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Personalized Early AAC Intervention to Build Language and Literacy Skills

A Case Study of a 3-Year-Old With Complex Communication Needs

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Personalized augmentative and alternative communication (AAC) intervention refers to an approach in which intervention is tailored to the individual's needs and skills, the needs and priorities of the individual's family and other social environments, the evidence base, and the individual's response to intervention. This approach is especially relevant to AAC intervention for young children with complex communication needs given their unique constellations of strengths and challenges, and the qualitative and quantitative changes that they experience over time as they develop, as well as the diversity of their families, schools, and communities. This article provides detailed documentation of personalized AAC intervention over a 6-month period for a 3-year-old girl with developmental delay and complex communication needs. The article describes (1) personalization of multimodal AAC supports to provide this child with the tools to communicate; (2) personalized intervention to build semantic and morphosyntactic skills; and (3) personalized instruction in literacy skills (i.e., letter sound correspondences, sound blending, decoding, sight word recognition, reading simple stories, reading comprehension, and encoding skills). Specific goals, instructional materials, and procedures are described; data on speech, language, and literacy outcomes are presented. **Key words:** *AAC*, *children*, *complex communication needs*, *developmental delay*, *early intervention*, *language development*, *literacy instruction*, *personalization*

THE TERMS "personalized medicine or personalized rehabilitation" refer to a model of service delivery in which interventions are tailored to the individual based on their unique makeup, the evidence base, and the individual's anticipated response to the intervention (e.g., Beukelman,

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2016; Hamburg & Collins, 2010; Nonnekes & Nieuwboer, 2018). This personalized approach is focused on ensuring that individuals receive the right intervention at the right time (cf. Hamburg & Collins, 2010). This model stands in contrast to a "one size fits all" approach in which all individuals receive the same intervention regardless of their individual needs and skills or the characteristics of their environments (Beukelman, 2016). A personalized approach is particularly relevant to guide decision-making in service delivery for young children who have complex communication needs (e.g., children with autism spectrum disorder, cerebral palsy, Down syndrome, or other developmental disabilities whose natural speech is not sufficient to meet all of their communication needs; Beukelman & Light, 2020). These children require augmentative and alternative communication (AAC) to support their communication. Augmentative and alternative communication is defined as strategies, techniques, and tools used to enhance communication (American Speech Language Hearing Association, 2005). A vast array of AAC strategies, technologies, and interventions are available that may support children with complex communication needs and decisions must be made as to which of these are the most appropriate fit for each individual child (Beukelman & Light, 2020).

Young children with complex communication needs each have unique constellations of strengths and challenges that impact their response to available AAC supports and interventions (e.g., Kasari et al., 2014; Romski et al., 2015, 2010). They experience significant changes as they learn and grow; their needs and skills show both quantitative and qualitative shifts over time, necessitating modifications to AAC strategies, technologies, and interventions over time to support their development (Light & McNaughton, 2012). Furthermore, children with complex communication needs do not exist in isolation; rather they interact within dynamic social systems including their families, schools, and broader communities. These children and their families are also impacted by the broader societal context that defines legislation, policy, and practices (e.g., Beukelman & Light, 2020). Each of these social systems presents their own unique constellations of strengths, challenges, values, and priorities that impact the uptake and ultimate success (or failure) of AAC systems and interventions (Mandak et al., 2017). For these reasons, the most effective AAC interventions are personalized so that they take into account the child's needs and skills; the needs and priorities of the family, school, and broader social context; and the available evidence base (Granlund et al., 2008; Mandak et al., 2017). Moreover, the most effective AAC interventions are dynamic; the team carefully monitors the child's response to intervention and makes modifications as required to reflect changes in the child's needs and skills as well as those of the environment (Beukelman & Light, 2020).

Augmentative and alternative communication interventions should support young children with complex communication needs so that they can participate actively in family, school, and community activities; these interventions should prepare them for later involvement in a wide range of meaningful adult activities (e.g., education, employment, volunteer activities, health care, and community living; McNaughton & Beukelman, 2010). To support such participation, personalized AAC interventions for children may need to target a broad range of individual goals to build communicative competence, foster language development, promote literacy learning, and enhance speech development (Light & McNaughton, 2014). In order to maximize outcomes for young children with complex communication needs, it is critical for practitioners to understand how to personalize AAC supports and interventions to meet targeted goals under a variety of social and environmental conditions at different stages of development.

The field of AAC is still in the early stages of investigating the personalization of AAC intervention. Future research is required to understand how to best implement intervention

in an individualized and evidence-based manner (Beukelman, 2016). Detailed case studies are an important first step to identify factors that warrant further investigation. In fact, it has been argued that: "... a scientific discipline without a large number of thoroughly executed case studies is a discipline without systematic production of exemplars, and a discipline without exemplars is an ineffective one" (Flyvbjerg, 2006; p. 219). This article is intended to contribute to advancing our understanding by providing a comprehensive case study of personalized AAC intervention with a 3-year-old child with complex communication needs over a 6-month period (from 38 to 44 months old). The personalized AAC intervention focused on two key domains across this period: (1) building language skills (specifically, semantic and morphosyntactic skills) to support more effective communication; and (2) teaching literacy skills to facilitate generative communication. The article provides detailed documentation of intervention goals, AAC supports, and instructional procedures across three phases of intervention over the 6-month period and presents data on speech, language, and literacy outcomes. The case study illustrates how we implemented personalized, evidence-based AAC intervention and how we modified intervention based on the child's response to intervention (Fuchs & Fuchs, 2006). It should be noted that this case study does not provide experimental control and therefore it is not possible to draw a definitive causal relationship between the AAC intervention and the outcomes observed; however, this case provides a source of data to help guide future intervention research.

BACKGROUND INFORMATION

We first met Jessica[1] when she was 35 months old. She was an only child and lived at home with her parents who were very supportive and actively involved with her. When Jessica was 15 months old, her parents had requested an early intervention assessment due to concerns about delays in her acquisition of speech and motor developmental milestones. She qualified for early intervention services at that time and started to receive home-based speech and language intervention, occupational and physical therapy, and vision services. At 26 months, she had a neurodevelopmental evaluation and was diagnosed with global developmental delays with severe expressive language delay, mild receptive language delay, and neuromotor dysfunction. She also had a diagnosis of strabismus, intermittent esotropia (i.e., her eyes turned inward when fixating on objects or activities; Molarte & Rosenbaum, 1991) and rotational nystagmus (i.e., involuntary eye movement when the head is rotated; Tibbling, 1969). She had been followed by an ophthalmologist since she was 4 months of age and had successful surgery to correct her eye alignment when she was 41 months old (during the course of our intervention). There were no concerns about her hearing. She had passed her newborn hearing screening as well as more formal sound field testing completed when she was a year old; she responded consistently to spoken input and environmental sounds.

At 35 months of age, Jessica received a comprehensive assessment of her motor, receptive language, expressive communication, and cognitive skills by her early intervention team in preparation for her transition to preschool services. At that time, she demonstrated the ability to walk independently, but did not run or jump. She was able to point with her index finger independent of her thumb and other fingers as well as scribble linear and circular patterns using a fist grasp. She required assistance to hold the paper while coloring, string beads, and fasten her clothing. Her cognitive development was assessed using the Battelle Developmental Inventory, Second Edition (BDI-2; Newborg, 2005). Her overall cognitive development domain score was 1.67 standard deviations

[1]This article uses a pseudonym to protect confidentiality.

below the mean, qualifying her for preschool services with the diagnosis of developmental delay. Her social and emotional development was also assessed using the BDI-2. Her score fell within the average range for children with typical development. Per report, she greeted familiar adults spontaneously, enjoyed activities with adults, and responded positively when familiar adults initiated social contact. She separated easily from her parents, used adults for resources, and asked for help when needed. She was able to follow rules within the classroom. She was reported to engage in parallel play with peers and was observed to imitate the play activities of other children. She did not initiate social contact with peers; however, she willingly shared toys with them.

When she was 35 months old, her communication skills were also assessed using the Preschool Language Scale, 5th Edition (PLS-5; Zimmerman et al., 2011), a language sample, and a phonetic inventory. Her scores on the auditory comprehension portion of the PLS-5 were within the average range for children her age. She was reported to engage in symbolic play, recognize actions in photographs, and understand quantitative concepts (e.g., one, some, and all). Neither her parents nor her early intervention team reported concerns with Jessica's receptive language abilities. Her speech production was extremely limited; standardized assessment tools were not administered due to her limited sound repertoire. Her phonetic inventory only included six consonant sounds. Her production of vowels was often distorted and her word shapes were reduplicated open syllables (CV, CVCV). Jessica presented with challenges in saliva management and was often observed to have her tongue out while engaging in activities.

Her expressive communication scores on the *PLS-5* fell below the average range for children her age. She recognized photographs and line drawings, but demonstrated difficulty naming objects in photographs due to her expressive limitations. She responded appropriately to bids for social attention and demonstrated referential looking. Her parents and early intervention team had introduced her to signs and a low-tech communication book to augment her communication. She demonstrated a preference for using signs to communicate with her parents and teachers. Her parents and early intervention team reported that she knew approximately 150 signs, including signs for people, animals, actions, objects, descriptors, etc. Her signs were approximations of the required hand shapes, locations, orientations, and movements, but were typically understood by adults who were familiar with her sign inventory. She also had a communication book that contained pictures to support her communication with others, especially those who were unfamiliar with signs. She communicated in single signs (mean length of utterance = 1.0) with a limited range of concepts. She used conventional gestures to communicate yes (head nod) and no (head shake). Jessica loved reading books with adults and her parents frequently read to her. Her parents had taught her the names of the letters of the alphabet, but not the sounds; she had not received any literacy instruction.

We used the participation model (as described in Beukelman & Light, 2020) to guide intervention, including consideration of Jessica's participation patterns and communication needs, her capabilities and skills, and environmental supports and constraints (see Table 1 for a summary of each of these domains when Jessica was 35 months old).

PERSONALIZED AAC INTERVENTION TO BUILD LANGUAGE AND LITERACY SKILLS

When Jessica turned 3 years old, she transitioned to a community preschool program 3 half-days per week where she received speech and language therapy, physical therapy, and vision services. She was also referred to the Penn State AAC program where she attended an early language group two mornings per week followed by individual instruction for 30 min (the focus of this article); she started these programs at the age of

Table 1. Summary of Jessica's communication needs and skills at 35 months of age, prior to the personalized augmentative and alternative communication intervention

Assessment Domain	Assessment Results
Communication needs and priorities	
Unmet communication needs and priorities at home and school	Share information and experiences with parents at home and educational staff at preschool
	Ask questions of familiar adults to support learning
	Participate in early childhood activities at home and preschool (e.g., colors and numbers)
	Develop early literacy skills to support communication and prepare for educational program
	Interact socially with peers at preschool
	Interact with grandparents
Capabilities/skills	
Vision and hearing	Hearing skills within normal limits; no specific constraints
	Strabismus-intermittent esotropia and rotational nystagmus
	• Requires clear, uncluttered visual materials (e.g., photographs and text)
	• Needs appropriate positioning to ensure head stability
	• Need to monitor performance as visual demands increase with literacy instruction
Motor	Walks independently
	Able to point with her index finger independent of her thumb and other fingers
	Uses a fist grasp to hold a marker or crayon
	Needs appropriate seating and positioning to ensure stability
	• Maximize motor function for selection and manipulation of materials
Natural speech	Uses appropriate intonation to communicate affect (e.g., happy, sad, and angry) and intent (e.g., asking a question, and asserting a statement)
	Has a limited number of spoken word approximations; speech is not functional to meet communication needs
	Has a very limited repertoire of speech sounds
	• Produces the consonant sounds /b, p, m, w, d, t/
	• Production of vowels often distorted
	• Demonstrates reduplicated open syllables (CV, CVCV)
	Challenges in saliva management
Receptive language skills	Comprehension skills at age level
	Understands range of words that express different semantic roles (e.g., people, actions, descriptors, objects, questions, relational terms, and social words)
	Understands simple instructions
	Understands range of wh-questions (e.g., who, what, and where)
Expressive communication	Demonstrates a substantial gap between comprehension and expression
	Has a limited expressive vocabulary
	• Expresses approximately 150 concepts through signs and photographs/line drawings (e.g., people, objects, and locations)
	Communicates in telegraphic one-word messages
	Demonstrates strengths in pragmatics
	• Takes turns consistently in interactions with familiar adults
	• Responds contingently to partner questions if she has the means to do so
	• Has difficulty initiating or expanding topics given limited means of expression

(*continues*)

Table 1. Summary of Jessica's communication needs and skills at 35 months of age, prior to the personalized augmentative and alternative communication intervention (*Continued*)

Assessment Domain	Assessment Results
Symbol representation/literacy	Recognizes and uses approximately 150 signs expressively
	Understands photographs and line drawings as representations of people, objects, places, and events
	Is very interested in books; family values literacy
	Knows all letter names but does not know letter sounds
	Does not yet decode/sound out words to read
	Does not yet encode or spell out words
Cognitive/linguistic organization	Groups concepts by activities (e.g., all the people, actions, objects, and descriptors for circle time go together; all the people, actions, objects, and descriptors for playing outside go together, etc.)
Environmental/partner supports and constraints	
Policy, practice, and attitude supports and barriers	Is an only child; lives with both parents who are very supportive of her needs
	• Parents are strong advocates; have sought out services as required
	Participates in an inclusive preschool program
	• Preschool staff demonstrate positive supportive attitude
Knowledge and skill supports and barriers	Preschool staff have limited experience with augmentative and alternative communication but are supportive
	Parents are resourceful and use supportive interaction strategies
	• Watch *Signing Time* with their daughter and practice signs with her
	• Read to their daughter regularly

38 months. Based on the assessment of her needs and skills and environmental supports and constraints, the following areas were identified as priorities for intervention in collaboration with her family and preschool team: (1) enhancing social communication skills with her peers; (2) building her language skills (with a focus on semantic and morphosyntactic skills) to allow her to share her experiences and participate effectively in education; and (3) learning literacy skills to support generative communication and learning. The first of these skills was addressed during the early language group and is not explicitly discussed in this article. This article focuses primarily on her individual sessions that provided literacy instruction with opportunities to enhance language skills integrated into the literacy instruction. The language and literacy intervention was delivered by the third author for the first 3 months and the fourth author for the following 3 months, both graduate students in speech–language pathology; these students were supervised by a qualified speech–language pathologist with expertise in AAC (the second author) whereas the first author provided consultative support.

As noted earlier, intervention occurred across a 6-month period and included three phases, each building on the skills acquired in the prior phase. Data were collected regularly to allow formative evaluation of her performance; modifications to goals, instructional materials, and procedures were made regularly depending on her performance. Thus, intervention was dynamic, reflecting her response to instruction. Table 2 presents a summary of the three intervention phases as well as the language and literacy goals targeted in each phase.

Jessica's parents were actively involved in intervention planning; a parent typically observed the intervention sessions and followed through with many activities in the home environment. Her parents regularly used the following interaction strategies with Jessica

Table 2. Phases of intervention and targeted language and literacy goals across a 6-month period

Intervention Phase	Targeted Goals
Phase 1 Months 1–2 of intervention 38–40 months of age	Language skills • Increase receptive and expressive vocabulary • Express early semantic relations (e.g., agent–action, action–object, and descriptor–object) Literacy skills • Demonstrate the phonological awareness skill of sound blending • Acquire six to seven letter sound correspondences • Recognize by sight a few highly motivating words (in isolation and during shared reading)
Phase 2 Months 3–4 of intervention 40–42 months of age	Language skills • Continue to increase receptive and expressive vocabulary • Combine concepts to communicate multiword sentences Literacy skills • Continue to acquire letter sound correspondences; locate letters on keyboard when presented with their sounds • Decode novel words (i.e., combine letter-sound knowledge and sound blending to read words) • Recognize highly motivating words (e.g., her name, swing, and bear) and frequently occurring irregular words (e.g., school and come) by sight • Decode or recognize by sight target words within shared reading activities with a familiar adult partner
Phase 3 Months 5–6 of intervention 42–44 months of age	Language skills • Continue to increase receptive and expressive vocabulary • Combine concepts to express a wide range of sentence structures • Incorporate function words and morphological structures into messages as appropriate • Tell stories with a beginning, middle, and end Literacy skills • Continue to practice decoding skills with a greater range of letter sounds • Continue to build sight word reading vocabulary for frequently occurring irregular words • Read simple stories • Demonstrate understanding of these stories by responding to questions and sharing information • Continue to build keyboard knowledge (i.e., locate letters when presented with their sounds) • Demonstrate phoneme segmentation skills (i.e., break words into individual sounds) as foundation for early writing/encoding

to support her communication: providing numerous opportunities for her to communicate, responding to her communication attempts, and expanding on her messages using speech plus signs. They read books regularly with her and talked about the stories, relating them to her experiences.

AAC supports for communication

Too often, AAC supports are selected for young children based on clinician preference or the practices of the educational program. In contrast, in keeping with the principles of personalized intervention, we selected and customized AAC supports for Jessica based

on her needs, skills, and preferences as well as the values and preferences of her family and preschool program. Most individuals with complex communication needs rely on multiple modes to communicate (e.g., Light et al., 1985). Thus, we supported Jessica in the use of multiple modes to enhance her communication across partners and environments, including use of natural speech; gestures and signs; low-tech photographs, pictures, written words, and letter cards; and mobile technology with an AAC app and keyboard.

The research clearly demonstrates that AAC intervention does not inhibit speech production in individuals with complex communication needs; in fact, the evidence suggests that AAC enhances speech production (e.g., Kasari et al., 2014; Millar et al., 2006; Romski & Sevcik, 2005; Romski et al., 2010). Furthermore, based on preliminary observational research of children with complex communication needs, reported by Light and McNaughton (2017), we believed that literacy learning might be especially facilitative of speech production, as the written word would provide a visual support for production of the target spoken word. Thus, we did not consider it to be an "either-or" decision to target natural speech or AAC; rather, as recommended by Oommen and McCarthy (2015), we worked with Jessica to further her speech development and also provided her with access to AAC (with an emphasis on literacy) to augment her speech and foster her language development. We modeled speech and AAC at all times and responded to all of her speech attempts. Measures of her speech production were collected regularly to determine gains.

Jessica had been introduced to signs during her home-based early intervention program as an infant and toddler; her parents frequently watched the *Signing Time* videos[2] and signed regularly with her. We continued to emphasize the use of signs with Jessica for a variety of reasons. First and foremost, the research demonstrates the importance of considering preference in selecting AAC supports for individuals with complex communication needs (e.g., van der Meer et al., 2011). Consideration of preferences plays a critical role in self-determination and uptake of AAC (Sigafoos et al., 2005). Jessica showed a preference for signs over aided AAC (e.g., low-tech photographs or pictures; AAC technology). In addition, signs were readily accessible throughout her day and they were easily integrated into all activities (e.g., play, meals, bath, and book reading). Furthermore, Jessica was able to approximate the hand shape and movement of the signs without undue effort. She was able to acquire new vocabulary spontaneously by watching others sign throughout her day, using fast mapping to acquire new vocabulary concepts as she needed them (just as children with typical development acquire new spoken words). In addition, Jessica's parents preferred the spontaneity and accessibility of signs over aided AAC technology; they had spent time developing their own signing skills to support her communication and made an effort to sign with her throughout the day. Jessica and her family had already demonstrated significant uptake and use of signs to enhance her communication. Thus, we built on these individual and family strengths and preferences, encouraging her service providers to sign with her at all times, thus modeling language use via speech and sign.

Despite the significant advantages of manual signs as a means to enhance Jessica's communication, it was clear that this modality was not effective to meet her needs when communicating with peers or adults who were unfamiliar with signs. Therefore, we worked with Jessica and her family to introduce mobile technology with an AAC app to support her communication, especially in the early language group and her preschool program. In keeping with personalized AAC intervention, we reviewed her communication needs and skills and environmental

[2]*Signing Time* resources are available from Two Little Hands Productions at https://www.signingtime.com/

supports and constraints, as outlined in Table 1. As recommended as part of the AAC assessment intervention process (Binger et al., 2012), based on these factors, we identified the features that Jessica required and selected potential apps that incorporated these features. We then provided opportunities for trial use within her preschool language group and collected data on her accuracy, the effectiveness of her communication, her efficiency, and her preferences. Based on these data, with input from her family and service providers, we introduced her to TouchChat with WordPower[3] 42 Basic on a 10.2-inch iPad. The WordPower vocabulary file was used as a foundation; personal vocabulary was added for Jessica as needed (e.g., personal information, family members, preferred activities, and classroom themes). TouchChat with WordPower provided Jessica with access to a range of vocabulary concepts, including a home page of frequently used concepts and 45 main categories of fringe vocabulary plus additional subcategories. Within the WordPower vocabulary file, Jessica had access to numerous displays reflecting various activities (e.g., art and calendar time). The vocabulary concepts were represented by line drawings (i.e., Symbolstix), organized in a grid layout of rows and columns. Each display was organized using a semantic–syntactic organization (see Beukelman & Light, 2020) to promote the development of sentence structures. Instruction with the application focused on (1) using a robust vocabulary of semantic concepts (e.g., people, animals, actions, and colors) to express a wide range of messages to fulfill a breadth of communicative functions; and (2) supporting Jessica to communicate phrases and sentences around her areas of interest. For example, when engaging in a classroom activity focused on sports, Jessica used the app to spontaneously communicate, "I like basketball." As Jessica acquired literacy skills during intervention, she also made use of the TouchChat WordPower phonetic keyboard to type words (see the section on literacy instruction for more details).

We also provided Jessica with access to low-tech AAC supports (e.g., photographs, line drawings, written words, and letter cards) to allow her to participate fully in educational activities and literacy learning and to support communication when manual signs and her AAC technology did not meet her needs. Thus, Jessica had access to multimodal AAC (including natural speech, gestures and signs, low-tech AAC, and mobile technology with an AAC app) to enhance her communication and increase her participation across partners and environments. Although these AAC supports were important, simply providing access to these tools was not sufficient to ensure the development of communicative competence (Light & McNaughton, 2014); rather Jessica also needed to develop language and literacy skills to enhance her communication.

Intervention to support language development

When Jessica started to receive AAC services at Penn State when she was 38 months old, she already demonstrated well-developed pragmatic skills with familiar adults (e.g., she fulfilled her turns in interactions, maintained the topic, and responded contingently). Therefore, language intervention focused on supporting peer interactions in the early language group, and on fostering semantic and morphosyntactic development to allow her to communicate more complex messages about a wide range of topics and to prepare her to be a full participant in her educational program. In general, we used what is known about the stages of early language development to guide our intervention goals and procedures (see Beukelman & Light, 2020; Gerber & Kraat, 1992). When Jessica was referred, she was at the stage of early symbolic

[3]TouchChat with WordPower is manufactured by PRC—Saltillo, 1022 Heyl Road, Wooster, OH 44691; https://www.prentrom.com/

development. She was an intentional communicator and had acquired more than 100 signs as well as a small number of spoken word approximations; however, she was not yet combining concepts to communicate more complex messages. At this stage, priorities were to continue to build her vocabulary and to extend the complexity of her messages (see Table 2).

Language intervention followed a social pragmatic approach, driven by Jessica's interests, needs, and skills. Some individuals with complex communication needs benefit from explicit instruction to support vocabulary learning (Reichle & Drager, 2010; Wilkinson & McIlvane, 2002). However, Jessica demonstrated the ability to use fast mapping to acquire new language concepts in the context of her daily activities, so we built on this individual strength and focused on this approach to intervention, supporting her language development in response to her needs and interests in naturally occurring interactions. Fast mapping is a developmental phenomenon whereby children acquire an initial understanding of a word's meaning with only minimal exposure; this initial understanding is subsequently fine-tuned with ongoing exposure and use of the word (Wilkinson & Albert, 2001). Throughout the early language group and her individual intervention sessions, Jessica was provided with numerous opportunities to acquire new vocabulary concepts and combine concepts using the following evidence-based strategies: (1) setting up meaningful opportunities for communication; (2) waiting to provide Jessica with the time to express herself; (3) responding to all of her communicative attempts by fulfilling her intent (e.g., requesting information, commenting on experiences, and requesting activities); (4) expanding on her message to model more complex language; and (5) using speech plus AAC (e.g., speech plus signs, speech plus written or typed text) in interactions with her to provide language models that were appropriate given her comprehension skills. The research suggests: (1) the importance of partner responsivity to foster communication early in development (e.g., Warren & Brady, 2007); (2) the positive impact of partner models on the expression of longer, more complex messages (e.g., Binger et al., 2008, 2011; Binger & Light, 2007); and (3) the facilitative effect of AAC input from partners on all aspects of language development, including pragmatic, semantic, and morphosyntactic development (e.g., Allen et al., 2017; O'Neill et al., 2018). Furthermore, the research suggests that children with complex communication needs are frequently pre-empted from opportunities to communicate by partners who dominate the interaction; waiting or expectant delay is a powerful strategy to cue children with complex communication needs to take a turn and to provide them with the time to do so (Kent-Walsh et al., 2015).

We provided Jessica with exposure to a rich language learning environment using speech and AAC to model a wide range of concepts reflecting various semantic roles. In recent years, some researchers have recommended a "universal core vocabulary" approach for beginning communicators (e.g., Geist & Erickson, 2016; Project Core, 2020); this approach focuses on teaching a very small number of words to beginning communicators. Despite the popularity of the core vocabulary approach with some service providers, we did not restrict Jessica's vocabulary or specifically emphasize a small number of predetermined words. There is no empirical evidence to support the effectiveness of this type of core vocabulary approach with beginning communicators as a foundation for robust language learning (Laubscher & Light, 2020). In fact, research suggests that development of a large, diverse vocabulary is a strong predictor of later language and literacy outcomes (e.g., Dickinson et al., 2003; Hemphill & Tivnan, 2008). Very few of the words included in core vocabulary lists actually reflect the kinds of words that children learn early in language development at the first words stage (cf. Fenson et al., 1994). Furthermore, there is no evidence to support restricting expressive vocabulary to a

limited set of "core" words; rather, children's ability to produce word combinations relies heavily on their acquisition of a robust vocabulary including a range of semantic concepts (Fenson et al., 1994). Children with typical development only start to combine language concepts when they have acquired a sufficient number of concepts to communicate a range of semantic relations, that is, once they have acquired approximately 50 concepts (Laubscher & Light, 2020). Thus, vocabulary development is critical to later morphosyntactic development (e.g., Marchman & Bates, 1994).

For these reasons, we immersed Jessica in a rich language learning environment that followed principles of language development and regularly introduced new, developmentally appropriate concepts in response to her interests and environmental demands (e.g., themes in her preschool, concepts from her favorite books). We strove to provide AAC models of everything that was said to her so that she could hear and see language used in communication. Throughout the personalized intervention, language targets were continually revised to reflect Jessica's learning and her changing needs and skills; in other words, we kept "raising the bar," targeting more and more complex language concepts and structures.

As summarized in Table 2, in Phase 1 of the intervention, we started by targeting acquisition of a wide range of single vocabulary concepts representing a variety of semantic roles (e.g., agents, actions, objects, descriptors, locatives, question words, and social words) and expression of early emerging two-word combinations (e.g., semantic relations such as agent–action, action–object, and descriptor–object; Phase 1). Once Jessica was regularly combining two concepts via speech, signs, and/or aided AAC, we continued to expand her vocabulary introducing new concepts every day in response to her needs and skills; and we used expectant delay to mark opportunities and provide time for her to express longer and more complex sentence structures (Phase 2).

As Jessica built greater fluency combining concepts, we gradually introduced specific function words and morphological and syntactic structures (e.g., use of articles, auxiliaries, and conjunctions) in Phase 3 of intervention. We did not target these concepts in isolation; rather we introduced them in the context of discourse and narratives. As Boenisch and Soto (2015) noted, " . . . function words become meaningful when used in combination with other words and are typically acquired through discourse" (p. 82). This third phase of language intervention coincided with Jessica's transition to reading sentences and stories (see the discussion of literacy intervention in the following section). Thus, in addition to modeling language using signs plus speech, we modeled more complex sentence structures using written text. These models using written language were particularly powerful, as they provided a permanent visual support for Jessica to learn specific aspects of morphology (e.g., third person singular -s; articles a or the). The written models were also important at this stage, as Jessica's need for more complex input was beginning to outstrip the sign language skills of her communication partners. Jessica used many of these morphosyntactic structures first when reading and later in her spontaneous interactions.

Language intervention outcomes

We collected data on Jessica's speech and language outcomes using the following techniques: (1) parent and clinician report of vocabulary concepts expressed spontaneously; and (2) transcription and coding of language samples collected each week from informal interactions at the beginning and end of sessions. We analyzed her expression via multiple modalities including natural speech, manual signs, and aided AAC. Table 3 presents data on the language outcomes of intervention. As illustrated in the table, Jessica demonstrated substantial gains in the frequency of her communication turns over the 6-month intervention, increasing from a rate of approximately five to six turns per minute

Table 3. Language and speech production outcomes of intervention over a 6-month period based on 10-min samples at baseline and after 3 and 6 months of intervention

Measure	Baseline at Referral	After 3 Months of Intervention	After 6 Months of Intervention
Speech production			
Number of different consonants produced in 10 min	6	...	12
Total number of consonants produced in 10 min	63 (76% were /m/ or /b/)	...	139 (28% were /m/ or /b/)
Percentage of spoken utterances intelligible in context	33%	74%	95%
Language			
Total number of utterances in 10 min	61	52	101
Mean length of utterances (range)	1.04 (1–2)	1.65 (1–3)	2.00 (1–5)
Examples of utterances communicated via speech and/or augmentative and alternative communication	Baby Bubble Mama More pop	Big boots Baby sad Open please book Mom hurt back	Cold outside Mom zip coat Dad hurt lip Fox backpack there Molly has a shirt Dad has a blue coat

at baseline to a rate of 10 turns per minute. She also demonstrated substantial gains in the acquisition of vocabulary concepts across the 6-month period, acquiring new concepts every day. In addition, she increased her mean length of message from 1.04 (e.g., a single telegraphic sign and/or speech approximation) to multiword sentences.

As is apparent from the examples in Table 3, her expressive language development across the 6-month intervention followed the sequence of typical language development: First she communicated via single words, typically content words (e.g., baby, bubble, and mama); next she began to combine semantic concepts such as object + descriptor (baby sad) or action + object (open book); later she started to use longer sentence structures and began to incorporate some structural words including, for example, the use of conjunctions or articles (e.g., Dad has a blue coat). It is interesting to note that very few of the words used spontaneously by Jessica in her early communication messages were on the list of core vocabulary proposed for beginning communicators (e.g., Geist & Erickson, 2016; Project Core, 2020); rather she utilized a rich array of content words to express herself early in her language development. It was only later in her language development that she began to draw on some of the structural words that are more frequently occurring. As noted earlier, Jessica's gains in morphosyntax were especially evident as she transitioned to reading sentences and stories where the written text provided a visual model of the structures.

Throughout the intervention, Jessica relied on multiple modes to communicate using a combination of signs and natural speech in spontaneous interactions, and also incorporating aided AAC during more structured interactions in the classroom. For example, when she was leaving to go home 1 day, Jessica communicated the following message about her backpack (which had a picture of a fox, one of her favorite animals): "Fox backpack there" with the word, "fox,"

communicated via sign alone, and the words, "backpack there," communicated via natural speech and sign simultaneously. At the end of a session, she pointed out her dad's coat and spontaneously communicated, "Dad has a blue coat" using speech and sign simultaneously to express each word. As noted earlier, Jessica also used aided AAC to express herself in more structured interactions. In a discussion of sports in the early language group, she used her AAC app to communicate: I like basketball. (See Table 3 for additional examples.)

Speech production outcomes

As noted earlier, throughout intervention, we modeled the use of both speech and AAC (sign and/or aided AAC) in interaction with Jessica and we responded to her communication attempts via any modality. As she developed literacy skills (see the section on literacy intervention for further details), the written text seemed to help to promote speech production. She knew the sounds produced by each letter and the written words provided a visual support marking each sound that should be produced in sequence. Her acquisition of the letters and sounds that underlie literacy coincided with significant increases in the number and range of consonants that she produced. In turn, these increases resulted in substantial increases in the intelligibility of her spoken utterances to familiar partners in context. A speech sample at the start of intervention indicated that her phonetic inventory included six consonant sounds: /b, p, m, w, d, g/. Her production of vowels was often distorted and her word shapes were reduplicated open syllables (CV, CVCV). In a 10-min sample of interaction, she produced a total of 63 consonants, but 76% of these were either /m/ or /b/. Only 33% of her spoken utterances were intelligible in context (i.e., number of intelligible words out of number of total words). After 6 months of language and literacy intervention (when she was 44 months old), she demonstrated significant gains in her speech production. She used a total of 139 consonants in a 10-min sample, including 12 different consonants (only 28% of these were /m/ or /b/ demonstrating much greater diversity of speech sounds). With her increased range of consonants, she improved to being intelligible 95% of the time to familiar partners in context.

Intervention to support literacy learning

Although language intervention was primarily driven by principles of typical development in determining appropriate goals, we "tampered" with the model of typical development (cf. Gerber & Kraat, 1992) and introduced instruction in conventional literacy skills earlier than might usually be expected. We considered the research evidence and Jessica's and her family's strengths and priorities in making this decision. The decision was driven by the following considerations. First, literacy skills are of significant importance in society and are fundamental to participation in all aspects of daily life, including education, employment, social interaction, activities of daily living, health care, and community living (Machalicek et al., 2010). Literacy skills take on even greater importance for individuals with complex communication needs who have limited speech, as they provide access to generative communication. Without literacy skills, children with complex communication needs remain dependent on others to provide and teach picture symbols to represent various vocabulary concepts. With literacy skills, they are able to independently generate any message to express themselves (Light & McNaughton, 2020). Therefore, the development of literacy skills offered Jessica tremendous potential to enhance her communication and support her full participation in educational activities.

In addition, literacy provides a powerful support for language learning. Through literacy, children with complex communication needs have access to a rich vocabulary of concepts (including ones that might not typically be encountered in daily activities), thus furthering their semantic and cognitive development (Clendon et al., 2014). In addition, as noted earlier, written text provides

a powerful visual support for learning the morphosyntactic aspects of language. Morphosyntactic skills are especially vulnerable in children with complex communication needs. The research shows that children who rely on AAC typically communicate in face-to-face interactions using telegraphic forms (e.g., Light et al., 1985). They often coconstruct messages with their communication partners, with a focus on the expression of meaning and communicative intent with limited attention to the structural aspects of language. In contrast, written language provides a clear visual representation of the structural aspects of language. Light and McNaughton (2017) have argued that the visual support provided by written text can be leveraged to support morphosyntactic learning by children with complex communication needs. Furthermore, literacy skills may also be beneficial for children with complex communication needs who experience significant challenges in speech production, as written language makes explicit the individual speech sounds and their sequence in words through application of letter-sound knowledge to the orthographic sequence of letters (Light & McNaughton, 2017). Finally, literacy skills were a priority for Jessica's parents. These skills are highly valued within society and the acquisition of literacy skills may significantly impact others' perceptions of a child's competence, thereby positively impacting learning opportunities and experiences (Stanovich, 2008).

Overall, our approach to literacy instruction followed the evidence-based principles laid out by Light and McNaughton (2009) with the first phase of instruction targeting the foundations for literacy skills (i.e., basic skills such as letter sound correspondences and sound blending) as well as sight word instruction and shared reading to demonstrate the power of literacy (see Table 2). As soon as Jessica acquired approximately six to seven letter sound correspondences, she transitioned to Phase 2 of instruction and we introduced her to decoding (i.e., the skills to look at the letters in a word in sequence, recall their sounds, and blend the sounds together to read the target word). We also continued instruction in the remaining letter-sound correspondences, shared reading, and sight word recognition (specifically of frequently occurring, irregular words, and high interest complex words). Once Jessica was consistently applying decoding skills and once she had learned to recognize a corpus of frequently occurring sight words, we focused on teaching her to read and understand simple stories. We also introduced her to keyboarding skills, phoneme segmentation skills, and early encoding/writing skills (Phase 3).

Overall literacy intervention integrated direct instruction in basic skills (e.g., letter sound correspondences, phonological awareness skills, decoding, and encoding skills) with numerous opportunities to apply these skills in meaningful literacy experiences such as shared book reading and shared story writing (Light & McNaughton, 2020). Direct instruction followed the procedures described by Light and McNaughton (2009): (1) we modeled the target skill; (2) we provided guided practice in the skill (i.e., provided prompting support to ensure Jessica's success); and (3) we provided independent practice in the skill with feedback for each response. When Jessica successfully demonstrated the target skill, we provided positive encouragement. When she demonstrated an incorrect response, we provided corrective feedback, modeling the correct response for her and providing her with guided practice in the skill. Over time, instructional supports were faded based on Jessica's learning.

Key instructional materials were personalized to reflect Jessica's interests and experiences. This personalization was critical to ensure her motivation and to support her understanding based on her experiences and world knowledge. For example, target words and books were personalized to include her family, her daily experiences, and her interest in animals. Instructional tasks and procedures were also adapted to accommodate Jessica's needs. Specifically, as described by Light and McNaughton (2009), we adapted

instruction to allow her to participate using a range of modalities (e.g., natural speech; signs; photographs, line drawings, written words, or letter cards; and AAC technology). We provided support initially to help her re-auditorize written letters or words to speech (i.e., translating the letters, c-a-t, to the spoken word). The following sections describe these adaptations in more detail for each of the literacy skills targeted as well as the outcomes of instruction.

Letter sound correspondences

At baseline, prior to instruction, Jessica knew the names of many letters but she did not consistently identify any of their sounds. Because it is knowledge of the sounds (not the names) of letters that is required for reading and writing, we focused on teaching letter sound correspondences, introducing letters and their sounds one at a time, until she acquired all of the individual letter sounds. Digraphs (e.g., th, sh) are typically introduced later in instruction. We started by teaching lower case rather than upper case letters, as the vast majority of words in books include lower, not upper case letters. We taught upper case as appropriate in context (e.g., the first letter of her name or other proper names). We did not teach the letter sounds in alphabetical order; rather we taught them in the sequence recommended by Light and McNaughton (2009), teaching those letter sounds that are most frequently occurring in children's books first so that Jessica would be able to read more words earlier. When introducing new letter sounds, we separated ones that were visually and auditorily similar (e.g., m and n). Because Jessica was not able to reliably say the letter sounds, we adapted instruction to support her participation. Specifically, we said the letter sound and Jessica found the appropriate letter from a field of four or more letter cards (Light & McNaughton, 2009). Once Jessica had learned to consistently identify 15 letters when presented with their sounds, we introduced her to a hard copy keyboard initially (and later a keyboard on the iPad) so that she could practice locating the letters on the keyboard for spelling and writing tasks. We used a standard QWERTY keyboard because Jessica had sufficient motor skills to select with an index finger; this keyboard is most frequently used in society and learning this keyboard would provide her with the greatest flexibility across educational, vocational, and community environments.

Figure 1 presents data on Jessica's acquisition of letter sound correspondences during the first two phases of intervention (months 1–3). As the graph illustrates, she required a total of 22 instructional sessions (approximately 8 min each) to learn all letters and sounds (a total of approximately 170 min of instruction). Initially, she required several sessions to learn a single letter sound correspondence (e.g., six sessions to learn a; two sessions to learn m; and three sessions to learn t). Once she had learned the first three letter sound correspondences, her rate of learning accelerated rapidly so that we consistently introduced two new letters each session.

Sound blending

Learning to read depends not just on letter sound knowledge but also on the phonological awareness skill of sound blending (i.e., blending sounds produced slowly to form words). Because Jessica was not able to reliably blend sounds and say words orally, we adapted instruction to support her participation. We said the letter sounds of a word slowly in sequence and then Jessica had to blend the sounds together in her head, determine the word, and then sign the word or indicate the photograph of the target word from a field of four or more photographs (Light & McNaughton, 2009). At baseline, prior to intervention, Jessica performed at chance levels; she had not yet learned to hold the sounds in her working memory and blend them together to determine the target word. For the most part, she demonstrated steady gains and required a total of 10 instructional sessions during months 1 and 2 of intervention (approximately 80 min total;

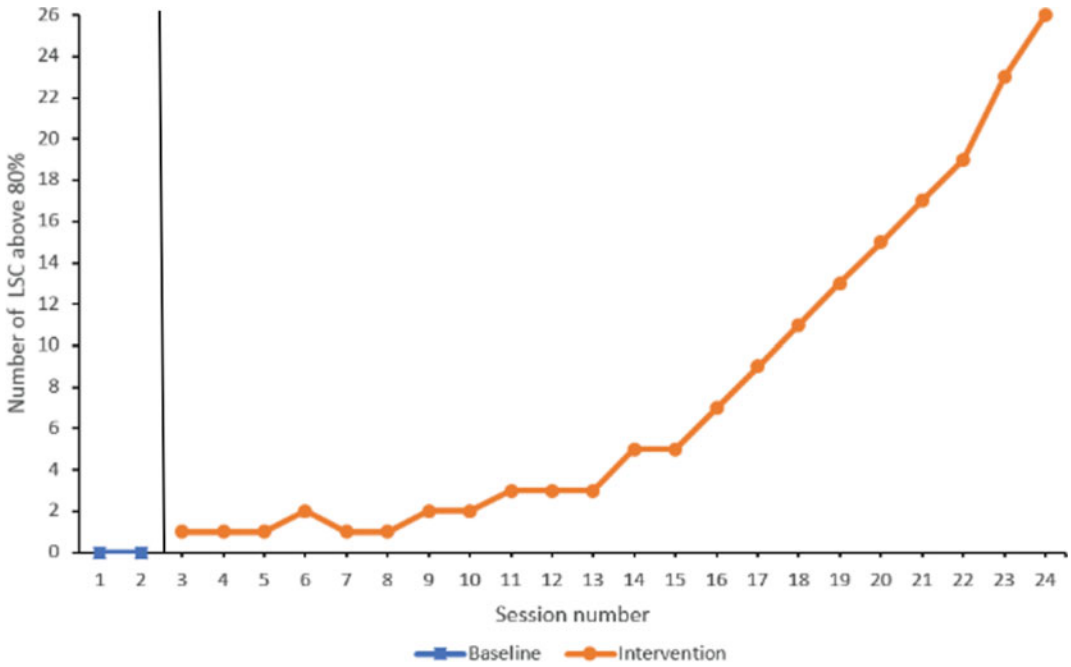

Figure 1. Number of letter sound correspondences successfully acquired with more than 80% accuracy across baseline and intervention (months 1–3 of intervention; 38–41 months old). This figure is available in color online (www.topicsinlanguagedisorders.com).

8 min for each session) to learn this phonological awareness skill (see Figure 2).

Sight word recognition and shared reading

In order to build motivation and ensure that Jessica recognized the power of literacy learning from the outset, we introduced her to approximately 12 high-interest words early on which she learned to recognize by sight (before she learned to decode). These high-interest words included family members (i.e., her name, mom, and dad), animals that were of great interest to her (i.e., cat, dog, fox, and bear), and favorite activities (i.e., book, bike, cook, swing, and rock). As with letter sound instruction, we introduced these words to Jessica one at a time, over time. Once she had learned to recognize these words by sight, we introduced her to additional high-interest sight words (e.g., sign, ball, jump, cookie, bubbles, snack, puzzle, juice, duck, and cup).

We incorporated these words into simple books so that Jessica could participate in shared reading activities. Each page of the book included a photograph of interest to her with a simple sentence typed under the photograph; the high-interest sight words were highlighted as they occurred. Initially, only a single word was highlighted on each page (often at the end of the sentence). Over time, as Jessica increased her sight word recognition skills and learned to decode words, additional words were targeted in each sentence (e.g., Jessica likes to cook with dad). A familiar adult (e.g., graduate student or parent) read the sentence to Jessica pausing at each of the highlighted words and waiting for Jessica to read the word and then sign it, say it, or point to a picture of the concept. These shared reading activities were her favorite instructional activities; they clearly demonstrated the power and joy of literacy learning.

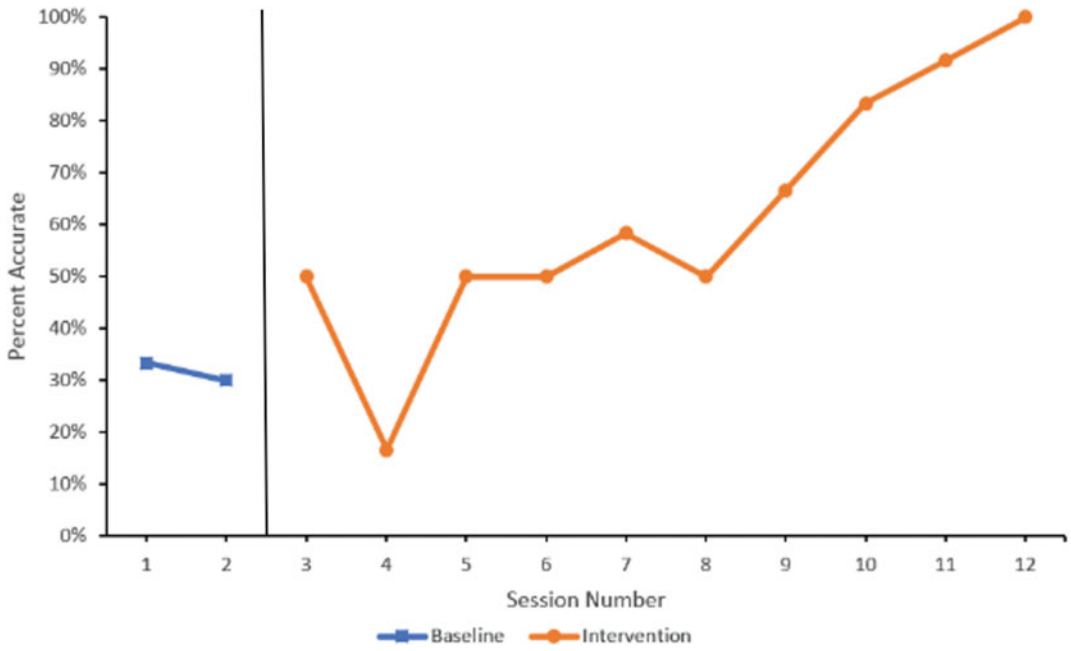

Figure 2. Percent accuracy with sound blending across baseline and intervention (months 1–2 of intervention; 38–40 months old). This figure is available in color online (www.topicsinlanguagedisorders.com).

Decoding skills

As soon as Jessica had acquired six to seven letter sounds and was able to reliably blend sounds, we taught her to decode regular words (e.g., CVC, VC, and CV words). Decoding skills are essential to literacy learning for they allow children to attack new words that they have not been taught (Ahlgrim-Delzell et al., 2016; Fallon et al., 2004). It is challenging to learn to decode. The child must look at the letters in sequence, recall the sound for each letter, hold these sounds in working memory, and then blend them together to determine the word. As Jessica acquired new letters and sounds, new words that included these letter sounds were regularly added to decoding instruction. Thus the task became more challenging over time.

Decoding instruction followed the adapted procedures described by Light and McNaughton (2009): We provided Jessica with four photographs or pictures, each representing a different CVC word; we then provided her with the written word; initially we provided her with guided practice and helped her to point to each of the letters in sequence and say the letter sound; she then blended the sounds together and selected the photograph that represented the word. Over time, we faded our support so that Jessica was expected to look at the letters in sequence, retrieve their sounds in her head, and blend them together independently (see Light & McNaughton, 2009, for further details). We selected the foils carefully so that, for the most part, each of the words represented by the photographs differed from the target by a single letter sound (e.g., if the target word was bug, the foils might be rug, bag, and bun); thus, we ensured that Jessica was decoding the entire word and not relying on recognizing the first letter(s). As noted by Mandak et al. (2018), there are various adaptations that can be used to support the participation of children with complex communication needs in literacy instruction (e.g., saying the target word and asking the child to choose from a field of four or more written words; providing a written

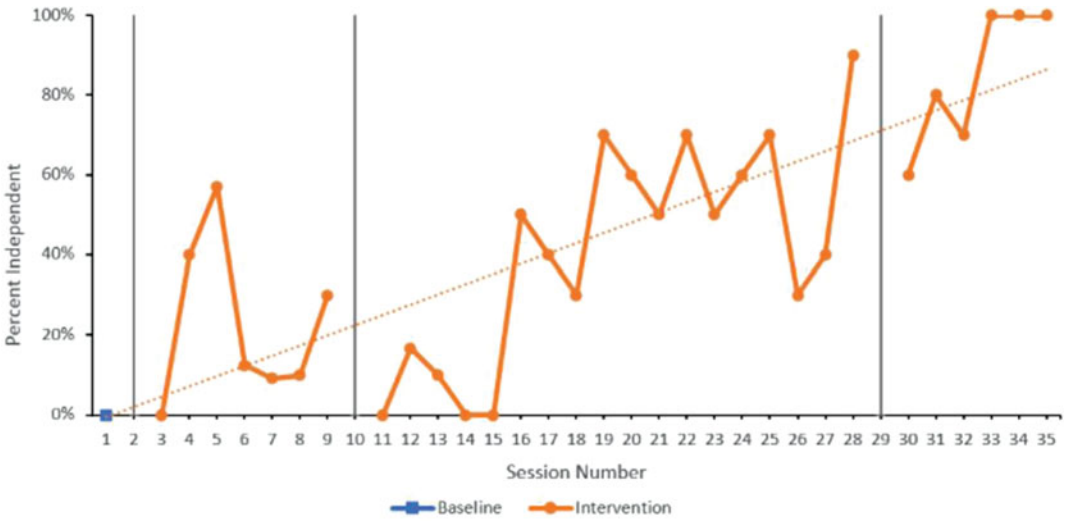

Figure 3. Percent accuracy independently decoding single words during baseline and intervention (months 2–6; and then during telepractice after a 2-month break due to COVID-19, marked by the third phase change line). Note that the number of letter sounds and words targeted increased significantly across sessions as Jessica acquired new letter sounds and was able to read new words (marked by the second phase change line). This figure is available in color online (www.topicsinlanguagedisorders.com).

word and asking the child to choose the picture that the word represents from a field of four or more, etc.). We specifically chose an approach that required Jessica to recode the word phonologically from its written form because this is a process that is typically challenging for children with complex communication needs (e.g., Dahlgren Sandberg, 2002). As Jessica learned to decode words, regular decodable words were also targeted in her shared reading books along with the sight words that she had acquired.

Figure 3 presents data on Jessica's performance independently decoding single words. At baseline, as expected with most 3-year-olds, Jessica was not able to decode words. She required 25 instructional sessions from months 2 to 6 (a total of approximately 300 min of instruction, approximately 10–12 min of instruction per session) to learn to decode single words and apply these word attack skills to new words. Her performance demonstrated some variability from session to session because she was expected to decode words including a steadily increasing range of letters and sounds over time.

Reading simple stories

As Jessica acquired decoding skills and learned to recognize many irregular frequently occurring words by sight, she began to take more and more responsibility in the shared reading activities until she was reading full sentences and simple stories independently. Figure 4 presents data on Jessica's performance reading simple stories (that were new to her) across 10 in-person instructional sessions conducted during months 5–6, followed by a 2-month break in instruction due to the coronavirus disease-2019 (COVID-19) pandemic and then subsequently followed by six additional telepractice sessions across a 1-month period. As is evident in the graph, the percentage of target words that she read independently increased steadily over time until she was consistently reading novel simple stories with greater than 80% accuracy.

Early writing skills

Literacy skills involve not just reading, but also writing activities. In this article, we use the term "writing" to refer to the production

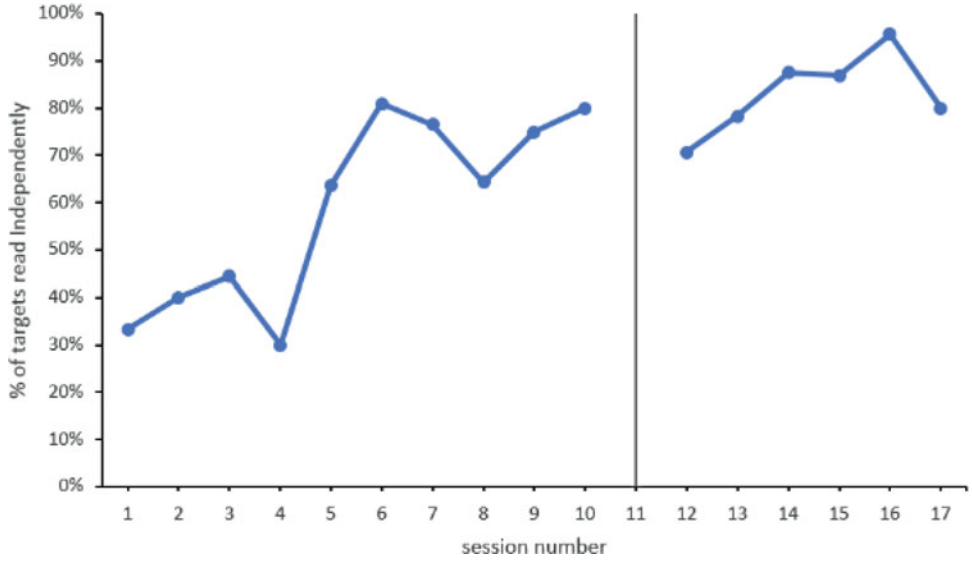

Figure 4. Percent accuracy reading words in sentences and simple stories during intervention (months 5–6) and then during telepractice after a 2-month break due to COVID-19 (marked by the phase change line). This figure is available in color online (www.topicsinlanguagedisorders.com).

of written text via whatever means (e.g., sequencing letter cards or typing). Learning to write is more difficult that learning to read, as the writing process places greater demands on working memory skills (e.g., Ehri, 2000). In addition, writing requires coordination of a writing implement of some sort (e.g., pencil, marker, letter cards, or keyboard; e.g., Millar et al., 2004). From the start of intervention, we ensured that Jessica had access to writing/typing tools and that she saw models of others writing and typing, but we waited to start instruction in conventional writing skills until she had demonstrated basic reading skills. Once Jessica had acquired 15 letter sounds, we introduced Jessica to instruction to start to build conventional writing skills (see Table 2). We started by introducing her to the keyboard. As noted earlier, we introduced her to the QWERTY keyboard on her iPad, as she had the motor and visual capabilities to use this layout; furthermore, it is the standard used in the vast majority of technology and it would provide maximum flexibility later in her educational program. We used the TouchChat WordPower phonetic keyboard, which had lower case letters that produced the letter sounds (rather than the letter names) upon selection. Jessica rapidly learned to locate and select the letters from the keyboard when presented with the sounds; her accuracy increased from 0% in session 1 to more than 90% after 14 sessions conducted over a 3-month period during months 3 to 6 (a total of approximately 37 min of instruction).

In Phase 3, we also worked with Jessica to introduce her to early encoding skills. We encouraged Jessica to choose a photograph or picture of interest to her and then write a story by first determining the word that she wanted to write, breaking it down into component sounds, identifying the letters to represent each of the component sounds in sequence, and then selecting the appropriate letter from a group of letter cards or from the keyboard. This instruction was ongoing when sessions had to be terminated due to the COVID-19 pandemic.

CONCLUSIONS

This case study illustrates the implementation of personalized AAC intervention

targeting language and literacy skills to support a 3-year-old child diagnosed with developmental delay and complex communication needs. Prior to intervention, she demonstrated strengths in her pragmatic skills with familiar adults, but she had significant limitations in her expressive vocabulary and her morphosyntactic skills. She communicated using a range of single signs and some speech approximations (approximately 33% intelligible in context). She enjoyed books and had learned the names for the letters, but did not know the letter sounds and was not able to decode, read, or produce written text. She demonstrated substantial gains in language, speech, and literacy skills following personalized AAC intervention that was driven by the research evidence and Jessica's and her family's needs, strengths, and priorities. Critical to these gains was the focus on: (1) setting challenging goals; (2) providing effective instructional supports to attain these goals; and (3) carefully monitoring her response to intervention. We collected data on her performance throughout intervention and modified instructional goals, materials, and procedures as required. It is especially important to note how rapidly we revised goals based on her response to intervention. Specifically, we regularly "raised the bar," setting appropriately high expectations and targeting progressively more complex skills, as she demonstrated gains in each domain. Too often, expectations for young children with complex communication needs are too low and goals are set for extended periods. The personalized approach to intervention implemented in this case ensured that we maximized gains during the intervention period by carefully monitoring response to intervention and adjusting accordingly.

After 6 months of intervention, Jessica had acquired a wide range of semantic concepts in response to her interests and needs; she regularly combined these concepts to communicate multiword messages and demonstrated increased use of the structural components of language (e.g., articles and conjunctions). Her speech production of vowels improved and the number and diversity of consonants that she produced also showed significant improvements; her spoken messages were 95% intelligible to familiar adults in context. After 6 months of intervention, at the age of 3 years 8 months, her literacy skills exceeded those of most of her peers with typical development significantly. She knew all of her letter sounds, demonstrated phonological awareness skills (e.g., sound blending), decoded and recognized by sight a wide range of single words, read simple sentences and stories, located letters accurately on a keyboard, and was beginning to demonstrate encoding/spelling skills. Jessica's parents reported that they had observed similar gains in her performance during daily activities at home. She had established a solid foundation of language and literacy skills to prepare her to participate actively in education, family, and community activities.

Despite the positive results of this study, it is important to note that the case study design does not provide experimental control, so it is not possible to draw definite conclusions regarding the effects of the intervention. Furthermore, outcomes were measured primarily through performance within individual sessions, supplemented by the report of her parents and intervention team. Future research is required to systematically investigate the effects of personalized early AAC intervention on the language and literacy skills of a larger number of young children with complex communication needs in order to establish intervention effectiveness. This future research should target measures of speech, language, and literacy performance not only within clinical sessions, but also within daily activities in the natural environment to determine the real-world effects. Such research is critical to ensure young children with complex communication needs receive the effective personalized AAC intervention they require to develop language and literacy skills and attain communicative competence.

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