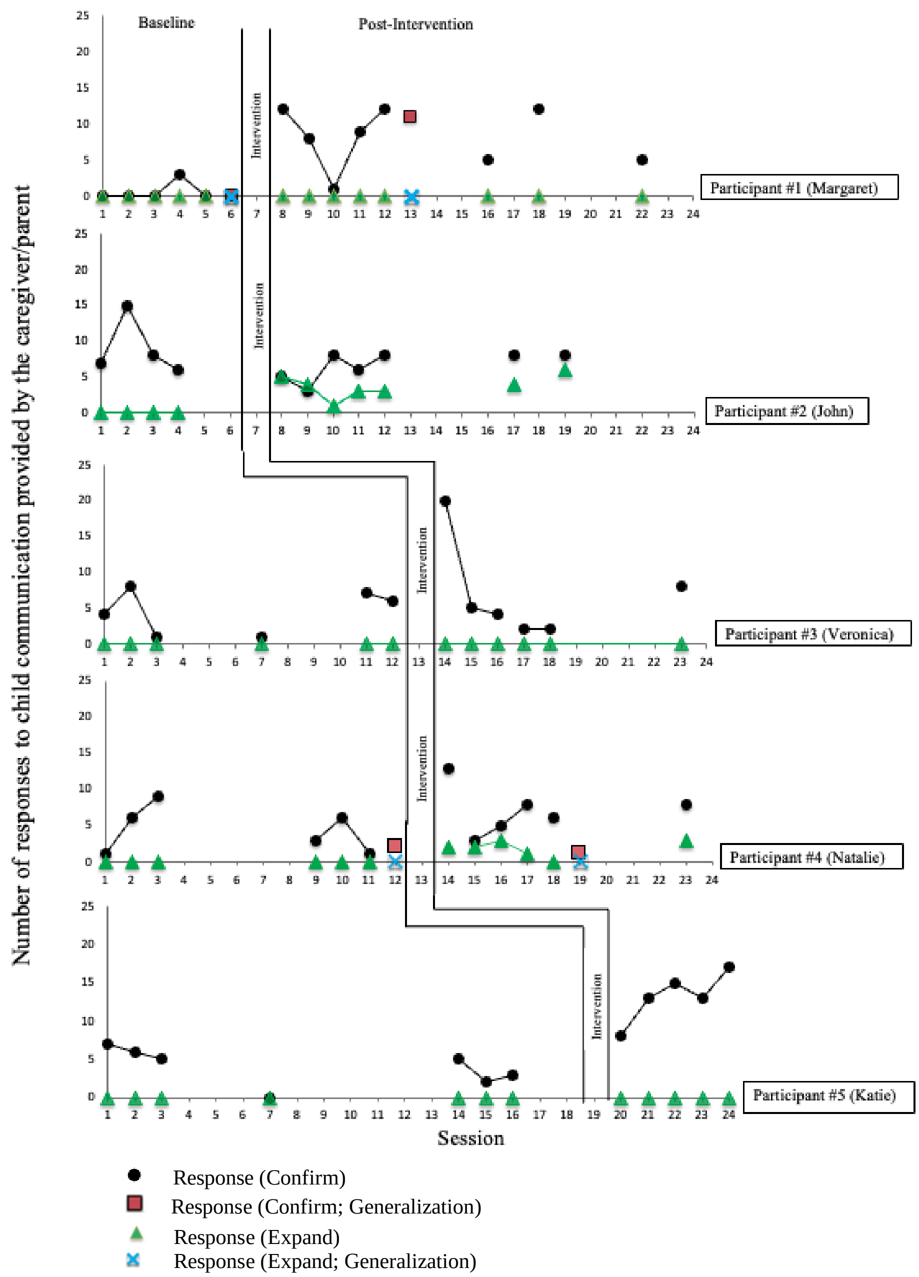

Figure **9**: Number of responses to child communication provided by the caregiver/parent.

Dyad 3 (Mother; Veronica)

SO(A)R Procedural Fidelity

Prior to completing the online training, Veronica used the SO(A)R strategy accurately an average of <1 occasion (M=0.33; range 0-1; Median = 0) per shared book reading session. Visual interpretation of the graph revealed a low level with no variability and a very slight increase in trend toward the end of the phase. After completing the online training, Veronica used the SO(A)R strategy on an average of 3.2 occasions (range 0-7; Median = 3) per book reading session with her child. Visual analysis of the graph indicates an immediate change in level followed by a consistent decreasing trend to baseline levels with no variability indicating no basic effect. Tau-U calculations suggest a small effect (Tau-U = 0.56) on Veronica's implementation of the SO(A)R strategy.

Modeling

Prior to receiving the online intervention, Veronica modeled vocabulary on the AAC device <1 (*M*=0.2; range 0-1; Median = 0) per shared book reading session. Visual interpretation of the graph indicated a low level with no variability and zero trend. Upon completing the online intervention, Veronica modeled vocabulary on the AAC device an average of 49.5 occasions (range 33-63; Median = 50) per shared book reading session. The graph demonstrated an immediate change in level with moderate variability and zero trend indicating a basic effect. Tau-u calculations suggest a very large effect (Tau-U = 1.00) on Veronica's use of modeling during shared book reading with her child.

Expectant Delay

Prior to completing the online parent training, Veronica provided an expectant delay on an average of <1 occasion (*M*=0.3; range 0-1; Median = 0) per book reading session. Visual analysis of the baseline data revealed a stable baseline with a low level and zero trend. Upon completion of the online parent training, Veronica provided an expectant delay an average of 5.8 occasions (range 3-11; Median = 4.5) per shared book reading session. Visual interpretation of the graph indicated an immediate change in level (i.e. demonstration of a basic effect) and an initial decrease in trend with moderate variability that sustained for the remainder of the phase. No data overlap was observed. Tau-*U* calculations suggested a large effect (Tau-*U* = 1.00) on Veronica's provision of expectant delays during shared book reading sessions.

Prompting

Data was collected related to Veronica's use of both pointing prompts and manual prompts. With regards to pointing prompts, Veronica provided an average of 1.8 pointing prompts (range 0-5; Median = 1) per shared book reading session prior to completing the online intervention. Visual analysis of the graph revealed low level with mild variability and zero trend. After completing the online training, Veronica provided a pointing prompt on an average of 3 occasions (range 2-7; Median = 2) per shared book reading session. Visual interpretation of the graph revealed no change in level with little to no variability and zero trend indicating no basic effect. Tau-*U* calculations suggested a small effect (Tau-*U* = 0.36) on Veronica's provision of pointing prompts.

Prior to completing the online training, Veronica provided manual prompts to her child on an average of 1.8 occasions (range 0-5; Median = 1) per shared book reading session. Visual analysis of the graph revealed a low level with mild variability and zero trend. During the post-intervention phase, Veronica provided an average of 9.8 manual prompts (range 5-25; Median = 6) per shared book reading session. Upon completion of the online training, the graph revealed an immediate change in level with moderate variability and zero trend indicating a basic effect. Tau-*U* calculations suggest a large effect (Tau-*U* = 0.94) on Veronica's provision of manual prompts.

Responding

Data was collected and analyzed for two types of responding behaviors – confirming the child's message and expanding the child's message. With regards to confirming the child's communication, Veronica responded to her child's communication message by confirming it on an average of 4.5 occasions (range 1-8; Median = 5) per shared book reading session prior to completing the online training. Visual interpretation of the graph indicated mild to moderate variability with zero trend. After completing the online parent training, Veronica responded to her child's communication message by confirming it at an average frequency of 6.8 times (range 2-20; Median = 4.5) per shared book reading session. Visual analysis of the graph revealed an immediate change in level followed by a decreasing trend to baseline levels indicating no effect. Tau-*U* calculations suggest little to no effect (Tau-*U* = 0.17) on Veronica's behavior.

Prior to completion of the online training, Veronica responded to her child's message by expanding his communication on zero occasions throughout the baseline phase (*M*=0; Median = 0; range 0-0). The graph revealed a stable baseline and zero trend. During the post-intervention phase, Veronica showed no change in this behavior and continued demonstrate no use of expansion to respond to her child's communication (*M*=0; Median = 0 range 0-0). Visual interpretation of the graph indicated no change in level with no variability and zero trend, indicating no basic effect.

NDW

The number of different vocabulary words communicated by Veronica on the AAC device during shared book reading was calculated. Prior to completing the online training, Veronica accessed the AAC device to communicate <1 word total (*M*=0.7; Median = 1; range 0-1) per shared book reading session. Visual interpretation of the graph indicated a stable baseline with no trend. Upon completion of the online training, Veronica used the AAC device to communicate an average of 17.8 words (range 13-22; Median = 17.5) per book reading session. Visual analysis of the graph indicated an immediate change in level with mild variability and no trend indicating a basic effect. Tau-*U* calculations suggest a large effect (Tau-*U* = 1.00) of intervention on Veronica's use of different vocabulary words on the AAC device during shared book reading with her child.

Dyad 3 (Child; Frankie)

Child Independent Communication

Accessing the AAC device to communicate without the parent/caregiver providing a pointing prompt or a manual prompt was counted as independent communication for the purposes of this study. Independent communication acts from the child were calculated for communication acts both without a spoken prompt or with a spoken prompt provided by the adult in the dyad. During baseline, Frankie communicated independently via AAC without a spoken prompt on an average of <1 occasion (*M*=0.7; range 0-2; Median = 0) per shared book reading session. Visual analysis of the graph indicated a low level, stable baseline and zero trend. After Frankie's caregiver completed the online training, he independently communicated via AAC on an average of 7.8 occasions (range 1-21; Median = 6) per shared book reading session. Visual analysis revealed an immediate change in level followed by a decreasing then increasing trend with no variability indicating a basic effect. Tau-*U* calculations indicated a medium to large effect (Tau-*U* = 0.83) on Frankie's independent communication via AAC during shared book reading.

Independent communication from the child in response to a spoken prompt from the parent was also calculated. Frankie communicated independently via AAC when given a spoken prompt on an average of 14.8 occasions (range 8-21) per shared book reading session during baseline. Visual interpretation of the graph revealed moderate to high variability with zero trend. After Frankie's caregiver completed the online training, he communicated independently via AAC given spoken prompts an average of 9.8 times per book reading session (range 1-14; Median = 13). Visual analysis of the graph revealed no change in level with continued high variability and no trend. No basic effect was observed. Tau-*U* calculations suggest a small effect (Tau-*U* = -0.42) on Frankie's independent communication when given a spoken prompt.

Child Prompted Communication

Prompted communication acts from the child included all AAC selections made as the result of receiving a pointing prompt or manual prompt from the parent/caregiver in the dyad. Prior to his mother receiving the training, Frankie engaged in a prompted communication act on an average of 3.2 occasions (range 1-6; Median = 2.5) per shared book reading session. Visual analysis of the graph shows mild variability and zero trend. After Frankie's mother completed the online training, he engaged in prompted communication acts an average of 12 times (range 7-26; Range 9.5) per shared book reading session. Visual interpretation of the graph indicated an immediate change in level and a gradually decreasing trend with mild to moderate variability indicating a basic effect. No overlap of data points was observed. Tau-*U* calculations suggest a large effect (Tau-*U* = 1.00) on Frankie's prompted communication.

Child Overall Communication

Data was analyzed for Frankie's overall communication acts (independent and prompted communication acts combined). Prior to his mother receiving the online training, Frankie communicated an average of 18.7 occasions (range 9-27; Median = 17.5) per shared book reading session. Visual analysis of the graph revealed moderate variability with zero trend. After his mother completed the online training, Frankie communicated an average of 29.7 occasions (range 13-49; Median = 28.5) per book reading session. Visual interpretation of the graph indicated an immediate change in level followed by a decreasing trend back to baseline levels and a subsequent increase and high variability. No effect was observed. Tau-*U* calculations suggest a small effect (Tau-*U* = 0.44) on Frankie's overall communication.

NDW

The number of different vocabulary words communicated by Frankie was calculated for his independent communication, prompted communication, and overall communication via AAC. Prior to Frankie's parent completing the online training, he independently communicated an average of 9.3 different words (range 6-12; Median = 10) per shared book reading session. Visual analysis of the graph indicated a moderate level with mild to moderate variability and no trend. After his mother completed the online training, Frankie independently communicated an average of 8.7 different words (range 5-12; Median = 9.5) per shared book reading session. Visual interpretation of the graph indicated no change in level and a gradually decreasing trend with moderate variability indicating no effect. Tau-*U* calculations suggest a very small effect (Tau-*U* = -0.14) on the number of different words communicated independently by Frankie.

Before Frankie's mother completed the online training, Frankie communicated an average of 2.8 different words (range 1-5; Median = 2.5) per shared book reading session when given a prompt (i.e. pointing, manual). Visual analysis of the graph indicated a low level with mild to moderate variability and zero trend. After his mother completed the online training, Frankie communicated an average of 9.5 different words (range 6-19; Median = 8) per book reading session when given a prompt. Visual interpretation of the graph revealed an immediate change in level, a gradually decreasing trend with mild to moderate variability, and no overlap from baseline, indicating an intervention effect. Tau-*U* calculations suggested a very large effect (Tau-*U* = 1.00) on the NDW communicated by Frankie when given a prompt.

The NDW Frankie communicated overall (prompted + combined) was calculated as well. Frankie communicated an average of 10.3 different words (range 6-14; Median = 11.5) overall per shared book reading session prior to his mother completing the online training. A visual analysis of the graph indicated mild to moderate variability with no trend observed. After his mother completed the intervention, he communicated an average of 15 different words (range 10-23; Median = 13.5) overall per shared book reading session. The graph visually indicated an immediate change in level followed by a decreasing trend with mild variability back to baseline levels indicating no effect. Tau-*U* calculations suggest a small effect (Tau-*U* = 0.58) on the NDW communicated overall by Frankie.

Dyad 3 Summary

Visual analyses revealed intervention effects on Veronica's behavior for the following dependent variables: (a) modeling, (b) expectant delay, (c) use of manual prompting, and (d) NDW communicated via the AAC device. Immediate changes in level were observed for all variables that demonstrated an effect, suggesting the intervention was "powerful" and/or immediately effective on Veronica's behaviors. In addition, Tau-*U* calculations suggest large effects of intervention for all four dependent variables for which an effect was observed.

No intervention effects were observed for accurate implementation of the SO(A)R strategy, pointing prompts, or responding to the child's communication. While Veronica demonstrated that she learned to incorporate individual components of the SO(A)R strategy (e.g. modeling, manual prompting) into shared book reading with her child, she did not learn to successfully implement the components of the SO(A)R strategy with procedural fidelity (model

→ wait time/expectant delay → pointing prompt followed by manual prompt → respond). Upon completion of the online training, she immediately began consistently modeling multiple vocabulary words per book page on the AAC device while reading aloud. However, when she finished reading, she immediately asked Frankie a "wh" question and presented him with the device in order to have him responsively label the picture in the book. Expectant delays were sometimes observed after she asked a "wh" question, which contributed to the increase observed in her use of expectant delays. If Frankie did not communicate independently and respond to her "wh" question, she would often ask the "wh" question repeatedly and then provide a manual prompt for Frankie to select the target vocabulary button. Veronica spoke the target vocabulary word aloud simultaneously as Frankie's selected the button with her. During these interactions, accurate SO(A)R implementation could not be counted for the following reasons: (a) the spoken prompts in the interaction made Frankie's communication responsive and SO(A)R was only counted if the child's independent communication was spontaneous, (b) she neglected to use pointing prompts prior to manual prompts, and (c) she did not respond to her child's communication message, rather, she communicated it simultaneously with him. This also narrates why there were no effects seen for pointing prompts and responding to Frankie's communication.

Visual analysis revealed intervention effects on Frankie's communication for the following dependent variables: (a) independent communication, (b) prompted communication, and (c) NDW communicated when given a prompt. Immediate changes in level were present for all dependent variables for which an effect was observed, suggesting the intervention had an immediate effect on these communication behaviors (Ledford & Gast, 2018). In addition, Tau-*U* calculations indicate medium to large effects on all behaviors for which an intervention effect was observed.

With regards to Frankie's communication, no effects were observed for overall communication and NDW overall. The inherent relationship between these two variables explains why no effects were observed for both. Although intervention effects were observed for his independent communication and his prompted communication, he exhibited a high level of responsive independent communication (i.e. response to spoken prompt) during baseline, which may have contributed to the lack of change in his overall communication during the post-intervention phase.

In conclusion, the online training intervention was not effective to teach Veronica implementation of the SO(A)R strategy. However, it was effective to teach Veronica individual component skills of the SO(A)R strategy including modeling on the AAC device, use of expectant delays, and manual prompting. Veronica frequently modeled a variety of vocabulary words during shared book reading with Frankie, which increased his exposure to meaningful language concepts on the AAC device. She also provided Frankie with more wait time/opportunities to communicate independently through use of expectant delays. These change in Veronica's behaviors may have positively impacted Frankie's communication, as he demonstrated increases in both independent communication and prompted communication.

Dyad 4 (Mother; Natalie)

SO(A)R Procedural Fidelity

Prior to completing the online training, Natalie used the SO(A)R strategy accurately an average of < 2 occasions (*M*=1.3; range 0-3; Median = 1) per shared book reading session. Visual interpretation of the graph revealed a low level with mild variability and zero trend. After completing the online training, Natalie used the SO(A)R strategy on an average of 6.6 occasions (range 5-8; Median = 7) per book reading session with her child. Visual analysis of the graph indicates an immediate change in level with mild variability and zero trend indicating a basic effect. Tau-*U* calculations suggest a very large effect (Tau-*U* = 1.00) on Natalie's implementation of the SO(A)R strategy.

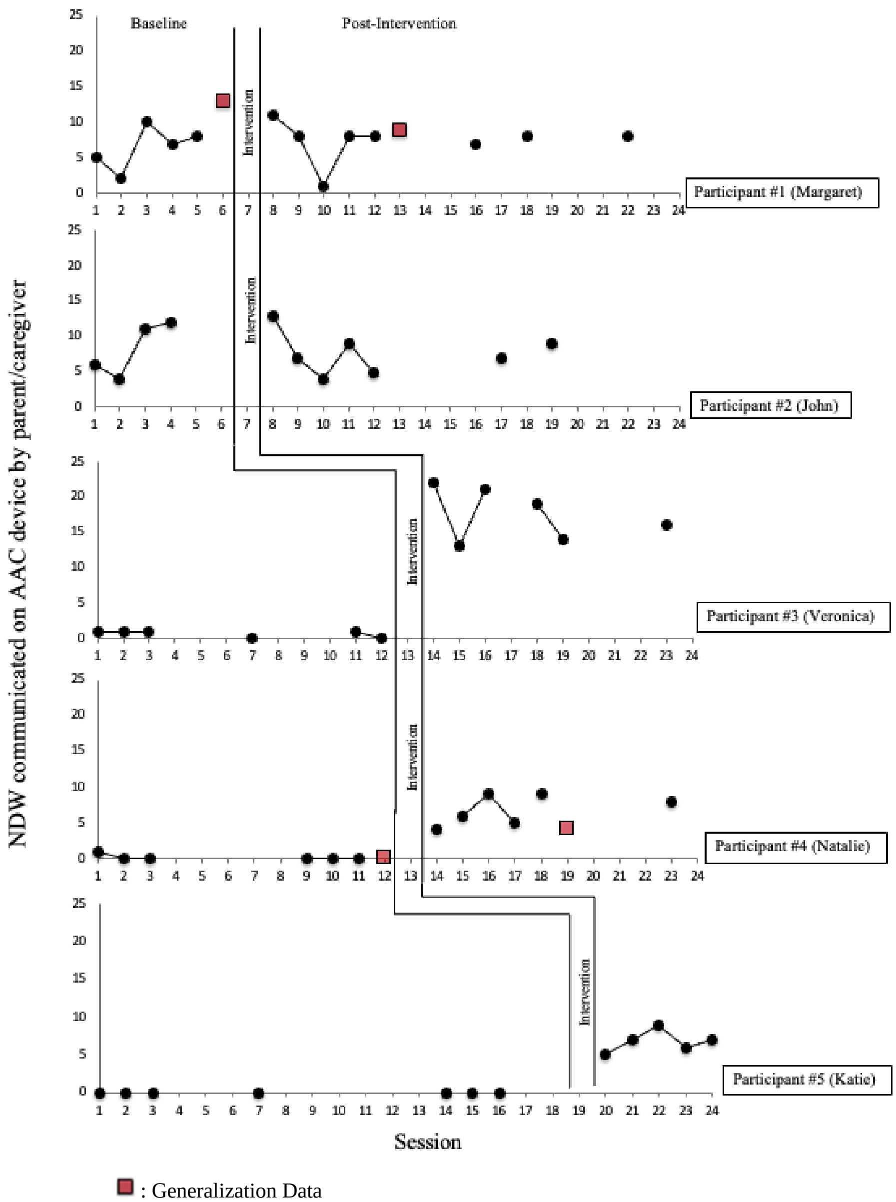

Figure **10**: Number of different words (NDW) communicated on the AAC device by parents/caregivers.

Modeling

Prior to completing the online training, Natalie modeled vocabulary on the AAC device an average of 0.2 times (range 0-1; Median = 0) per shared book reading session. Visual interpretation of the graph indicated a low level with no variability and zero trend. After Natalie completing the online training, Natalie modeled vocabulary on the AAC device on an average of 5.3 occasions (range 1-9; Median = 5) per shared book reading session. Visual analysis revealed a change in level followed by a gradually increasing trend that eventually sustained with mild variability, indicating a basic effect. Tau-*U* calculations suggest a large effect (Tau-*U* = 0.97) on Natalie's use of modeling during shared book reading with her child.

Expectant Delay

Before completing the online training, Natalie provided an average of <1 expectant delay (*M*=0.5; range 0-2; Median = 0) per book reading session. The graph demonstrates a low level of performance with no variability and no trend. Upon completion of the online training, Natalie continued to provide an average of <1 expectant delay (*M*=0.3; range 0-2; Median = 0) per book reading session. Visual analysis of the graph indicated no change in level with no variability and zero trend, indicating no basic effect. Tau-*U* calculations suggest small effects (Tau-*U*= -0.14) on Natalie's use of expectant delays during shared book reading with her child.

Prompting

Prior to completing the online training intervention, Natalie provided a pointing prompt to Tim on an average of <1 occasion (*M*=0.8; range 0-3; Median = 0.5) per book reading session. Visual analysis of the graph indicated a low level with little to no variability and zero trend. After completing the online training, Natalie provided an average of 1 pointing prompt (range 0-3; Median =1) per book reading session. Visual analysis of the graph revealed no change in level with little to no variability and zero trend, indicating no basic effect. Tau-*U* calculations suggest very small effects (Tau-*U* = 0.14) on Natalie's behavior.

Data was also analyzed for the use of a manual prompting. During the baseline phase, Natalie provided no manual prompts during book reading sessions (*M*=0; range 0-0; Median = 0). After completing the online training, Natalie provided an average of <1 manual prompt (*M*=0.2; range 0-1; Median = 0) per book reading session. Tau-*U* calculations suggest very small effects (Tau-*U*=0.17) on Natalie's use of manual prompts.

Responding

Prior to completing the online training, Natalie responded to Tim's communication by confirming his message on an average of 4.3 occasions (range 1-9; Median = 4.5) per shared book reading session. Visual analysis of the graph revealed moderate variability and zero trend. After completion of the online training, Natalie responded to Tim's communication by confirming his message on an average of 7.2 occasions (range 3-13; Median = 7) per shared book reading session. Visual interpretation of the graph indicated an immediate change in level (i.e. first post-intervention data point) followed by a decrease to baseline levels with mild to moderate variability, indicating no basic effect. Tau-*U* calculations suggest a small effect (Tau-*U* = 0.42) on Natalie's responding to her child by confirming his message.

Natalie responded to her child's communication by expanding his message on zero occasions (*M*=0; Median = 0; range 0-0) during the baseline phase. After completion of the online training, Natalie responded by expanding her child's communication on an average of 1.8 occasions (range 0-3; Median = 2) per book reading session. Visual interpretation of the graph indicated a change in level with mild variability and zero trend, indicating a basic effect. Tau-*U* calculations suggest a medium to large effect (Tau-*U*=0.83) on Natalie's behavior of expanding her child's communication message.

NDW

Prior to completing the online training, Natalie used an average of <1 vocabulary word (M=0.2; Median = 0; range 0-1) on the AAC device during shared book reading sessions. After completion of the online training, Natalie used an average of 6.8 different words (range 4-9; Median = 7) on the AAC device per shared book reading session. Visual interpretation of the graph revealed an immediate change in level with mild variability and zero trend, indicating a basic effect. Tau-*U* calculations indicate a large effect (Tau-*U*=1.00) on the number of different words Natalie communicated on the AAC device.

Dyad 4 (Child; Tim)

Child Independent Communication

Prior to Tim's mother completing the online training, Tim independently communicated on an average of 7.5 occasions (range 4-11; Median = 7.5) per shared book reading session. The graph revealed a moderate level with moderate variability and zero trend. After his mother completed the online training, Tim independently communicated on an average of 18.8 occasions (range 11-32; Median = 18) per book reading session. Visual interpretation of the graph revealed an immediate change in level with moderate to high variability and zero trend indicating a basic effect. Tau-*U* calculations suggest a large effect (Tau-*U* = 0.97) on Tim's independent communication via AAC.

Tim's independent AAC communication in response to a spoken prompt was also calculated. Prior to his mother completing the online training, Tim independently communicated in response to a spoken prompt an average of 7.3 times (range 2-12; Median = 8) per shared book reading session. Visual interpretation revealed moderate variability and zero trend. After his mother completed the training, Tim independently communicated in response to a spoken prompt an average of 2.8 times (range 0-14; Median = 0.5) per book reading session. Visual analysis of the graph indicated a change in level and a steep decreasing with little to no variability that sustained at low levels, indicating a basic effect. Tau-*U* calculations suggest a small effect (Tau-*U* = -0.67) on Tim's independent communication in response to a spoken cue.

Child Prompted Communication

Prior to Tim's mother completing the online training, Tim engaged in prompted communication acts on an average of <1 occasion (*M*=0.7; range 0-2; Median = 0.5) per shared book reading session. Visual analysis of the graph indicated a stable baseline at a low level and zero trend. After his mother completed the online training, Tim engaged in prompted communication on an average of 1.3 occasions (range 0-3; Median = 1) per shared book reading session. Visual interpretation of the graph revealed no change in level with little to no variability and zero trend indicating no basic effect. Tau-*U* calculations suggest a small effect (Tau-*U* = 0.39) on Tim's prompted communication.

Child Communication Overall

Tim's communication overall (independent and prompted AAC selections) was analyzed as well. Prior to his mother completing the online training, Tim engaged in communication on an average of 15.5 occasions (range 10-22; Median = 15) per book reading session. Visual interpretation of the graph revealed a gradually decreasing trend with moderate variability. After his mother completed the online training, he communicated an average of 23 times per book reading session (Range 11-48; Median = 19.5). Visual analysis of the graph revealed no change in level with moderate variability and zero trend indicating no basic effect. Tau-*U* calculations suggest a small effect (Tau-*U* = 0.56) on Tim's overall communication.

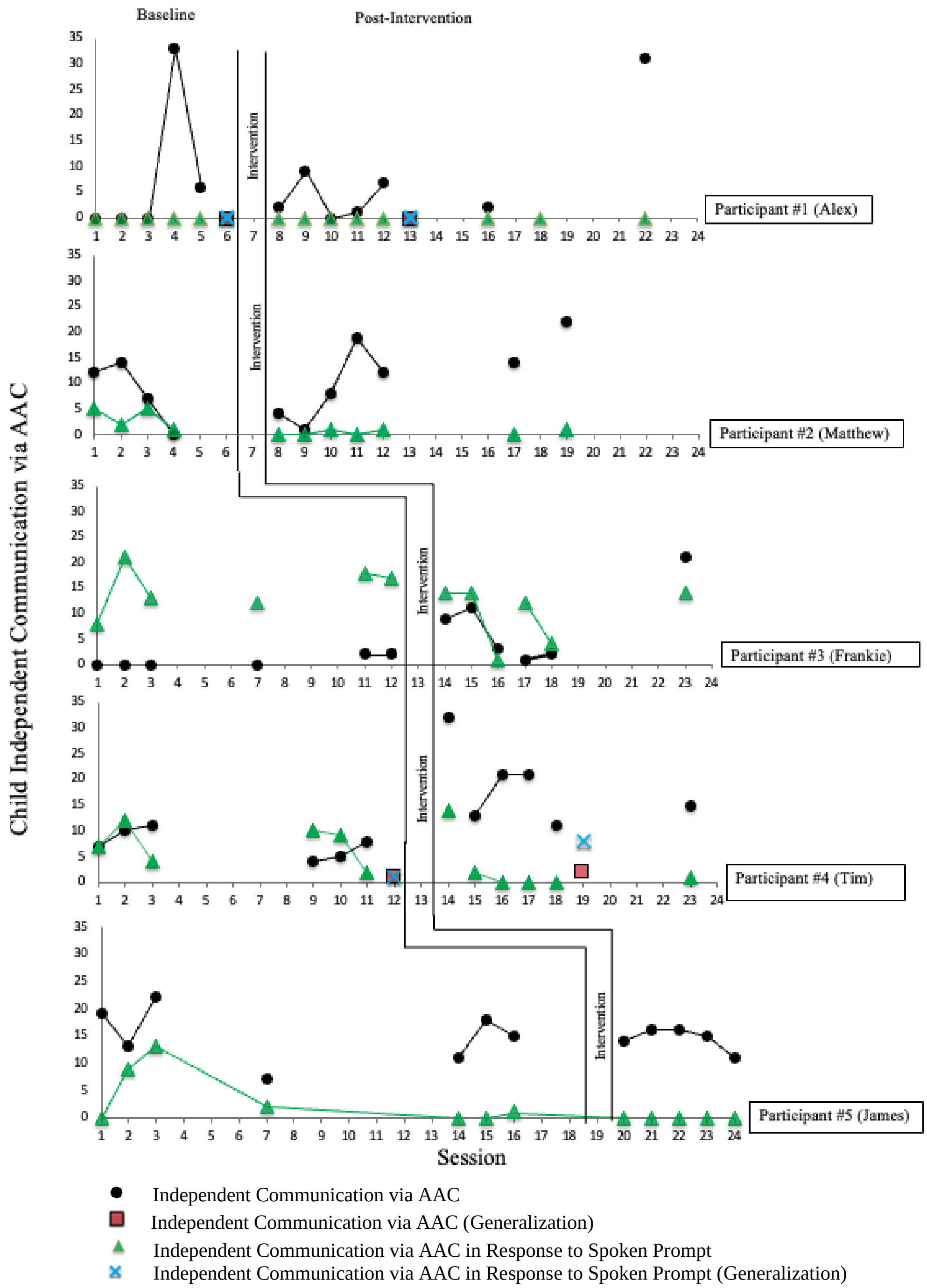

Figure **11**: Number of independent AAC communication acts from the child.

NDW (Child)

The number of different words included the number of different vocabulary words communicated by Tim on the AAC device, and the NDW were calculated for his independent, prompted, and overall communication. Prior to his mother completing the online training, Tim independently communicated an average of 8.7 different words (range 7-10; Median = 9) per book reading session. The graph revealed a moderate level with mild variability and zero trend during the baseline phase. After his mother completed the online intervention, Tim maintained an average of 8.7 different words (range 6-14; Median = 10) per book reading session. Visual interpretation of the graph indicated no change in level with moderate variability and zero trend indicating no basic effect. Tau-*U* calculations revealed a small effect (Tau-*U* = 0.23) on Tim's communication.

Tim communicated an average of <1 word (M = 0.7; range 0-2; Median = 0.5) when provided with a prompt during the baseline phase. The graph reveals a low, stable baseline pattern with zero trend. After his parent completed the online training, Tim communicated an average of 1.3 different words when given a prompt (range 0-3; Median = 1) per shared book reading session. Visual interpretation of the graph revealed no change in level with low variability and no trend indicating no basic effect. Tau-*U* calculations suggest a small effect (Tau-*U* = 0.39) on Tim's communication.

Finally, the number of different words communicated overall by Tim was calculated. Prior to his parent completing the online training, he communicated an average of 9.2 different words (range 7-11; Median = 10) per book reading session. The graph revealed a relatively stable baseline at a moderate level and zero trend. After his mother completed the online training, Tim communicated an average of 10.3 different words (range 7-15; Median = 10) per shared book reading session. Visual analysis of the graph indicated no change in level with mild variability and no trend indicating no basic effect. Tau-*U* calculations suggest a very small effect (Tau-*U* = 0.19) on Tim's communication.

Dyad 4 Summary

Visual analyses revealed intervention effects on Natalie's behavior for the following dependent variables: (a) accurate implementation of the SO(A)R strategy, (b) modeling, (c) responding to her child's communication using expansion, and (d) the NDW communicated on the AAC device. Immediate changes in level were observed for the accurate SO(A)R implementation and NDW, suggesting the intervention was immediately effective on Natalie's behavior (Ledford & Gast, 2018). In addition, Tau-*U* calculations suggest very large effects of intervention on accurate SO(A)R implementation, modeling, and the NDW, while Tau-U calculations suggest medium to large effects for Natalie expanding her child's communication via the AAC device.

No intervention effects were observed for use of expectant delays, prompting (i.e. pointing and manual), and confirming her child's communication message. The child in this dyad frequently independently communicated via AAC when Natalie turned to a new page, while she was reading, or as soon as she was done reading. Therefore, no intervention effects were observed for expectant delays or prompts because the child often communicated before she had the opportunity to provide either. No intervention effects were observed for responding by confirming the child's message because Natalie was already demonstrating this skill in baseline and thus, there was not a significant change from baseline to intervention.

Visual analysis revealed effects on Matthew's communication behaviors for the following dependent variables: (a) independent communication and (b) independent communication in response to a spoken prompt. Immediate changes in level were observed for Tim's independent communication, suggesting the intervention had an immediate effect on his independent communication. Tau-*U* calculations indicate large effects on increasing Tim's independent communication. In contrast, Tau-*U* calculations indicate medium to large effects on decreasing Tim's independent communication in response to a spoken prompt. This result is influenced by Natalie's use of the SO(A)R protocol. Tim's caregiver frequently provided spoken prompts by asking "wh" questions (e.g. "Where's the trampoline?") or giving spoken instructions (e.g. "You show me") during the baseline phase. After completing the online training, Natalie demonstrated an increase in use of the SO(A)R strategy and therefore, a reduction in spoken prompts was observed.

No effects were observed for Tim's prompted communication, overall communication, or the NDW (independent, prompted, or overall). As previously discussed, Tim often communicated independently resulting in limited opportunities for Natalie to provide him with prompts. Therefore, the lack of effects observed for prompted communication and NDW would be expected. The lack of effects for prompted communication may have contributed to no effect observed for overall communication and consequently, NDW overall. While the frequency of Tim's independent communication increased after the intervention, the NDW remained consistent across phases.

In conclusion, the online training intervention was highly effective to teach Natalie how to implement the SO(A)R strategy accurately in addition to AAC communication partner skills including modeling and expansion. Natalie's implementation of the SO(A)R strategy and engagement with the device herself via modeling and expansion resulted in increased independent communication from Tim during shared book reading. Natalie's completion of the online training also resulted in a reduced amount of "wh" questions, providing Tim with more opportunities for spontaneous communication rather than responsive labeling.

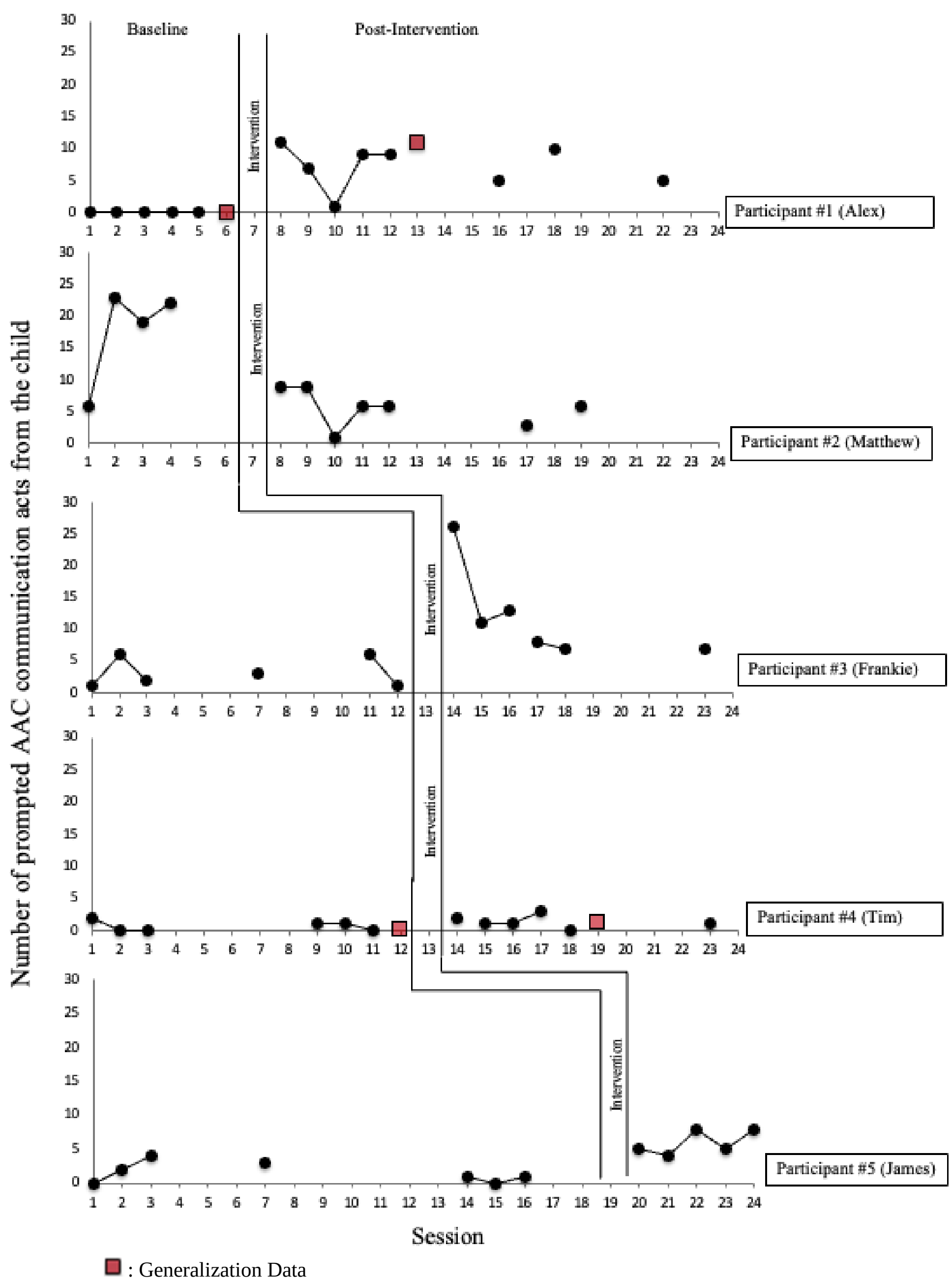

Figure **12**: Number of prompted AAC communication acts from children.

Dyad 5 (Mother; Katie)

SO(A)R Procedural Fidelity

Prior to completion of the online training, Katie implemented the SO(A)R strategy accurately on an average of 3.6 occasions (range 1-7; Median = 3) per shared book reading session. Visual analysis of the graph revealed moderate to high variability with zero trend. High levels of SO(A)R strategy use were observed during the 1st, 2nd, and 5th baseline sessions. This was due to Katie frequently responding to her child's independent communication by repeating the message aloud before turning the page. According to the operational definition of SO(A)R, if the child communicated independently and the parent responded by either confirming or expanding the message, SO(A)R was used accurately. Therefore, each confirmation of her child's independent communication was counted as an instance of SO(A)R. However, the sequence of skills in the SO(A)R strategy was not observed during baseline. After completion of the online training, Katie accurately implemented the SO(A)R strategy on an average of 11.4 occasions (range 8-13; Median = 12) per book reading session. Visual analysis of the graph indicated an immediate increase in level (i.e. demonstration of basic effect) with mild to moderate variability and a gradually increasing trend. Tau-*U* calculations suggest a large effect (Tau-*U* = 1.00) on Katie's use of the SO(A)R strategy during shared book reading.

Modeling

Prior to completing the online training, Katie modeled vocabulary on the AAC device on zero occasions (*M*=0; range 0-0; Median = 0). After completing the online training, Katie modeled vocabulary on the AAC device at an average frequency of 7 occasions per book reading session (Range 6-9; Median = 7). Visual analysis of the graph indicated an immediate change in level with mild variability and zero trend, indicating a basic effect. Tau-*U* calculations indicated large effects (Tau-*U*=1.00) on Katie's use of modeling during book reading sessions.

Expectant Delay

Prior to completing the online training, Katie provided an average of <1 expectant delays (*M*=0.4; Median =0; range = 0-2) per book reading session. Visual analysis of the graph revealed a consistently low level with no variability or trend. During the post-intervention phase, Katie provided an average of 4.6 expectant delays during shared book reading (Range 3-6; Median = 5). Visual analysis of the graph revealed an immediate change in level with mild variability with no trend indicating a basic effect. Tau-*U* was calculated to be 1.00 indicating a large effect on Katie's use of expectant delays during shared book reading with her child.

Prompting

During the baseline phase, Katie provided an average of 1.3 pointing prompts (range 0-3; Median = 1) per book reading session. Visual analysis of the data demonstrated a low, stable baseline with zero trend. During the post-intervention phase, Katie provided a pointing prompt to James on an average of 5.6 occasions (Range 4-8; Median = 5) per book reading session. Visual interpretation of the graph indicated an immediate change in level and a gradually increasing trend with mild to moderate variability indicating a basic effect. Tau-*U* was calculated to be 1.00 indicating a large effect on Katie's use of pointing prompts during book reading sessions.

Katie provided no manual prompts during the baseline phase (*M*=0; Median = 0; Range = 0-0). After completing the online training intervention, Katie provided a manual prompt during book reading on an average of <1 occasion (M=0.6; range 0-1; Median = 1) per session. The graph revealed no change in level (i.e. no basic effect) with no variability and zero trend. Tau-*U* calculations suggest small effects (Tau-*U* = 0.60) on Katie's use of manual prompts.

Responding

Prior to completing the online training, Katie responded to James's communication by confirming his message at an average rate of 4 times (range 0-7; Median =5) per book reading session. Visual interpretation of the graph indicated mild to moderate variability and zero trend. After completing the online training, Katie responded to James's communication by confirming his message on an average of 11.2 occasions (Range 8-17; Median = 13) per book reading session. Visual analysis of the graph revealed a change in level and a gradually increasing trend with mild variability indicating a basic effect. Tau-*U* calculations suggest large effects (Tau-*U* = 1.00) on Katie's responding to her child's communication by confirming his message during shared book reading.

Katie did not respond to James's communication by expanding his communication messages during baseline (*M*=0; Median = 0; Range 0-0) or post-intervention (*M*=0; Median = 0; Range 0-0) phases. Visual analyses for both baseline and post-intervention phases indicated low levels of stable data patterns with zero trend. No effect was observed.

NDW

Prior to completing the online training, Katie communicated zero vocabulary words via the AAC device during shared book reading sessions (*M*=0; range 0-0; Median =0). After completion of the online training, Katie communicated an average of 6.8 different words (range 5-9; Median = 7) on the AAC device per shared book reading session. Visual interpretation of the graph revealed an immediate increase in level and a gradual increasing trend with mild variability, indicating a basic effect. The median level line increased from 0 (baseline) to 7 (post-intervention). Tau-*U* calculations indicate a large effect (Tau-*U*=1.00) on the number of different words Katie communicated using the AAC device during shared book reading with her child.

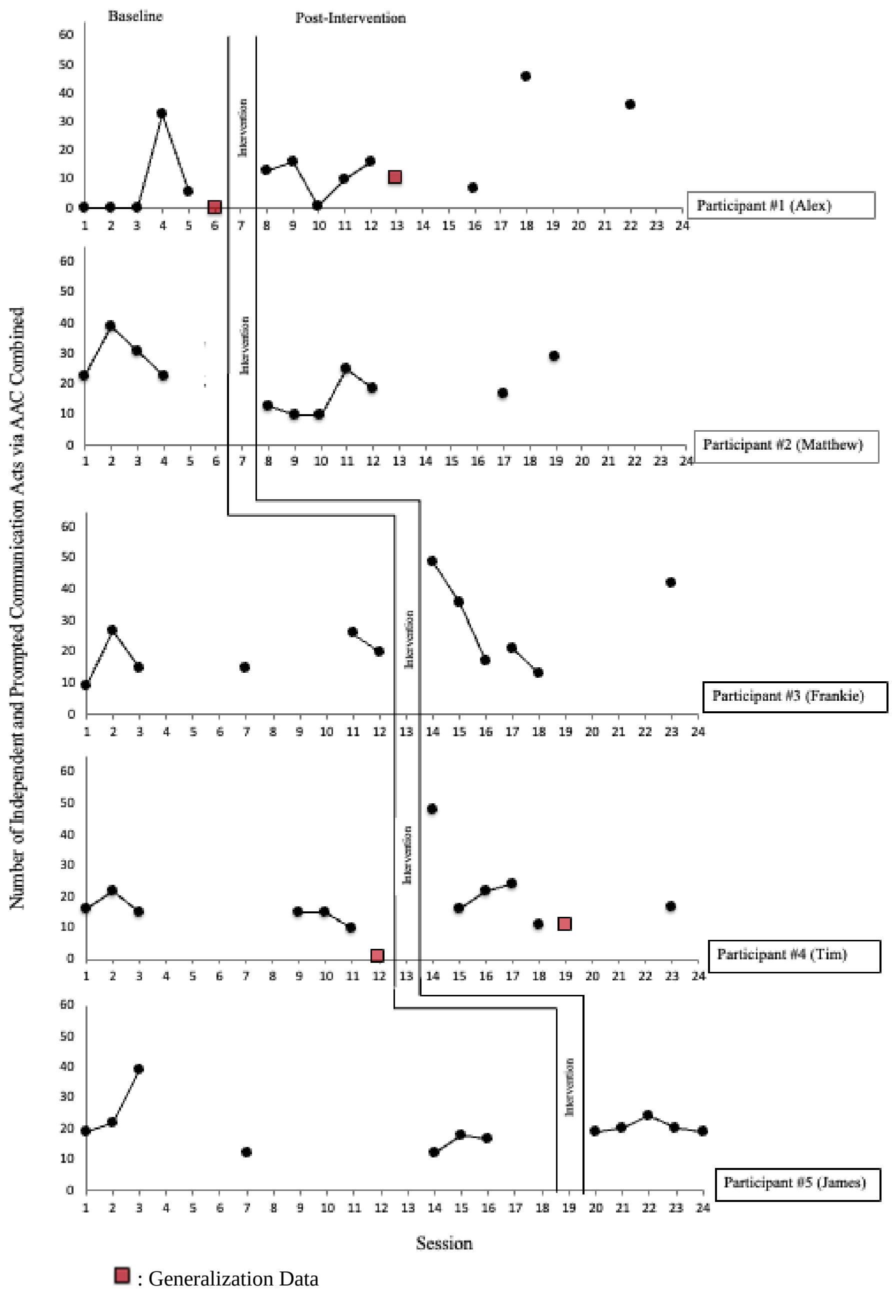

Figure **13**: Child Overall Communication – Number of independent and prompted communication acts via AAC combined.

Dyad 5 (Child; James)

Child Independent Communication

Prior to James's mother completing the online training, he independently communicated on an average of 15 occasions (range 7-22; Median = 15) per shared book reading session. The graph revealed a moderate to high level of variability and zero trend. Data points for the first three baseline sessions demonstrate high levels of independent communication. James often repeatedly selected buttons on the AAC device (e.g. selected “swirl” button 8 times consecutively) during one communication turn during these initial 3 baseline sessions, which contributed to the variability observed. After his mother completed the online training, James independently communicated on an average of 14.4 occasions (range 11-16; Median = 15) per book reading session. Visual interpretation of the graph revealed no change in level (i.e. no basic effect) with mild variability and zero trend. Tau-*U* calculations suggest a small effect (Tau-*U* = -0.09) on James’s independent communication via AAC.

James’s independent AAC communication in response to a spoken prompt was also calculated. Prior to his mother completing the online training, James independently communicated in response to a spoken prompt an average of 3.6 times (range 0-13; Median 1) per shared book reading session. Visual interpretation revealed initial variability (i.e. first three data points) followed by a decrease in trend that sustained with little to no variability for the remainder of the phase. After his mother completed the training, none of James’s independent communication was in response to a spoken cue (*M*=0; Median = 0; range 0-0). Visual analysis of the graph indicated a change in level (decrease) with no variability and zero trend indicating a basic effect. Tau-*U* calculations suggest a small effect (Tau-*U* = -0.57) on James’s independent communication in response to a spoken cue.

Child Prompted Communication

Prior to James’s mother completing the online training, he engaged in prompted communication acts on an average of 1.6 occasions (range 0-4; Median 1) during shared book reading sessions. Visual analysis of the graph indicated a low level with mild variability and zero trend. After his mother completed the online training, James engaged in prompted communication on an average of 6 occasions (range 4-8; Median = 5) per shared book reading session. Visual interpretation of the graph revealed an immediate change in level and a gradually increasing trend with moderate variability indicating a basic effect. Tau-*U* calculations suggest a large effect (Tau-*U* = 0.97) on Tim's prompted communication.

Child Communication Overall

James's communication overall (independent and prompted AAC selections) was analyzed as well. Prior to his mother completing the online training, James engaged in communication on an average of 19.9 occasions (range 12-39; Median = 18) per book reading session. Visual interpretation of the graph revealed a high level of variability and zero trend. The outlier observed in the third baseline session influenced the variability during baseline. During this session, James was observed the repeatedly select the same button multiple times during one communication turn, which resulted in the outlier data point. After his mother completed the online training, he communicated an average of 20.4 times per book reading session (Range 19-24; Median = 20). Visual analysis of the graph revealed no change in level with moderate variability and zero trend indicating no basic effect. Tau-*U* calculations suggest a small effect (Tau-*U* = 0.43) on James's overall communication.

NDW (Child)

The number of different words included the number of different vocabulary words communicated by James on the AAC device, and the NDW were calculated for his independent, prompted, and overall communication. Prior to his mother completing the online training, James independently communicated an average of 6.1 different words (range 3-11; Median = 4) per book reading session. The graph revealed moderate variability with zero trend during the baseline phase. After his mother completed the online intervention, James communicated an average of 7 different words (range 5-9; Median = 7) per book reading session. Visual interpretation of the graph indicated no change in level with moderate variability and zero trend indicating no basic effect. Tau-*U* calculations revealed a small effect (Tau-*U* = 0.23) on the number of different words independently communicated by James's.

James communicated an average of 1.3 words (range 0-3; Median = 1) when provided with a prompt during the baseline phase. The graph reveals a low baseline level with mild variability and zero trend. After his mother completed the online training, James communicated an average of 5.4 different words when given a prompt (range 4-7; Median = 5) per book reading session. Visual interpretation of the graph revealed an immediate change with and a very gradual increase in trend with mild variability indicating a basic effect. Tau-*U* calculations suggest a large effect (Tau-*U* = 1.00) on the NDW communicated by James when prompted.

Finally, the number of different words communicated overall by James was calculated. Prior to his mother completing the online training, he communicated an average of 6.9 different words (range 3-12; Median = 5) per book reading session. The graph revealed a moderate variability and zero trend. After his mother completed the online training, James communicated an average of 11 different words (range 9-14; Median = 10) per shared book reading session. Visual analysis of the graph indicated no change in level with mild to moderate variability and no trend indicating no basic effect. Tau-*U* calculations suggest a small effect (Tau-*U* = 0.50) on the number of different words communicated by James via AAC during shared book reading.

Dyad 5 Summary

Visual analyses revealed intervention effects on Katie's behavior for the following dependent variables: (a) accurate implementation of SO(A)R, (b) modeling (c) expectant delay,

(d) pointing prompts, (e) responding by confirmation, and (f) NDW. Immediate changes in level were observed for all of these variables, with the exception of responding by confirmation, suggesting the intervention was “powerful” and/or immediately effective on Katie’s behavior (Ledford & Gast, 2018). In addition, Tau-*U* calculations suggest large effects of intervention on all dependent variables for which an effect was observed.

No intervention effects were observed for manual prompts or responding by expanding the child’s message. Katie’s limited use of manual prompting during shared book reading is likely the result of accurate SO(A)R strategy implementation. James often accessed the AAC device to communicate when given an expectant delay or a pointing cue. According to the SO(A)R strategy, Katie should then respond to her child’s communication, and a manual prompt would not be provided. Therefore, James’s communication impacted Katie’s limited use of manual prompting following the intervention. No effect was observed for responding by expansion because Katie did not access the device to expand James’s communication messages from a one-button selection to a two-button selection when responding. Katie only accessed the device throughout the study to provide models of vocabulary.

Visual analysis revealed effects on James’s communication for the following dependent variables: (a) independent communication in response to a spoken prompt, (b) prompted communication, and (c) the NDW prompted. Immediate changes in level were present for both prompted communication and the NDW prompted, suggesting the intervention had an immediate effect on these communication behaviors (Ledford & Gast, 2018). In addition, Tau-*U* calculations indicate large effects for prompted communication and NDW prompted. James’s mother provided little to no prompts prior to completing the online training. If James did not communicate, his mother continued to read the book aloud without providing any supports. Due to the increase in her provision of pointing prompts after completing the online training, it would be expected to see an increase in James's prompted communication. A decrease in level was observed for independent communication in response to a spoken prompt, and small effects (Tau-U = - 0.57) are suggested for this variable. A decrease in this behavior would be expected if the caregiver was accurately following the SO(A)R protocol, as it encourages providing wait time quietly and nonspeaking prompts.

With regards to James's communication, no effects were observed for independent communication or overall communication. As previously described, James often repeatedly selected a single button on the AAC device during baseline, which contributed to the observed high levels of independent communication. For example, he communicated independently on 19 occasions during session 1, but he only communicated a total of 3 different words. Therefore, James may have demonstrated more intentional button selections during the post-intervention phase in addition to a more consistent, broad selection of vocabulary when supported by his mother.

In conclusion, the online training intervention was highly effective to teach Katie how to implement the SO(A)R strategy accurately in addition to AAC communication partner skills such as modeling, providing wait time (expectant delay), providing prompts in a hierarchy format (pointing → manual) to encourage AAC output from the child, and responding to the child's communication message. Katie's completion of the online training positively impacted James's communication by providing more opportunities for spontaneous communication due to the reduction in spoken prompts. Katie was also able to provide prompts effectively to engage James in using the AAC device to express a variety of vocabulary terms to spontaneously commenting during shared book reading.

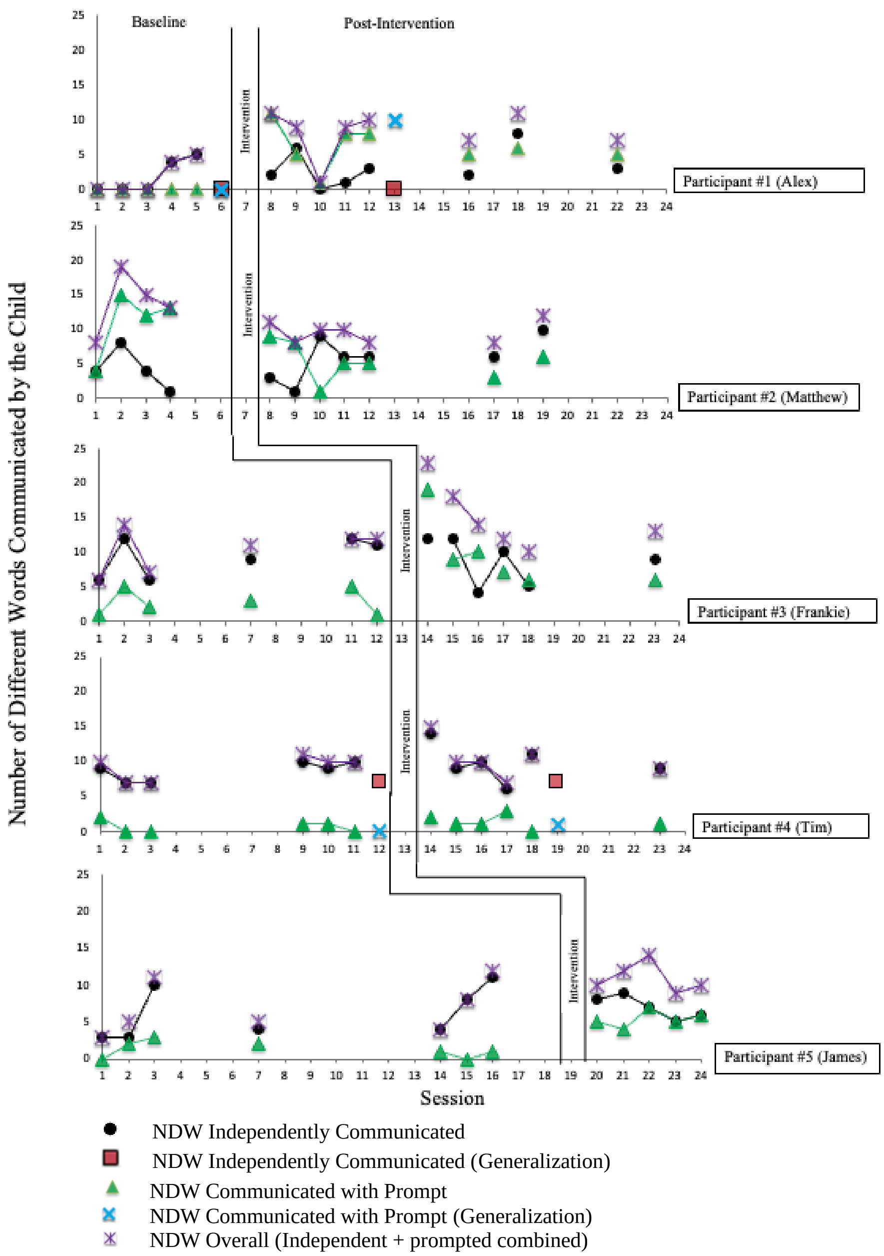

Figure **14**: Number of different words (NDW) communicated by the child via AAC

Table 4. Standardized Mean Differences, Tau-*U* Calculations, & Effect Sizes for Caregiver/Parent Behaviors

Participants	SO(A)R Procedural Fidelity	Modeling	Expectant Delay	Prompt (Point)	Prompt (Manual)	Respond (Confirm)	Respond (Expand)	NDW
Dyad 1 (Margaret)	Tau-*U*: 0.85 (Med-Large)	Tau-U: 0.38 (Small)	Tau-U: 0.88 (Med-Large)	Tau-U: 0.98 (Large)	Tau-U: 1.00 (Large)	Tau-U: 0.95 (Large)	Tau-U: 0.00 (None)	Tau-U: 0.25 (Small)
Dyad 2 (John)	Tau–*U*: 1.00 (Large)	Tau-U: -0.61 (Small)	Tau-U: 1.00 (Large)	Tau-U: 0.04 (Small)	Tau-U: -1.0 (Large)	Tau-U: -0.25 (Small)	Tau-U: 1.0 (Large)	Tau-U: -0.04 (Small)
Dyad 3 (Veronica)	Tau–*U*: 0.56 (Small)	Tau-U: 1.0 (Large)	Tau-U: 1.00 (Large)	Tau-U: 0.36 (Small)	Tau-U: 0.94 (Large)	Tau-U: 0.17 (Small)	Tau-U: 0.0 (None)	Tau-U: 1.00 (Large)
Dyad 4 (Natalie)	Tau–*U*: 1.00 (Large)	Tau-U: 0.97 (Large)	Tau-U: -0.14 (Small)	Tau-U: 0.14 (Small)	Tau-U: 0.17 (Small)	Tau-U: 0.42 (Small)	Tau-U: 0.83 (Med-Large)	Tau-U: 1.00 (Large)
Dyad 5 (Katie)	Tau–*U*: 1.00 (Large)	Tau-U: 1.00 (Large)	Tau-U: 1.00 (Large)	Tau-U: 1.00 (Large)	Tau-U: 0.60 (Small)	Tau-U: 1.00 (Large)	Tau-U: 0.00 (None)	Tau-U: 1.00 (Large)
ALL	*Weighted Tau-U: 0.88 (Med-Large)*	*Weighted Tau-U: 0.57 (Small)*	*Weighted Tau-U: 0.74 (Med- Large)*	*Weighted Tau-U: 0.51 (Small)*	*Weighted Tau-U: 0.37 (Small)*	*Weighted Tau-U: 0.47 (Small)*	*Weighted Tau-U: 0.36 (Small)*	*Weighted Tau-U: 0.65 (Small)*

Note. Tau-U calculations accounted for baseline corrections and measured nonoverlap from baseline to post-intervention phases; effect size estimates are according to Vannest & Ninci (2015)

Table 5. Tau-*U* Calculations & Effect Sizes for Child Behaviors

Participants	**Child Comm. Independent**	**Child Comm. Independent in Response to Spoken Prompt**	**Child Comm. Prompted**	**Child Comm. Overall***	**NDW Independent**	**NDW Prompted**	**NDW Overall***
Dyad 1 (Alex)	Tau-U: 0.38 (Small)	Tau-*U*: 0.00 (None)	Tau-*U*: 1.00 (Large)	Tau-*U*: 0.65 (Small)	Tau-*U*: 0.33 (Small)	Tau-*U*: 1.00 (Large)	Tau-*U*: 0.90 (Med-Large)
Dyad 2 (Matthew)	Tau–*U*: 0.29 (Small)	Tau–*U*: -0.89 (Med-Large)	Tau–*U*: -0.75 (Med-Large)	Tau-*U*: -0.71 (Med-Large)	Tau-*U*: 0.32 (Small)	Tau-*U*: -0.64 (Small)	Tau-*U*: -0.61 (Small)
Dyad 3 (Frankie)	Tau–U: 0.83 (Med – Large)	Tau–*U*: -0.42 (Small)	Tau–*U*: 1.00 (Large)	Tau-*U*: 0.44 (Small)	Tau-*U*: -0.14 (Small)	Tau-*U*: 1.00 (Large)	Tau-*U*: 0.58 (Small)
Dyad 4 (Tim)	Tau–U: 0.97 (Large)	Tau–*U*: -0.67 (Med-Large)	Tau-*U*: 0.39 (Small)	Tau-*U*: 0.56 (Small)	Tau-*U*: 0.23 (Small)	Tau-*U*: 0.39 (Small)	Tau-U: 0.19 (Small)
Dyad 5 (James)	Tau–U: - 0.09 (Small)	Tau–*U*: -0.57 (Small)	Tau-*U*: 0.97 (Large)	Tau-*U*: 0.43 (Small)	Tau-*U*: 0.23 (Small)	Tau-*U*: 1.00 (Large)	Tau-U: 0.50 (Small)
ALL	*Weighted Tau-U: 0.48 (Small)*	*Weighted Tau-U: -0.50 (Small)*	*Weighted Tau-U: 0.54 (Small)*	*Weighted Tau-U: 0.29 (Small)*	*Weighted Tau-U: 0.20 (Small)*	*Weighted Tau-U: 0.57 (Small)*	*Weighted Tau-U: 0.33 (Small)*

Note. Tau-U calculations accounted for baseline corrections and measured nonoverlap from baseline to post-intervention phases; effect size estimates are according to Vannest & Ninci (2015)

*Overall: Independent + prompted communication combined

Table 6. Caregiver Means, Medians, & Ranges of Dependent Variables

	SO(A)R Procedural Fidelity	Modeling	Expectant Delay	Prompting (Point)	Prompting (Manual)	Responding (Confirm)	Responding (Expand)	NDW
Margaret								
Baseline								
M	0.2	6.8	0	0.4	0	0.6	0	6.4
Median	0	8	0	0	0	0	0	7
(range	(0-1)	(2-11)	(0-0)	(0-2)	(0-0)	(0-3)	(0-0)	(2-10)
Post-Intervention								
M	6.3	8.4	5.4	6.9	7	8	0	7.4
Median	6.5	9	6	7	7	8.5	0	8
(range)	(0-11)	(1-12)	(0-10)	(2-10)	(1-11)	(1-12)	(0-0)	(1-11)
John								
Baseline								
M	1.75	12.75	0	4.5	13	9	0	8.3
Median	1.5	13.5	0	4.5	13	7.5	0	9
(range)	(0-3)	(6-18)	(0-0)	(2-7)	(6-20)	(6-15)	(0-0)	(4-12)
Post-Intervention								
M	8	6.3	3.6	5	2	6.6	3.7	7.7
Median	9	7	2	5	2	8	4	7
(range)	(4-10)	(0-12)	(1-9)	(0-10)	(1-4)	(3-8)	(1-6)	(4-13)
Veronica								
Baseline								
M	0.33	0.2	0.3	1.8	1.8	4.5	0	0.7
Median	0	0	0	1	1	5	0	1
(range)	(0-1)	(0-1)	(0-1)	(0-5)	(0-5)	(1-8)	(0-0)	(0-1)
Post-Intervention								
M	3.2	49.5	5.8	2.7	9.8	6.8	0	17.5
Median	3	50	4.5	2	6	4.5	0	17.5
(range)	(0-7)	(33-63)	(3-11)	(1-7)	(5-25)	(2-20)	(0-0)	(13-22)
Natalie								
Baseline								
M	1.3	0.2	0.5	0.8	0	4.3	0	0.2
Median	1	0	0	0.5	0	4.5	0	0
(range)	(0-3)	(0-1)	(0-2)	(0-3)	(0-0)	(1-9)	(0-0)	(0-1)
Post-Intervention								

M	6.6	5.3	0.3	1	0.2	7.2	1.8	6.8
Median	7	5	0	1	0	7	2	7
(range)	(5-8)	(1-9)	(0-2)	(0-3)	(0-1)	(3-13)	(0-3)	(4-9)
Katie								
Baseline								
M	3.6	0	0.4	1.3	0	4	0	0
Median	3	0	0	1	0	5	0	0
(range)	(1-7)	(0-0)	(0-2)	(0-3)	(0-0)	(0-7)	(0-0)	(0-0)
Post-Intervention								
M	11.4	7.2	4.6	5.6	0.6	11.2	0	6.8
Median	12	7	5	5	1	13	0	7
(range)	(8-13)	(6-9)	(3-6)	(4-8)	(0-1)	(8-17)	(0-0)	(5-9)

Table 7. Child Means, Medians, & Ranges of Dependent Variables

	Independent Communication	Independent Communication W/ Spoken Prompt	Prompted Communication	Overall Communication*	NDW Independent	NDW Prompted	NDW Overall*
Alex							
Baseline							
M	7.8	0	0	7.8	1.8	0	1.8
Median	0	0	0	0	0	0	0
(range)	(0-33)	(0-0)	(0-0)	(0-33)	(0-5)	(0-0)	(0-5)
Post-Intervention							
M	11	0	7.1	18.1	3.1	6.1	8.1
Median	4.5	0	8	14.5	2.5	5.5	9
(range)	(0-36)	(0-0)	(1-11)	(0-46)	(0-8)	(1-11)	(1-11)
Matthew							
Baseline							
M	8.3	3.25	17.5	29	4.25	11	13.8
Median	9.5	3.5	20.5	27	4	11	14
(range)	(0-14)	(1-5)	(6-22)	(23-39)	(1-8)	(4-15)	(8-19)
Post-Intervention							
M	11.4	0.4	5.7	17.6	5.6	5.3	9.6
Median	12	0	6	17	6	5	10
(range)	(1-19)	(0-1)	(1-9)	(10-29)	(1-10)	(1-9)	(8-12)
Frankie							
Baseline							
M	0.7	14.8	3.2	18.7	9.3	2.8	10.3
Median	0	15	2.5	17.5	10	2.5	11.5
(range)	(0-2)	(8-21)	(1-6)	(9-27)	(6-12)	(1-5)	(6-14)
Post-Intervention							
M	7.8	9.8	12	29.7	8.7	9.5	15
Median	6	13	9.5	28.5	9.5	8	13.5
(range)	(1-21)	(1-14)	(7-26)	(13-49)	(5-12)	(6-19)	(10-23)

<u>Tim</u>							
Baseline							
M	7.5	7.3	0.7	15.5	8.7	0.7	9.2
Median	7.5	8	0.5	15	9	0.5	10
(range)	(4-11)	(2-12)	(0-2)	(10-22)	(7-10)	(0-2)	(7-11)
Post-Intervention							
M	18.8	2.8	1.3	23	8.7	1.3	10.3
Median	18	0.5	1	19.5	10	1	10
(range)	(11-32)	(0-14)	(0-3)	(11-48)	(6-14)	(0-3)	(7-15)
<u>James</u>							
Baseline							
M	15	3.6	1.6	19.9	6.1	1.3	6.9
Median	15	1	1	18	4	1	5
(range)	(7-22)	(0-13)	(0-4)	(12-39)	(3-11)	(0-3)	(3-12)
Post-Intervention							
M	14.4	0	6	20.4	7	5.4	11
Median	15	0	5	20	7	5	10
(range)	(11-16)	(0-0)	(4-8)	(19-24)	(5-9)	(4-7)	(9-14)

*Overall Communication: Independent and Prompted Communication combined

Generalization

Dyad 1 (Margaret & Alex)

Generalization data was collected for Dyad 1 in the context of a play activity. During baseline, Margaret implemented the SO(A)R strategy during play with Alex on zero occasions. After completing the online training, Margaret implemented the SO(A)R strategy a total of 6 times during play with Alex. Before completing the online training, Margaret provided zero expectant delays, no prompts (either pointing or manual), and no responses to any child communication. After completing the online training, increases in the following caregiver/parent behaviors were observed after the online training during the play activity: (a) provision of expectant delay (n=6), (b) pointing prompts (n=11) (c) manual prompts (n=11), and (d) responding to the child's communication by confirming the message (n=11). No change in responding via expanding the child's message was observed, as she continued to provide zero expansions of the child's communication after the training.

A decrease in modeling behavior observed, as Margaret provided 31 AAC models during baseline and 10 AAC models during post-intervention. During the baseline play activity, the only communication acts observed, both vis speech and AAC, were from Margaret. She consistently modeled vocabulary on the AAC device while talking aloud, and it was the only skill from the SO(A)R strategy that was used prior to the training. After completing the training, Margaret incorporated expectant delays, prompting, and responding in addition to modeling vocabulary throughout the activity. Therefore, the decrease in modeling is likely attributable to the addition of the other skills in the SO(A)R strategy following the training completion.

During the generalization activity, there was no change in Alex's independent communication observed from baseline to post-intervention, as he required prompts to communicate via AAC during this activity. Prior to his grandmother completing the training, Alex engaged in prompted communication acts on zero occasions. After Margaret completed the online training and began using prompts, Alex's prompted communication acts increasing to 11 during play. As a result, an increase in the NDW (both prompted and overall) communicated by Alex was observed after his grandmother completed the training. In conclusion, Margaret demonstrated generalization of the SO(A)R strategy to an activity other than shared book reading (i.e. play) that resulted in the provision of more expectant delays, prompts, and responses to Alex's communication. Consequently, Alex engaged in more communication acts and communicated a variety of vocabulary items.

Dyad 4 (Natalie & Tim)

Generalization data was collected for Dyad 4 in the context of a snack activity. No significant change in use of the SO(A)R strategy was observed from baseline to post-intervention indicating it was not generalized from shared book reading to snack. No changes were observed in the provision of expectant delays, prompting, and responding via expanding the child's message. Increases in modeling and responding to (confirming) the child's communication were observed during the snack activity after Natalie completed the online training. With regards to the child's communication, an increase in independent communication with a spoken prompt was observed, contributing to an increase in the child's communication overall (independent and prompted combined) and the NDW communicated by the child.

During the snack activity that was used for the measure of generalization, Natalie appeared to have a difficult time engaging Tim in social interaction. Natalie was observed to ask many "wh" questions throughout the activity to elicit responses from Tim rather than modeling vocabulary item on the device and providing an expectant delay to give Tim an opportunity to communicate. As a result, almost all of Tim's communication throughout the activity was in response to a spoken prompt. Therefore, these communications were not counted as within the SO(A)R strategy. An additional potential confounding factor was that the foods Tim was eating during both the baseline and post-intervention snack videos did not match the pre-programmed vocabulary (as discussed with Natalie) on the AAC device. Snack items pre-programmed on the device included toaster strudel and popcorn. However, Tim was eating ice cream during baseline and candy during the post-intervention phase. This may have left Natalie and Tim with limited vocabulary to use during the interaction.

In conclusion, the SO(A)R strategy was not successfully generalized to a snack activity for Dyad 4. However, increases in Natalie's use of modeling and responding by confirming Tim's message were observed, which may have positively impacted Tim's overall communication acts and number of vocabulary words used during snack time.

Summary

Generalization data was collected from Dyad 1 and Dyad 4. The caregiver/parent in Dyad 1 demonstrated generalization of the SO(A)R strategy to a novel activity (i.e. play), which resulted in increased communication acts and vocabulary words communicated by the child. The caregiver/parent in Dyad 4 showed no generalization of SO(A)R to a novel activity (i.e. snack). However, generalization of individual skills from SO(A)R, specifically modeling and responding, were observed throughout the snack activity that may have positively affected the child's communication acts and number of vocabulary words communicated by the child.

Social Validity

All parents/caregivers who participated in the study completed the social validity survey and open-ended questions. All parents strongly agreed that they were satisfied with the online instruction, they would recommend the training to other parents, they will continue using the SO(A)R strategy beyond the study. All participants strongly agreed that they would participate in another online training and that they wanted to learn more about how to support their child's communication in other contexts. When asked to describe what they liked about the online training, participants reported that the training was easy to understand, access, and navigate, and they enjoyed being able to complete the training whenever they had time available. Participants also enjoyed the many different video models and examples. One participant indicated that knowing the training was created by professionals who could help his child encouraged him to push through his son's hesitation to try new things and work to support his child's communication. All participants who responded to the open-ended questions (4 out of 5) agreed that the online format was helpful to alleviate family stressors. Parents/caregivers were asked what changes they would make or suggest for the training. No changes to the training were recommended by participants in the current study.

Table **8.** Social Validity Questions & Responses (*M*, range)

Question	**Mean (range)**
I have noticed positive changes in my child's communication since this training.	3.8 (2-5)
I feel more confident that I can help my child learn to communicate.	4.6 (4-5)
The AAC device was easy to use while reading with my child.	5.0 (5-5)
It was beneficial to use books that were personalized and tailored towards my child's interests.	5.0 (5-5)
I feel more confident when interacting with my child while using AAC (e.g. device, picture symbols).	4.8 (4-5)
I am satisfied with the instruction I received.	5.0 (5-5)
I would participate in another online training if given the opportunity.	5.0 (5-5)
I would recommend this program to other parents.	5.0 (5-5)
I believe this program benefited my child overall.	4.8 (4-5)
I would like to learn more about how to help my child communicate effectively during different activities and situations, such as play, arts and crafts, and during meal-times.	5.0 (5-5)
I will continue to use the SO(A)R strategy with my child beyond this study.	5.0 (5-5)

CHAPTER 4

DISCUSSION

Parent-implemented language and communication interventions are considered evidence-based practice for children with ASD (Wong et al., 2013). Training parents to implement strategies to support their child's communication development has been consistently associated with better outcomes for children with CCN (Akemoglu et al., 2020), and the use of telepractice services has been demonstrated as an effective modality to deliver parent training to support language and communication of children with ASD (Akemoglu et al., 2020). Telepractice is supported as an alternative or supplemental method of service delivery by the American Speech-Language-Hearing Association (ASHA), however, there is a robust need to explore effective telepractice methods as advancements in technology and internet-based services continue to increase (Timpe et al., 2021; Aklemoglu et al., 2020).

The results of the current study contribute to the evidence base for the use of asynchronous telepractice to conduct parent trainings for children with ASD. Further, the findings of this study contribute to the limited evidence available for training parents of children with ASD who have LNFS and who are actively learning to use AAC for communication. Akemoglu and colleagues (2020) conducted a systematic review of telepractice to teach parents of children with ASD language and communication strategies. Only one of the twelve studies that were included in that review referred to AAC within their online training (Douglas et al., 2018), and none of the included studies aimed to teach AAC specific strategies. Further, none of the child participants with ASD in the included studies used aided AAC for communication. Therefore, the current study offers a unique contribution to the field by placing a focus on teaching AAC specific strategies via asynchronous telepractice to parents. Additionally, previous research has evaluated the effectiveness of online training to teach communication strategies to parents, but the impact of individual strategy components was not evaluated (Douglas et al., 2018). This study included an analysis of each component within the SO(A)R strategy to describe impacts of individual parent and child behaviors.

Finally, the current study evaluated the effects of an asynchronous training in isolation, without the inclusion of direct interactions with professionals. Eleven of the twelve studies included in the systematic review conducted by Akemoglu and colleagues (2020) incorporated a synchronous coaching component (face-to-face and/or via telepractice). Therefore, the results of the current study contribute to the evidence base for effectiveness of online training resources for parents who might not have access to direct coaching or feedback from professionals.

Overall Effects of Intervention on Parent Strategy Use

The current study provides preliminary evidence that a completely asynchronous, self-paced, online parent training program employing the learning principles from the ImPAACT program can effectively teach parents a multi-step strategy to support their child's communication via AAC. Four of the five parent/caregivers included in this study effectively learned to use the SO(A)R strategy in the context of shared book reading with their child. In addition, Tau-*U* calculations suggested the online intervention had a large effect on individual parent strategy use, and between case SMD calculations (1.838) indicated a large effect (Cohen, 1988) of the online intervention on strategy use across all participants in the study. Therefore, universally available online trainings may be a valuable resource for parents of children with CCN who lack access to services or to trainings provided directly from professionals.

While a functional relation was established between the online training and parent/caregiver use of the SO(A)R strategy, analysis of individual strategy components indicated varying results for each parent/caregiver. For example, intervention effects were observed for AAC modeling for some participants but not for others. Given the SO(A)R protocol, it is not surprising that intervention effects were not observed for each component of SO(A)R for some participants. These diverse results were influenced by the SO(A)R protocol itself in addition to communication abilities of the child and parent/caregiver skill use during the baseline phase.

A functional relation for the provision of expectant delays was observed in all dyads except for Dyad 4. However, the child in Dyad 4 often communicated independently before the 5-second wait-time was complete. Therefore, no change in this behavior was observed from baseline to post-intervention due to the already positive child communicative behaviors.

When evaluating the use of modeling, an intervention effect was observed for all parents/caregivers (i.e. Dyad 3, Dyad 4, Dyad 5) who used little to no modeling during the baseline phase. An intervention effect was not observed for parents/caregivers in Dyads 1 and 2, however they were modeling vocabulary on the AAC device prior to receiving the online training.

When evaluating the use of a pointing prompt, an intervention effect was observed within two dyads (i.e. Dyad 1 and Dyad 5). The child in Dyad 4 frequently communicated independently during book reading sessions, therefore his mother did not have opportunities to provide pointing prompts. The parent in Dyad 2 was already implementing pointing prompts during the baseline phase, thus there was not a significant change observed from baseline to post-intervention. Veronica in Dyad 3 used some pointing prompts in baseline as well, however she often immediately provided a manual prompt, which contributed significantly to her limited use of SO(A)R in the post-intervention phase.

When evaluating use of manual prompting, intervention effects were observed for Dyads 1, 2, and 3. The child behaviors in Dyads 4 and 5 impacted parent/caregiver provision of manual prompts. The frequent independent communication from Tim in Dyad 4 reduced the need for manual prompting, and James in Dyad 5 often responded immediately to a pointing prompt, again limiting the requirement for the parent to provide a manual prompt. Thus, the limited change in manual prompting for Dyads 4 and 5 in fact support accurate use of the SO(A)R strategy.

When evaluating responding to child communication, intervention effects for confirming the child's communication were observed for Dyads 1 and 5. Veronica in Dyad 3 often failed to confirm the child's communication according to the operational definition, also contributing to the limited observation of SO(A)R strategy use. Natalie in Dyad 4 demonstrated responding via confirmation of her child's communication during baseline phase, thus there was not a significant change in behavior observed post-intervention. The parent in Dyad 2 demonstrated some confirmations of the child's communication baseline a well. However, after completing the online training, he often expanded his child's communication when responding, resulting in an intervention effect for responding by expansion. An intervention effect for expanding the child's communication was also observed for Dyad 4, as Natalie only began to employ expansion after completing the online training. Parents in Dyads 1, 3, and 5 demonstrated no expansion of child communication during baseline or post-intervention phase.

In summary, the online training increased the parent/caregiver use of the SO(A)R strategy in addition to modeling and provision of expectant delays for all dyads who were not demonstrating those skills in baseline. Some parents/caregivers adopted both expansion and confirmation as methods of responding to their child's communication. Other parents/caregivers only demonstrated use of responding by confirming their child's message, although use of expansion may have been particularly beneficial to their child. A reduction in spoken prompts (e.g. "wh" questions) was observed for all participants who frequently used spoken prompts during baseline, with the exception of the parent in Dyad 3.

Overall Effects of Intervention on Child Communication

Demonstration of a functional relation between the online intervention and child communication was observed for independent child communication with a spoken prompt. An intervention effect for Dyads 2, 3, and 4 was observed that was characterized by a reduction in child communication in response to spoken prompts. This suggests that the SO(A)R strategy may have reduced parent provision of spoken prompts and replaced them with expectant delays and/or prompting. The use of expectant delays and/or prompting may provide the child with more independent and spontaneous AAC communication opportunities and decrease responsive, adult-directed communication during shared book reading.

A functional relation was also demonstrated between the online intervention and both prompted child communication and the NDW communicated with a prompt. Children showed an increase in prompted communication after parents completed the online training, indicating that parents learned how to effectively prompt their child to use the AAC device to communicate. Provision of prompts to encourage AAC output from the child during intervention is associated with improved communication outcomes (Romski et al., 2010). Parents/caregivers in this study demonstrated that they learned to promote AAC output from their child, which could positively impact language and communication development.

An intervention effect for an increase in independent communication was observed for the children in Dyads 3 and 4. A substantial increase in modeling vocabulary on the AAC device was observed for the parents in both dyads. The primary parent behavior that increased within these dyads was parent use of the device during the book reading session. These results may further confirm the positive impacts of the communication partner engaging with the AAC device during interactions.

Parent Perception of Online Training

All the parents/caregivers who participated in this study positively perceived the online training, describing it as helpful, easily accessible, and easy to navigate and understand. All participants reported they will continue use of the SO(A)R strategy and would recommend the program to other parents. All participants indicated they wanted to learn more about supporting their child's communication in other activities and that they would participate in another online training if given the opportunity. No participants reported any suggested modifications to the current format of the online training. These results suggest that the online training provided parents with an effective strategy and an activity that they will continue to engage in with their child, which can have significant positive impacts on their child's language and communication development via AAC. In addition, the accessibility and flexibility of online trainings make them a preferred format for parents and caregivers across different roles (i.e. mothers, fathers, grandparents) and with varying work schedules. For example, Margaret was unemployed, and John worked a full-time job, yet both participants reported the online training format to be helpful and effective to alleviate family stressors.

Comparison to Previous Work

This study included a unique population of child participants when using the ImPAACT program principles to train communication partners. All children in this study were diagnosed with autism spectrum disorder, demonstrated severely impaired language skills, and communicated solely via the AAC system during the shared book reading activity. All previous studies applying the ImPAACT principles to train communication partners included a total of only two participants with an ASD diagnosis, both of whom were able to use speech to communicate. Moreover, previous ImPAACT studies included speech, gestures, sign, and AAC when calculating child communication dependent variable measures. In addition, all child participants in previous ImPAACT studies demonstrated a receptive language age of at least 2 years. Therefore, while child communication increased less in the current study compared to previous communication partner training studies using ImPAACT, the children in the current study demonstrated more severely impaired language processing abilities and used fewer modalities of communication related to the severity of their diagnosis. Communication partners were still able use the SO(A)R strategy successfully to engage with their child during shared book reading despite the additional communication challenges experienced by the children. Thus, results of this study uniquely contribute to the field by providing evidence that asynchronous trainings incorporating ImPAACT principles can positively impact caregivers of children with severe ASD with little to no functional speech who demonstrate severe language impairments, require AAC, and who are communicating at the early symbolic level.

Clinical Implications

Findings from this study suggest that asynchronous online training programs can be a valuable resource for parents and caregivers of children with ASD who require AAC. The results also suggest that some parents/caregivers prefer access to online trainings due to the inherent flexibility and easy accessibility. The incorporation of online training in intervention programs places little to no extra demands on professionals or parents/caregivers. Speech-language pathologists can easily share access links with parents via text and/or emails. Moreover, parents can easily open trainings right on their Smart Phones, as the majority of participants in this study completed the training using this platform. Therefore, it may be both beneficial and convenient for professionals to share evidence-based online trainings with parents/caregivers who are unable to have consistent, ongoing communication with the child's educational team. This can result in significantly more widespread distribution of important information to parents of children with ASD who use AAC. Consequently, the number of children with ASD using AAC who are receiving parental support for language and communication development would increase and/or these children could receive support from parents at a younger age to improve communication outcomes.

The Pictello application used in the current study also serves as a valuable clinical tool for SLPs, allowing SLPs to easily create books with real-time or personalized photos. Parents in this study could engage with their child and provide models of meaningful vocabulary in addition to assisting their child to express important vocabulary terms. Therefore, use of the Pictello application may allow SLPs to bridge communication between school and home by providing the child with ASD an opportunity to use functional vocabulary to talk about personalized and motivating topics (e.g. family).

All of the children who had high-tech AAC systems in place prior to this study (i.e. Matthew, Frankie, Tim, James) had been using their AAC system for at least 1 year (range 1-5.5 years), however, none of them were reported to be using it for social communication functions with their parents. All parents/caregivers described the device as being used to strictly communicate wants/needs. Additionally, four out of five participants reported they had never received AAC training, although the child had been using an AAC device for 5 years. Hence, this suggests that parents are not receiving access to parent training programs despite having access to speech therapy services. Given the enormous impact of engagement in social interaction on language development, professionals need to include intervention methods to promote social communication at home. The current study suggests that online training programs can effectively teach evidence-based strategies to parents to promote social communication in the home. As the evidence for and availability of online trainings continues to grow, it may be beneficial for clinicians to use these resources to promote social communication via AAC in the home – a critical communication context for both the child and the parent.

The findings of this study indicate that online trainings can be effective to teach parents strategies to support their children with ASD who are beginning communicators learning to use AAC. Best practice supports providing children with LNFS with AAC as early as possible to promote child success (Beukelman & Light, 2020). Therefore, parents should be provided with information as to how to support their child's communication at home as early as possible. Professionals working with families of children with ASD who are unable to meet during working hours or attend in-person trainings should share evidence-based online training resources, so parents still have access to essential information to support their child's AAC communication development.

Limitations

The current study has several limitations that warrant discussion. First, while the investigator attempted to collect generalization data from all participants, generalization data was only available for participants in Dyads 1 and 4. Further, generalization measures could not be compared across participants due inconsistent conditions. For example, participants were instructed to submit a video that was 8 minutes in length for the generalization measure. Dyad 1 submitted 8-minute-long generalization data videos for both baseline and post-intervention;

however, the generalization videos submitted for Dyad 4 were only 4 minutes in length because the child did not cooperate for the activity after that time. Therefore, the increased time available for the participant in Dyad 1 resulted in more opportunities for the parent/caregiver to implement the SO(A)R strategy. Thus, the potential for generalization of use of the SO(A)R strategy or the individual skills used in SO(A)R to activities other than shared book reading is inconclusive.

Second, due to the asynchronous and virtual nature of the intervention, procedural fidelity measures depended on the integrity of the adult participants. Participants were required to send the investigator a screenshot of their completion certificate when they finished the training. However, the training software allowed participants to fast-forward videos, and the software platform did not allow the investigator to remove that option. Therefore, while the training required participants to press play on each video, it was possible for participants to complete the program while watching fewer instructional videos and video models. In addition, a portion of the training instructed parent/caregivers to practice using SO(A)R on their own and with their child. However, these sessions were not videotaped or documented for verification purposes. Again, the completion of these activities depended on the integrity of the adult participants. One purpose of the training being self-paced was to allow participants to learn individually and practice at their own rate. Thus, participants did not have to report or describe their experiences with practicing the SO(A)R strategy and post-intervention data may have been influenced by varying practice opportunities.

Third, the goal of the current study was to evaluate the impact of an online training resource for parents/caregivers without the direct input from an interventionist. Therefore, this study did not include an active intervention component (e.g. feedback, coaching) to improve use of the SO(A)R strategy for participants who did not respond positively to the online training. The current study also did not evaluate what factors might have contributed to one parent/caregiver learning the SO(A)R strategy less successfully than others. Thus, additional supports that might be needed for parents/caregivers who do not effectively learn how to implement SO(A)R using a strictly technology-based training still need to be explored.

Future Directions

Future research should explore how to identify parents and children who are most appropriate for receiving the SO(A)R training. Parents who have received AAC training prior to completing the online training may already be familiar with the skills incorporated in the SO(A)R strategy and respond differently. Furthermore, all of the child participants in this study were primarily non-speaking beginning communicators at the early symbolic stage of communication who were using AAC strictly for requesting. SO(A)R training may be less appropriate for parents/caregivers of children who are at a later developmental communication stage (e.g. combining symbols) and who are already using AAC for multiple communication functions. Preliminary investigation of the use of the strategies incorporated in SO(A)R by these parents/caregivers would indicate whether they might also benefit from learning about these means of encouraging more communication with their children with ASD who use AAC.

In addition, future research should explore how to identify parent training formats that best support individual families. As previously discussed, families possess a variety of different resources which affect their availability for parent education programs. Therefore, parents/caregivers who experience increased life stressors of lack of time and energy may benefit from an online training format. While all participants in this study positively perceived online training, parents/caregivers may have different preferences for learning. Some parents/caregivers may prefer to rely on self-paced and asynchronous information while others may prefer direct, in-person instruction with immediate feedback. Thus, how to determine "best fit" formats of parent education should be explored.

The results of this study clearly demonstrated that the diverse behaviors exhibited by parents/caregivers and children within each dyad affected behavioral outcomes. For example, the provision of expectant delays or prompts from parents/caregivers was reduced for dyads in which the child engaged in frequent independent communication. To address these differences in parents/caregivers and child communicators, future research should investigate the effects of adding an individualized coaching component (e.g. strength-based video feedback) that can still maintain the asynchronous nature of the intervention but provide parents/caregivers with ongoing support as their child's communication changes. Online training resources typically teach the same content to parents regardless of their child's communication skills. However, if, for example, these children are already independently commenting using a single-button message, the parents/caregivers could focus on modeling or expanding utterances via multi-symbol messages. Thus, the individualized coaching component could improve efficacy of universal online trainings by supporting application of AAC strategies to children across differing communication levels. Research could determine how coaching could be paired with asynchronous trainings while still placing minimal demands on the parents/caregivers.

Given the importance of context for individuals with ASD, especially for those with severe language impairments, future research should explore the impact of context-rich photos on a child's language use. For example, books can be created using Visual Scene Displays (VSD) incorporating images of familiar contexts. Images placing meaningful vocabulary in familiar environments may increase the child's use of vocabulary and communication during shared book reading.

The current study evaluated parent/caregivers' ability to learn use of an AAC strategy in the context of one activity – shared book reading. Limited information was provided in this study about parent/caregivers’ ability to generalize the SO(A)R strategy to everyday activities. Future research should better explore parent/caregivers’ ability to apply the SO(A)R strategy to activities other than shared book reading upon completion of the online training. Interventions need to be incorporated into the daily routines/activities of the family to reduce parental stress and support the most positive outcomes for children with ASD (Hardan et al., 2018; Koegel et al., 2020; Beukelman & Light, 2020). Intervening in frequently occurring daily routines allows for a large number of trials for strategy implementation and exposure to meaningful vocabulary (Hardan et al., 2018; Beukelman & Light, 2020).

Limited research is available on the whether the learning principles from the ImPAACT program, which were used to teach the SO(A)R strategy, can be effectively implemented in a context other than shared book reading. All previous studies applying the ImPAACT program principles, including the current study, have focused on teaching communication partners AAC strategies in the context of shared book reading. Parents in the current study expressed a desire to learn how to apply SO(A)R to other activities with their child, and previous research highlights that parents have expressed a desire to learn to incorporate strategies into their child’s everyday routines (Biggs et al., 2018). Therefore, future research should evaluate efficacy of teaching AAC strategies to communication partners using the learning principles from the ImPAACT program in different activities that might be frequently occurring in households (e.g. snack time).

While there is much research supporting the effectiveness and feasibility of online trainings, the impacts over time still need to be explored (Vismara et al., 2018). Clinical recommendations suggest the need for ongoing, long-term, coordinated programs for parent education (Dawson-Squibb et al., 2019; Koegel et al., 2020). Thus, future research also needs to explore how to best develop online training programs for optimal learning success and incorporate progressive trainings to support parents as their child's communication changes over time.

Finally, diverse results for individual SO(A)R strategy skills (e.g. expectant delay, prompting) were observed for caregivers in the dyads. This was due to child behaviors and the SO(A)R protocol. For example, if a child independently communicated immediately following the parent providing a model, the parent did not have an opportunity to provide an expectant delay. Thus, visual analysis may indicate there was no change in parent behavior for provision of expectant delay. However, this was the result of a lack of opportunity rather than failure to learn the skill. Future research should thoroughly evaluate the relationships between the parent and child behaviors within each dyad to more accurately depict the efficacy of the online training program.

Conclusions

In conclusion, ImPAACT learning principles applied to an asynchronous, online training were effective to teach parents/caregivers of children with ASD with LNFS the SO(A)R strategy to support their child's social communication via AAC in the context of shared book reading. The online training intervention was also effective for teaching parents/caregivers the use of aided AAC modeling and expectant delays in the context of shared book reading. The online training was effective for a variety of caregivers (i.e. mothers, father, grandmother) with diverse employment demands and schedules.

Online trainings may be a valuable resource for parents of children with CCN who do not possess resources that allow them to participate in time-consuming parent education programs.

Online trainings may also be a beneficial additional resource to those parents who are able to attend in-person AAC parent trainings, as they provide unlimited access to video models and instruction. They can efficiently promote widespread distribution of beneficial information to support families and their child with ASD who relies on AAC, which can ultimately improve communication outcomes.

The current study and other related research have reported online trainings to be effective. Moreover, parents may prefer online training education programs due to the flexibility and ease of accessibility. Therefore, the exploration of online training programs for parents of children with CCN is a significant, socially valid area of research that deserves further investigation. While the use of telepractice or technology-based trainings is supported as an alternative or supplemental method of educating parents, much work still needs to be done to determine how to best support parents by using these technological tools for learning to make a difference for children with significant communication needs and their families.

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Appendix A

Child Book Topics

Participant Dyad 1	Participant Dyad 3	Participant Dyad 5
1. My Favorite Foods 2. My Book of Trucks 3. Places I Like To Go 4. Toy Story and Monster's University 5. Moana and Rapunzel 6. My Family 7. Cars 8. My Favorite Toys 9. Encanto and Coco 10. Going To School	1. My Book of Fish 2. My Book of Dogs 3. Animals on the Farm 4. My Family 5. Places I Like to Go 6. Frozen 7. Finding Nemo 8. Things That Go in the Ocean 9. I Like to Play 10. Elmo's World	1. My Family 2. My Book of Fruits 3. My Book of Vegetables 4. Smokey Bones 5. Things at the Pool 6. Ice Cream! 7. I Like to Move 8. I Like to Play 9. Mr. Potato Head 10. Flashlight
Participant Dyad 2	Participant Dyad 4	
1. Meet the Bubble Guppies 2. Bubble Guppies Adventures 3. My Favorite Foods 4. Balloons! 5. Going to McDonald's 6. My Favorite Books 7. I Like to Play! 8. Frozen 9. Bubble Guppies Adventures Part 2 10. I Go To Disney World	1. My Favorite Foods 2. I Like to Have Fun 3. My Family 4. Spongebob 5. Bubble Guppies Adventures 6. Bubble Guppies Adventures Part 2 7. I Like Nickelodeon 8. Dora! 9. Blue's Clues 10. Places to Eat	

Appendix B

Social Validity Survey

Parents were asked to respond to the statements below by rating them on a 5-point scale indicating if they *Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree.*

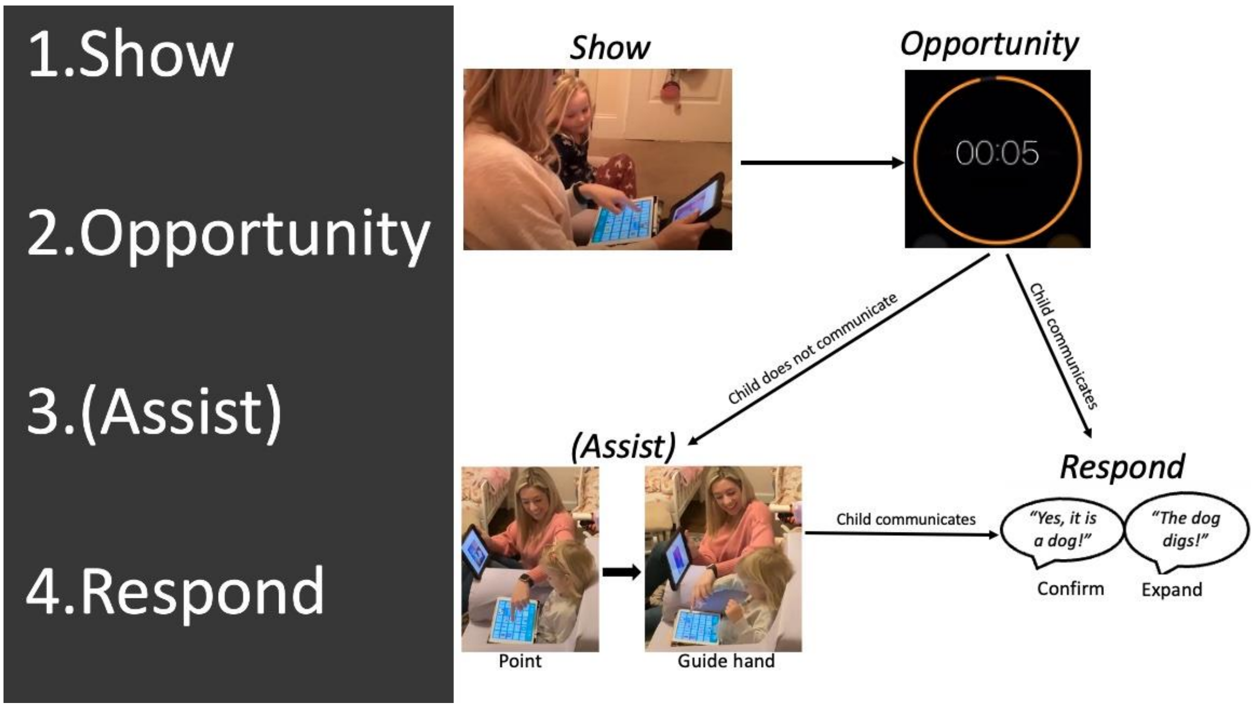
1. I have noticed positive changes in my child's communication since this training.
2. I feel more confident that I can help my child learn to communicate.
3. The AAC device was easy to use while reading with my child.
4. It was beneficial to use books that were personalized and tailored towards my child's interests.
5. I feel more confident when interacting with my child while using AAC (e.g. device, picture symbols).
6. I am satisfied with the instruction I received.
7. I would participate in another online training if given the opportunity.
8. I would recommend this program to other parents.
9. I believe this program benefited my child overall.
10. I would like to learn more about how to help my child communicate effectively during different activities and situations, such as play, arts and crafts, and during mealtimes.

Parents were asked to type a response to the following open-ended questions:

1. What did you like most about the online training?
2. What changes, if any, would you make to this training?
3. Do you feel the online format was helpful? Did the self-paced, online format help alleviate family stressors (e.g. travel time, scheduling conflicts, childcare for siblings) while receiving information to support your child's use of AAC?

Appendix C

SO(A)R Visual Handout Mailed to Parents



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Publications and Presentations

Coburn, K., Jung, S., Ousley, C., Sowers, D. J., **Wendelken, M**., Wilkinson, K. (2021). Centering the family in their system: A framework to promote family-centered AAC service. *Augmentative and Alternative Communication*, *37*(4), 229-240.

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Wendelken, M. & Williams, D. L. (2022, November). AAC interventions with individuals with autism with significant receptive language challenges: A qualitative study. American Speech-Language-Hearing Annual Convention, New Orleans, LA. [Poster Presentation]

Wendelken, M. & Williams, D. L. (2021, November). Beyond requesting: A systematic review of AAC intervention for children with Autism Spectrum Disorders. American Speech-Language-Hearing Association Annual Convention, Washington, DC. [Poster Presentation]

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