

*This is the accepted version of an article published by the International Society for Augmentative and Alternative Communication (ISAAC) in *Augmentative and Alternative Communication*, © 2020, 36(2), 128 - 141. It is available online at <https://doi.org/10.1080/07434618.2020.1782988> and is re-printed here with permission from ISAAC.*

Growing up with AAC in the Digital age: A Longitudinal Profile of Communication Across  
Contexts From Toddler to Teen

Marika King<sup>1</sup>

Department of Psychology Georgia State University

MaryAnn Romski

MaryAnn Romski, Departments of Communication and Psychology, Georgia State University

Rose A. Sevcik

Department of Psychology, Georgia State University

Georgia State University

Author Note

<sup>1</sup> Marika King is now at the Department of Communicative Disorders and Deaf Education, Utah State University

Correspondence concerning this article should be addressed to Marika King, Department of Communicative Disorders and Deaf Education, Utah State University, Logan, UT, 84322.

Email: [marika.king@usu.edu](mailto:marika.king@usu.edu)

## GROWING UP WITH AAC IN THE DIGITAL AGE

### Abstract

Smart technology (e.g., smartphones, smartwatches, tablets) and the age of information has transformed our society and changed the lives of individuals who rely on assistive technology. This study provides a detailed description of an adolescent growing up in the digital age using augmentative and alternative communication (AAC). It documents the participant's development across language, cognitive, and social domains from ages 2- to 15-years-old, and explores how changes in AAC technology and contextual factors contributed to broad-based outcomes associated with AAC use. In general, results from standardized assessments show growth or stability across domains from ages 2 to 15. Data from a parent interview provides a narrative description of AAC device use, AAC interventions, and school and family environments. Despite communicative challenges, the participant leveraged advances in AAC technology to develop communicative competence and creatively used his smart devices and the Internet to interact with friends both online and in person.

*Key words:* Augmentative and alternative communication; Case study; Intervention decisions; Longitudinal research; Outcomes

## GROWING UP WITH AAC IN THE DIGITAL AGE

### Growing up with AAC in the Digital Age: A Longitudinal Profile of Communication Across Contexts from Toddler to Teen

The field of augmentative and alternative communication (AAC) has evolved substantially over the last 30 years. Researchers have moved from describing individual successes in AAC to understanding broader trends (Ronski et al., 2015). Some of these trends include increased access to mobile technologies as communication supports, increased options for communication supports, and increased expectations for participation and engagement by individuals who use AAC (Light et al., 2019). The proliferation of smart devices and mobile technologies (e.g., smartphones, smartwatches, tablets) and AAC applications has made AAC more accessible through decreased costs and increased social acceptance (McNaughton & Light, 2013; Shane et al., 2012). Children growing up in the digital age have access to information and technology (including assistive technologies) unlike any previous generation. Yet, despite technological advancements and progress in the field of AAC, there is minimal longitudinal research that describes long-term outcomes for AAC users. The purpose of this report is to characterize the evolution of AAC intervention and communication development from toddler to teen through the case of a young man with intellectual and developmental disability.

Longitudinal case studies indicate that AAC has facilitated communication development over time in children of various ages and with a range of etiologies (e.g., Adamson & Dunbar, 1991; Blischak, 1995; Goossens', 1989; Letto et al. 1994; Light et al., 1988; Molteni et al., 2010; von Tetzchner et al., 2005). Several group studies also have used longitudinal designs to investigate intrinsic and extrinsic factors that predicted a range of outcomes for children who use or may benefit from AAC interventions (Barker et al., 2013; Brady et al., 2013; Dahlgren

## GROWING UP WITH AAC IN THE DIGITAL AGE

Sandberg, 2001; Medeiros et al., 2016; Udwin, 1990) including youth with developmental disabilities (Ronski et al., 1994).

Other studies have used retrospective longitudinal analyses to look at outcomes for adult AAC users (Hamm & Miranda, 2006; Hunt-Berg, 2005; Koppenhaver et al., 1991; Lund & Light, 2006, 2007a, 2007b). In a series of three papers, Lund and Light (2006, 2007 a, b) were the first to document wide-reaching, long-term adult outcomes following AAC interventions for seven adult males with cerebral palsy (aged 19 – 23) who had used AAC systems for at least 15 years. Outcomes were evaluated across the domains of receptive language, reading comprehension, communicative interaction, linguistic complexity, functional communication, educational and vocational achievement, self-determination, and quality of life.

Findings from Lund and Light (2006, 2007b) indicated that intrinsic factors such as cognition, motor skills, and motivation appeared to contribute to overall outcomes. Participants with higher cognitive skills and increased motivation had better outcomes than those with lower cognitive abilities. Extrinsic factors (familial support, educational placement, community support) appeared to affect quality of life most noticeably. Participants whose parents were considered strong advocates for their adult children and set high expectations for achievement, tended to have more positive outcomes than children whose parents were less involved in their lives. Access to appropriate and high-quality AAC services also supported positive outcomes. Furthermore, participants who were placed in inclusive classrooms and received early literacy instruction (i.e., beginning in kindergarten) fared better than participants who did not receive the same curriculum as their typically developing peers and were not introduced to literacy until later in elementary school.

## GROWING UP WITH AAC IN THE DIGITAL AGE

Clinicians, educators, and families often raise questions about the length of time required to learn to use AAC or what makes a successful AAC user; however, answers to these questions are complicated and we are only beginning to address these challenging yet important issues. Lund and Light (2006) pointed out how defining a “good” outcome is subjective and varies across individuals. The authors advised that outcomes be evaluated on an individual basis using a person-centered approach and with the input and involvement of key stakeholders, including the AAC user.

The available longitudinal and retrospective research in AAC indicates that an array of intrinsic and extrinsic factors influence both short-term (2-5 years) outcomes for children who use AAC as well as long-term outcomes into adulthood. Internal factors such as motivation and self-determination, language abilities, and cognitive skills, and environmental factors such as family involvement, educational placement, and AAC intervention, seem to have an influence. Current research in this area is composed of studies that have followed children or adults for a brief number of years or have investigated how current functioning in adulthood or later school years is related to earlier experiences and abilities; none has followed an individual AAC user from early intervention through adolescence.

Given that there is minimal longitudinal research that describes long-term outcomes for AAC users, the current study tracked the progression of AAC intervention and communication development from early intervention to high school, and involved following the developmental progress of Kyle (pseudonym) who had a rare neurological disorder, bilateral perisylvian polymicrogyria. Specifically, the goal was to understand the evolution of AAC technology and how intrinsic and extrinsic factors influenced Kyle’s communication skills. Two main research questions were asked: How did Kyle’s abilities across domains (language, cognition, adaptive

## GROWING UP WITH AAC IN THE DIGITAL AGE

functioning) change from age 2- to 15-years old ? How did his communication systems change over time with advances in AAC technology and changes in communicative contexts?

### **Method**

#### **Research Design**

This study utilized retrospective case-based research to create a longitudinal report of the participant's development and AAC use. Case-based research is an important aspect of evidence-based practice as it builds clinically useful knowledge and may complement the outcomes of multivariate research by preserving the complexities of real life (Edwards et al., 2004). Kyle's abilities, environment, and AAC use were profiled across five time points from age 2 to 15 (ages 2, 4, 8, 10, 15). Throughout the 13-year period, various assessments measured skills across cognition, language, adaptive behavior, and speech/articulation domains. At age 2, Kyle and his mother participated in the Toddler Intervention Project (Ronski et al., 2010) a 12-week parent-coached AAC intervention study during which Kyle received his first speech-generating device (SGD). In 2017, Kyle's mother contacted the second author to request further assistance and consultation regarding AAC. Kyle and his mother each provided informed consent for participation in this study according to the Georgia State University Institutional Review Board regulations. Kyle's mother had previously consented for herself and Kyle to participate in the Ronski et al. study which provided baseline data for Kyle at age 2. Assessment information from ages 4-, 8-, and 10-years-old was obtained from SLP, psychology, and academic assessment reports provided by Kyle's mother. Additional testing was administered at age 15 for the purpose of this study.

#### **Participant**

## GROWING UP WITH AAC IN THE DIGITAL AGE

Kyle (age 15) was the third child of Caucasian middle-class parents. English was the only language spoken at home. He had a brother who was 6 years his elder and a sister who was 14 months his elder. Both of his parents were college graduates. Kyle's mother worked previously as a special educator and his father was an accountant. Kyle was born at 38 weeks gestation after a complicated pregnancy. While hearing in his left ear was within normal limits, he was diagnosed at 10-years-old with mild sensorineural hearing loss in his right ear that continued to decline. He wore a hearing aid in his right ear until kindergarten. At that time, it was determined that Kyle's hearing was profoundly impaired and had not improved with amplification. After brain scans revealed that the impairment was the result of an underdeveloped right cochlea, use of the hearing aid was discontinued. By age 15, Kyle's hearing loss remained profound in his right ear, while his hearing was within normal limits in the left ear.

Kyle achieved developmental motor milestones, including crawling and walking, within typical age expectations; however, his language milestones were delayed. His mother reported that he spoke his first word at age 2. Kyle's early medical history is notable for complex partial seizures, sleep problems, esophageal reflux, hypotonia, and feeding difficulties. A magnetic resonance imaging scan at age 1 revealed abnormal myelination, gyri, and sulci; these conditions, along with cortical thickening in the bilateral frontal and temporal regions of his brain, led to a diagnosis of bilateral perisylvian polymicrogyria. In addition, Kyle was later diagnosed with severe apraxia of speech and dysarthria.

### **Procedures**

#### *Assessments*

Normed and standardized individual assessments were utilized, as well as parent report. Measures were administered by either a licensed speech-language pathologist (SLP), a trained

## GROWING UP WITH AAC IN THE DIGITAL AGE

evaluator with a bachelor's degree in psychology, or a clinical psychologist. Table 1 provides a summary of the measures and includes a timeline of when assessments were administered.

Testing at age 15 included several measures used at initial testing (see Table 1) and was administered by the first author, a certified and licensed SLP. Testing took place at Kyle's school, at his home, or at an outpatient clinic.

Insert Table 1 about here

### ***Parent Interview***

The first author conducted an in-person retrospective and a current interview with Kyle's mother to gather detailed information about the changes in his communication contexts and abilities from ages 2 to 15. The interview was conducted in a quiet room in the family's home during the final assessment time point when Kyle was 15. An interview guide was used to structure the questions (see Appendix). Kyle's mother expounded on any answers or topics that she wished. For each age (2, 4, 8, 10, 15), Kyle's mother recounted a typical day for Kyle and outlined the various therapies he received and described his typical communication, including different communication modalities he used. At each time point, she also explained the most significant challenges and concerns she had regarding Kyle. At this time, Kyle was also invited to participate in an interview about his own experiences and perspectives on using AAC. Although he agreed to participate and had good rapport with the authors, he was reluctant to answer interview questions about his own experiences or expound on one-word answers. Per Kyle's request, the interview was terminated.

### **Results**

Findings from standardized assessments, parent questionnaires, and the parent interview provided distinct snapshots of Kyle's 15-year development. The results illustrate these

## GROWING UP WITH AAC IN THE DIGITAL AGE

developmental snapshots in narrative fashion, highlighting key areas of change. Growth in AAC-related skills is discussed through the lens of technology and communicative contexts. Standard scores are reported including confidence intervals and percentile ranks where available.

### **Changing Abilities across Domains and Time**

Results from standardized assessments provided a description of Kyle's developmental changes across the domains of language, cognition, and adaptive functioning. In general, Kyle showed significant delays across all domains at all ages. Figure 1 presents Kyle's standardized test scores across domains and ages.

Insert Figure 1 about here

### ***Cognition***

Cognitive skills were assessed at ages 2, 10, and 15. At age 2, Kyle's Nonverbal Intelligence Quotient (NVIQ) based on the Mullen Scales of Early Learning (Mullen; Mullen, 1995) was 75 which is below average ( $M = 100, SD = 15$ ). At ages 10 and 15, Kyle's nonverbal cognitive abilities remained below average and showed little change over time. At 10, Kyle's full-scale IQ on the Wechsler Nonverbal Scale of Ability (WNV; Wechsler & Naglieri, 2006) was estimated to be within the borderline impaired range (NVIQ = 78, 4th percentile); at age 15 his NVIQ score on the Leiter International Performance Scale, Third Edition (Leiter-3; Roid et al., 2013) was 77, 95% CI [71, 83] (6th percentile).

### ***Language***

Language assessments included broad measures of linguistic ability as well as measures of receptive and expressive vocabulary. Language assessments administered at ages 2 and 4 were both broad based measures. At age 2, Kyle's receptive and expressive language scores on the Mullen showed a floor effect. His expressive language  $t$ -score was 20, 95% CI [13, 27] (1st

## GROWING UP WITH AAC IN THE DIGITAL AGE

percentile) and his receptive language *t*-score was 20, 95% CI [12, 28] (1st percentile). On the MacArthur-Bates Communicative Development Inventories (MCDI; Fenson et al., 1993)—a parent report instrument designed to document children’s understanding and use of early vocabulary words across various categories—Kyle’s mother reported that at age 2, Kyle understood 60 words and said three words out of a total of 396. By age 4, however, Kyle’s language abilities had improved significantly and although still below average, his receptive and expressive language standard scores on the Preschool Language Scales, Fourth Edition (PLS-4; Zimmerman, 2002) were within 1.5 standard deviations from the mean. His standard score for Auditory Comprehension on the PLS-4 was 83, 95% CI [75, 91] (13th percentile), his standard score for Expressive Communication was 81, 95% CI [73, 89] (10th percentile).

During his elementary and middle school years, language assessment reports provided by Kyle’s mother only indicated measures of receptive and expressive vocabulary. For expressive vocabulary assessment tasks, he was permitted to answer using his speech or SGD. His receptive and expressive vocabulary scores on the Peabody Picture Vocabulary Test, Third Edition (PPVT-3; Dunn & Dunn, 2007) and English One Word Picture Vocabulary Test, Fourth Edition (EOWPVT-4; Martin & Brownell, 2011) were below average. At age 8, Kyle’s standard score on the PPVT-3 was 73 (4th percentile), indicating below average vocabulary knowledge. Kyle’s expressive language score on the EOWPVT-4 was 72, which was commensurate with his receptive vocabulary abilities. At age 10, his standard score on the PPVT-3 was 66, indicating a decline of 13 points from age 8. Kyle’s expressive vocabulary skills at age 10 were assessed using the EOWPVT-4, the same measure he received at age 8. On the EOWPVT-4 Kyle’s expressive vocabulary skills were 83, indicating an increase of 11 points from age 8.

## GROWING UP WITH AAC IN THE DIGITAL AGE

At age 15, Kyle received assessments for receptive and expressive vocabulary as well as a broader measure of expressive and receptive language. Although still below average, he showed modest gains in receptive vocabulary (PPVT-4 standard score = 78, 95% CI [72, 85], 7th percentile). At age 15, Kyle's expressive vocabulary skills were slightly lower than at age 10, (Expressive Vocabulary Test, Second Edition (EVT-2) standard score = 76, 95% CI [69, 85], 5th percentile). Kyle also was administered the Clinical Evaluation of Language Fundamentals, Fourth Edition (CELF-4; Semel et al., 2003) to assess areas of language abilities more broadly, including receptive and expressive syntax, understanding spoken paragraphs, and receptive and expressive word classes. Kyle's standard scores on the CELF-4 were 56 on the receptive language index and 45 on the expressive language index, falling well below the average range for his age.

**Parent Perception of Language Development (PPOLD).** Kyle's mother completed the PPOLD (Ronski et al., 2011) when he was 2 years and 15 years to provide her perception of his communication abilities and challenges. The PPOLD is a 15-item survey that uses a 5-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*) and yields a composite score for perceived communication success (10 items) and perceived communication difficulty (five items). Table 2 compares parent ratings across the survey items on the PPOLD at ages 2 and 15. Compared to parent ratings when he was 2-years-old, Kyle's communication success score at age 15 showed a 20% increase; his communication difficulty showed a decrease of 40%. Under communication success, eight of the 10 items showed change in a positive direction over time and the two items that did not show change were both high to begin with. Communication difficulty decreased on 5 of the 6 items.

Insert Table 2 about here

## GROWING UP WITH AAC IN THE DIGITAL AGE

### *Adaptive Functioning*

Kyle's adaptive functioning skills also were assessed at ages 2, 10, and 15 and were below average but stable across time. At age 2, Kyle's adaptive behavior composite on the Vineland Adaptive Behavior Scales, Second Edition (VABS-2; Sparrow et al., 2005) was below average (standard score = 70). On the non-communication subdomains, his Daily Living Skills standard score was 71 (3rd percentile), his Socialization standard score was 84 (14th percentile), and his motor skills standard score was 81 (10th percentile).

At age 10, Kyle's adaptive functioning skills were assessed using the Adaptive Behavior Assessment System<sup>1</sup>, Second Edition (ABAS-2; Harrison & Oakland, 2003) that uses domain scores to yield a General Adaptive Composite (GAC). Kyle's GAC was 68 (2nd percentile), indicating lower than average functioning across adaptive skills. His standard score on the Conceptual Composite, which summarizes skills across Communication, Functional Academics, and Self-Directions skill areas, was 69 (2nd percentile), placing him in the mildly impaired range. The Practical Composite summarizes performance across Community Use, Home Living, Health and Safety, and Self-Care skills. Kyle's Practical Composite score was 50 (<1st percentile) indicating moderate impairment. On the Social Composite, which includes performance across Leisure and Social skill area, his score was 99 (47th percentile), which was within the average range.

At age 15, Kyle's adaptive behavior composite on the Vineland Adaptive Behavior Scales, Third Edition (VABS-3; Sparrow et al., 2016) was 75 (5th percentile). His Communication standard score was 72 (3rd percentile) while his Daily Living Skills standard score was 77 (6th percentile) and his Socialization standard score was 85 (16th percentile). Subdomain scores from the VABS-2 and VABS-3 at age 2 and 15 respectively, were remarkably

## GROWING UP WITH AAC IN THE DIGITAL AGE

similar; across all ages socialization skills emerged as an area of strength on both the VABS-2 and VABS-3, and the ABAS-2.

**Social and interpersonal development.** No formal assessments of social networks or friendships were available prior to age 15. To assess Kyle's social networks, the Social Network: A Communication Inventory for Individuals with Complex Communication Needs and their Communication Partners (Blackstone & Hunt Berg, 2003) was administered as an interview with Kyle's mother. Figure 2 describes the circles of communication partners Kyle interacted with on a regular basis and the primary modes of communication he used within these circles. Kyle's primary mode of communication was speech; however, his most effective mode of communication was using a text-to-speech application (Proloquo4Text<sup>2</sup>) on his phone. He also used the Internet on his smart devices (i.e., smartphone, smartwatch, tablet) to provide contextual cues to supplement his speech (e.g., searching for movies, toys, or news events).

Insert Figure 2 about here

### *Literacy*

School-reported literacy measures were not consistently administered to Kyle. At age 7, Kyle was administered the Georgia Criterion-Referenced Competency Tests (Georgia CRCT; Georgia Department of Education, 2010) in the spring semester of Grade 2. His reading score was 812 (Level 2), which met the state standard for reading. Kyle's Lexile<sup>3</sup> Information on the Georgia CRCT was 225L. Lexile measures provide information about text difficulty and Kyle's score indicated he was reading at the 1.6 grade level. According to the Georgia CRCT, students at Performance Level 2 for reading were able to understand what they read, were able to deduce word meaning based on how the word is used and according to word parts. They were also able to answer inference-based questions about the text.

## GROWING UP WITH AAC IN THE DIGITAL AGE

At age 10, Kyle was administered the Iowa Tests of Basic Skills<sup>4</sup> (ITBS; Hoover et al., 2001), which provided a standardized reading total score and included measures of vocabulary and reading comprehension and yielded standard scores, grade equivalents (GE), national percentage rank (NPR), and descriptive achievement levels. Kyle's vocabulary standard score was 156 (GE = 2.1, NPR = 3%), his reading comprehension standard score was 159 (GE = 2.3, NPR = 5%), his reading total standard score was 158 (GE = 2.2, NPR = 2%). These results indicated that Kyle's reading abilities were not proficient, according to the descriptive achievement levels on the ITBS. Kyle's Individualized Education Plan (IEP) at this time indicated that his reading level was upper Grade 2 – lower Grade 3. Furthermore, the IEP documented that, although his written language skills were significantly below average, he could write 5-6 sentences on a topic but required assistance to create a cohesive paragraph.

### *Speech*

Formal assessments of Kyle's speech and articulation abilities were not available before age 15; however, Kyle's mother reported significant challenges in speech articulation from early on. Kyle's speech intelligibility was significantly impacted and his speech was less than 50% intelligible even to familiar listeners. At age 15, Kyle was administered the Goldman-Fristoe Test of Articulation, Third Edition (GFTA-3; Goldman & Fristoe, 2015) to assess his articulation. Kyle's standard score on the GFTA-3 was 40 (95% CI = 37 – 52, <.1 percentile). At 15, his spontaneous speech was primarily single words or short phrases (e.g., “good,” “I don't know”). He demonstrated numerous phonological and speech errors including unconventional and inconsistent errors. Phonological processes included initial consonant deletion, final consonant deletion, cluster reduction, syllable deletion, and substitution. His consonant inventory included initial: /h, g, w, p, ʔ, b, k, m, j, d/, medial: /h, ʔ, b/, and final: /w, m, n/.

## GROWING UP WITH AAC IN THE DIGITAL AGE

### **Changes in AAC Systems across Time and Contexts**

Since receiving an SGD at age 2, AAC has been integral to Kyle's communication. The devices and systems he has used have evolved as his language and literacy skills matured, his social contexts changed, and technological advances in the hardware and software of AAC systems occurred. In the 15 years that Kyle has used AAC technology, there have been massive changes in the technology available to individuals who use AAC, particularly with the proliferation of mobile devices and AAC applications. Figure 3 illustrates the evolution of Kyle's AAC systems across time. It summarizes Kyle's communication contexts, partners and aided AAC modalities across the five time points assessed in this study.

Insert Figure 3 about here

#### ***Toddler Years***

Before Kyle received an AAC device at age 2, his mother reported that he communicated using home signs, gestures, vocalizations, and a few word approximations. As part of his participation in the 12-week Toddler Intervention Project (Ronski et al., 2010), Kyle received augmented language intervention using AAC, and Kyle's mother received parent coaching on strategies to support his language development using an AAC device. These strategies included aided language modeling and creating opportunities for communication during play, snack, book reading, and home routines. Initially Kyle was given a GoTalk 8<sup>5</sup>, an SGD with an 8-symbol grid display. This battery powered device allowed for creation of various symbol overlays that were customized for different communication contexts and activities. Vocabulary was selected in consultation with Kyle's mother to include functional, motivating, and developmentally appropriate vocabulary that were represented using Picture Communication Symbols<sup>6</sup>, which are color line drawings. Intervention sessions at Weeks 9 and 12 were transcribed and Kyle's

## GROWING UP WITH AAC IN THE DIGITAL AGE

utterances were coded. During these sessions, Kyle used 10 different target vocabulary symbols independently and used one spoken word during the 30-minute sessions. Over the course of the 12-week intervention study, Kyle's expressive language skills progressed and he ultimately received a GoTalk 20<sup>5</sup>, with a grid display of 20 symbols and five levels. Each vocabulary level allowed for a new symbol overlay with activity or context specific vocabulary.

### *Preschool and Kindergarten*

Before beginning preschool at a community-based preschool inclusion program, Kyle received a full AAC evaluation and was given the Dynavox Gateway 40<sup>7</sup>, a dedicated, computer-based SGD with a dynamic layout with 40 locations. This type of AAC system facilitates language development by allowing users to combine symbols to form syntactically complete sentences. Symbols on the Dyanvox included color line drawings and orthographic symbols. Beginning in kindergarten, literacy instruction was expected in the general education classroom and despite his speech and language delays, Kyle's parents set the expectation that he would learn to read and write. Kyle brought his SGD to school where his school SLP worked on incorporating his AAC device in the classroom. In addition to using his SGD, Kyle continued to communicate using home-signs, vocalizations, and word approximations; however, his speech was mostly vowels and was limited in terms of intelligibility. Kyle also received private speech-language therapy focusing on oral-motor techniques to improve speech production.

### *Elementary School*

Kyle attended his neighborhood elementary public school until Grade 5. Although his mother reported that the public-school administrators were initially skeptical about Kyle's ability to succeed in the inclusion program because of his AAC use, the school staff and teachers quickly realized the benefit of Kyle's presence at the school. In Elementary school, language and

## GROWING UP WITH AAC IN THE DIGITAL AGE

literacy instruction incorporated the use of his SGD. Kyle's teachers sent home a story of the week and his mother programmed the story line-by-line into his Dynavox. Kyle could follow along during read aloud and then could use his Dynavox to read aloud when it was his turn. During elementary school, Kyle continued to use multimodal communication, including home signs, vocalizations, speech, and AAC. His speech skills had improved to include several consonants but intelligibility was still severely limited. Kyle continued to receive private oral-motor speech therapy as well as private therapy from an AAC specialist. According to his mother, at school Kyle received a combination of "push-in" and "pull-out" speech-language therapy for a total of 2 hr per week. He continued to use the Dynavox AAC system at school and at home and progressed to the Gateway 60 vocabulary system with 60 locations.

In 2013, when Kyle was 8-years-old, his mother reported that she heard about a new AAC software program that was available for Apple Inc<sup>8</sup> devices. This software, called Proloquo2Go<sup>2</sup>, is an app-based AAC system with a dynamic grid-based layout. Kyle received a beta version of the Proloquo2Go software on an iPod Touch<sup>8</sup>. Symbols on the Proloquo2Go software were color line drawings (SymbolStix<sup>9</sup>) with a written word gloss and a keyboard. Although Kyle quickly learned to use the Proloquo2Go system, he continued to use the Dynavox at school. When describing Kyle's communication at that time, his mother remembered, "It was all about having a lot of different options in his toolbox...and being able to be flexible and move between them."

### ***Middle School***

By age 10, Kyle transitioned from using both the Dynavox and Proloquo2Go to using the Proloquo2Go exclusively. Kyle's parents advocated for Kyle to use Proloquo2Go on an iPad<sup>8</sup> because of the device's portability, social acceptance, and options for using text to speech, word

## GROWING UP WITH AAC IN THE DIGITAL AGE

documents, and picture-based communication. His mother recalled that getting public school officials to agree to this transition was challenging but the documented gains of Kyle's communicative success using Proloquo2Go eventually convinced the school's assistive technology team. Although Kyle's parents had been strong advocates for inclusive education, they were concerned about his safety in the public middle school and no typical private school would accept a student with Kyle's challenges. In Grade 6, Kyle transferred to a private middle school for children with special needs.

During late elementary school and into middle school, Kyle received weekly myofunctional therapy from a private SLP. The goal of this therapy was to use oral-motor techniques and strengthening and coordination exercises to improve his articulation skills; however, after 4 years, Kyle had made little progress in his speech abilities and began to resist speech therapy appointments. His mother described how Kyle refused to get out of the car for the appointments and remained screaming in the car. Finally, he said, *No more speech therapy! I tired of speech, I done!* Kyle's parents acquiesced to his wishes and ended the oral-motor speech therapy.

### ***High School***

At the time of his most recent assessment in the Fall of 2018, Kyle was 15-years-old and attended high school at a private school for children with special needs. Kyle communicated using a wide variety of modalities including facial expressions and body language, gestures, vocalizations, manual signs, speech and speech approximations, text-to-speech, phone (text, FaceTime<sup>8</sup>), Google Search<sup>10</sup>, and Internet chat rooms.

Like any typical teenager, Kyle's phone was always with him. For Kyle, his phone was integral to his communicative interactions with others. He used the Proloquo4Text<sup>2</sup> text-to-

## GROWING UP WITH AAC IN THE DIGITAL AGE

speech application on his iPhone<sup>8</sup> and iPad to participate in classroom activities, communicate with peers, and order food at restaurants. Kyle used the Proloquo4Text application to type novel messages consisting of short phrases or complex sentences (e.g., “*When we done?*”, “*I not here on Friday because I go to my sister graduation*”). He also used pre-stored messages such as “*Give me one moment while I type please*”, “*That’s not what I’m trying to say*” or “*Wait, let me show you on Google*” to reduce communication breakdowns and facilitate interactions. Kyle was independently able to program settings on his communication application (he enjoyed talking in an Australian accent) and to add or edit pre-stored vocabulary words.

In the classroom, Kyle used the Proloquo4Text app to participate in classroom discussions, answer the teacher’s questions, and complete assignments. What follows is a writing sample that Kyle wrote using his text-to-speech application in response to a prompt to write a persuasive paragraph.

*“I think dogs are the best pets. First they are cute. They act cute, or look cute. For example, my dog likes to relax on the couch and look cute. Some dogs are so small they fit in a teacup. Next, dogs are fun to play with because we can throw toys and balls and we can pet small dogs. Last, dogs are good for kids because dogs teach them about responsibility and are good for your health. When I was a kid I played with my dog. This is why, I think you should get a dog.”*

Kyle was resourceful in using technology and the Internet to make himself understood. His phone served as a digital remnant book or contextual referent source. Kyle frequently used the Internet to supplement his communication and to provide context for his communication partners. A Google search may pull up the picture of a new LEGO<sup>11</sup> he received, the trailer of a movie he watched, or a Wikipedia page for an actor he liked. The calendar on his phone allowed

## GROWING UP WITH AAC IN THE DIGITAL AGE

him to provide temporal context when he described a friend's birthday party a few weeks earlier, or an upcoming trip, and the photo gallery on his phone provided a visual reference when he describes his family dog, or his best friend. At school, Kyle used his iPhone and iPad to support his communication and occasionally used an Apple Watch<sup>8</sup> to connect to the text-to-speech application on his phone. Kyle enjoyed playing video games, and in the evenings, often spent a few hours playing video games on line. He communicated with other players through online chat rooms and was quite proficient in exchanging information rapidly through texting and in shorthand. His mother stated that she was often amazed with his proficiency in communicating so rapidly and effectively in the chat rooms.

### **Summary**

Kyle's journey with AAC has not been linear. The devices and language systems he used changed as his language and cognitive skills improved and as he moved through his school years. During his preschool and kindergarten years, Kyle's aided communication use consisted of picture symbols; however, during his school-aged years, his communication systems included both line drawings and orthographic symbols, and eventually he transitioned to using exclusively text-based aided AAC. Kyle did not use a consistent single software system for language organization. In fact, he changed software systems five times and hardware systems nine times. At times, he used more than one software system at a time (e.g., Proloquo2Go at home; Dynavox Gateway 60 at school). Despite these changes, Kyle's communication skills have continued to progress and, even though they are below average, his assessed language skills have remained consistent over the years.

### **Future Considerations**

## GROWING UP WITH AAC IN THE DIGITAL AGE

Kyle's parents' long-term goals are for him to be an independent productive member of society. Now that Kyle is in high school his parents are most concerned with figuring out what his adult life will look like. As his mother put it, "I'm starting to feel the panic that the clock is ticking. Now he's 15 and it does feel like there is a sense of urgency....what is this going to look like for him?" She explained that the challenge for the future is helping Kyle establish his place in the world, find true friends, and find a community of people where he feels valued and able to contribute with purpose. Kyle's mother described how her stress now is worrying whether she and her husband are doing everything they can to support Kyle to get to the point where he can feel independent enough to function on his own. Kyle's parents are not sure what future independence will look like for their son because he is still quite reliant on them for self-care tasks. They are optimistic about future technology supports, however, and want to let Kyle direct what he wants to do so that he feels like a productive and contributing member of society.

### **Discussion**

This case study used a variety of assessment measures to document Kyle's development from ages 2 to 15 across the domains of cognition, language, speech, and social and adaptive functioning. Results from the standardized assessment measures revealed a pattern of below average performance across all domains. Kyle's most significant impairments were in his language abilities and his greatest strengths were in his social skills. Results from the Social Networks survey indicated that he had close connections with family and friends as well as larger circles of acquaintances and online friends. Kyle's perceived communicative competence increased substantially from 2 to 15 years of age according to parent report on the Parent Perception of Language Development, even as his standardized scores in language, cognition, and adaptive functioning remained consistently below average.

## GROWING UP WITH AAC IN THE DIGITAL AGE

Kyle's case provides support for the position that the ability to use AAC is not dependent on prerequisite cognitive abilities (National Joint Committee for the Communication Needs of Persons with Severe Disabilities, 2003). Even though his NVIQ, processing speed, and nonverbal memory abilities were significantly below average on standardized assessments, by age 15 Kyle was communicating with a highly advanced form of AAC (i.e., using text-to-speech on an AAC-specific application on his iPhone). In addition to a virtual keyboard that permitted generative communication, the AAC-specific application on his mobile devices (i.e, iPhone, iPad, Apple Watch) had folders for pre-programmed messages and archived conversations. Kyle could navigate easily between folders and could independently modify and add stored messages. His use of advanced AAC technologies shows that he was able to communicate functionally and independently despite impairments in language, cognition, and adaptive functioning.

Although not directly assessed, the social validity of AAC was a strong theme that emerged during the interview with Kyle's mother. She highlighted how AAC contributed to a more typical and inclusive life experience for Kyle. For example, during preschool and elementary school, access to AAC supported Kyle's full inclusion in the regular education classroom. By using pre-programmed phrases he was able to participate in scripted activities as well as express himself through novel messages. Later in middle school and high school, Kyle's AAC systems supported his participation in community and social activities especially as the speech-output technologies he used became smaller and more portable. The versatility and social acceptability of the iPhone as a speech-output technology allowed Kyle to communicate effectively using a mobile device popular among his peers.

Kyle's journey with AAC systems paralleled the changes in his development and communicative contexts. One interesting observation is that Kyle transitioned through multiple

## GROWING UP WITH AAC IN THE DIGITAL AGE

AAC systems with differing symbols and layouts. AAC systems can vary greatly and system changes may be confusing and challenging for individuals who use the technology as they learn new software and hardware features. In Kyle's case, however, the changes in his AAC devices served to facilitate communication in a wider variety of contexts. For example, transitioning from the computer-based Dynavox system to the iPad with Proloquo2Go required Kyle to learn new symbols and new vocabulary organization. The change allowed him to use a more portable device than he had used previously. Similarly, switching from the Proloquo2Go picture-based system to Proloquo4Text on his iPhone helped him to communicate more efficiently using text-to-speech and also increased the portability of his AAC device. Kyle and his family took advantage of advancements in AAC hardware and software to expand and promote his communicative skills.

### **Factors that Influenced Kyle's Communication Outcomes**

Several factors identified from assessments and parent interviews likely influenced Kyle's communication development and outcomes, including self-determination, education environment, SLP services, family involvement, and advances in AAC technology. For individuals who use AAC, self-determination and motivation are key concepts that influence their communication success. Self-determination promotes causal agency and forms an individual's feeling of control over decisions and choices that affect the individual directly or indirectly (Wehmeyer et al., 2000). A child's preference for using one AAC system over another may help promote self-determination (Sigafoos et al., 2005). When children who use AAC have tangible and frequent evidence that using AAC enhances the quality of their lives, they in turn value the AAC systems and will use them independently to achieve communication goals (Calculator & Black, 2009).

## GROWING UP WITH AAC IN THE DIGITAL AGE

Although not directly assessed, Kyle's self-determination was expressed in several ways throughout his life. For much of Kyle's early years, he received intensive oral motor therapy to improve his speech articulation and intelligibility. But despite consistent efforts to improve these skills, Kyle made little progress in improving speech intelligibility. In resisting continued oral-motor speech therapy when he was in middle school, Kyle exerted self-determination in the decisions surrounding his speech therapy. Kyle also demonstrated his autonomy by choosing which modality of communication he wanted to use (e.g., text, speech, speech-output technologies, gestures). His mother recalled that beginning in Grade 4, Kyle often chose to use text to communicate instead of the graphic symbols on his speech-output devices. She remembered that before he began to use Proloquo4Text (a text-to-speech application), he often preferred to type a message in the search bar on his iPad instead of using the picture symbols on his AAC application. As a 15-year-old, he exerted his self-determination again through choosing which speech-output technology he preferred (i.e., iPhone, iPad, or Apple Watch).

Kyle's education environment also played a significant role in his language and literacy outcomes and in the support he received for AAC, a factor that has been previously documented in longitudinal studies of individuals who use AAC (Blischak, 1995; Lund & Light, 2006). Kyle's parents pushed for him to be enrolled in an inclusion program during preschool and elementary school because they wanted Kyle to interact both with typical peers and peers with disabilities and to meet his full academic potential. In the general education classroom, he was taught the same curriculum as his typically developing peers, which was a more rigorous curriculum than that of the self-contained classroom. Although in middle school and high school Kyle attended private schools for children and adolescents with special needs, his early start in regular education provided a solid foundation for his academic development.

## GROWING UP WITH AAC IN THE DIGITAL AGE

Consistent SLP services to support AAC were also integral to Kyle's communicative success. Beginning with early intervention, Kyle received SLP services to support his language development using AAC. During the 12-week toddler intervention project, he received bi-weekly augmented language intervention. This early, parent-coached language intervention using AAC provided Kyle and his family with key tools and strategies to continue to build his communication skills. As he grew older, Kyle continued to receive SLP services that used AAC to support his language and literacy development. He was also fortunate to receive additional services from AAC specialists in elementary school and high school. The intensive, long-term speech-language services to support his communication using AAC was likely an important factor that contributed to Kyle's communication success.

Family involvement and support is a key component to achieving successful communication and academic outcomes for children with disabilities (Granlund et al., 2008; Lund & Light, 2007b; Mandak et al. 2017; Rackensperger, 2012; Sevcik & Ronski, 2007). Kyle was fortunate to have parents who advocated for him and were motivated to support his communication in any way possible. Beginning with the toddler intervention when Kyle first received an SGD, his mother realized that AAC would be a key tool for supporting Kyle's communication and language development. She became a strong advocate for AAC and throughout his life sought opportunities for Kyle to have access to the latest AAC technologies. Kyle's mom was also key in encouraging his teachers and therapists to set high expectations for his success. The family support that Kyle received certainly was critical to his communication success, yet it is important to note that many families who have a child with a disability may not have the financial resources to pay for additional services nor the time or knowledge to advocate for their children at school.

## GROWING UP WITH AAC IN THE DIGITAL AGE

### **Harnessing Technology and the Internet**

In recent decades, advances in mobile technology have increased the accessibility and prevalence of assistive technologies for people with disabilities. Increasingly, individuals with disabilities are finding ways to leverage or repurpose every day mobile technologies to support communication needs (O'Brien et al. 2020; Schlosser et al., 2017; Shane et al., 2012). Kyle is part of a generation of individuals growing up in the digital age where information is a click away and smart devices are integral to the classroom and at home. Throughout his life, Kyle was able to take advantage of the latest AAC technologies to support his communication, and he was one of the first children to Beta test an early version of the Proloquo2Go application on an iTouch<sup>8</sup> device. Kyle's mother described him as always being open to using his assistive technology devices, and he was quick to learn how to program them. By kindergarten, he was independently programming his Dynavox. His mother believed that Kyle took ownership of his AAC devices and embraced their use because he began using an SGD when he was very young. She remarked, "He's never known any different. [AAC] is just a part of who he is."

As a teenager, Kyle used his iPhone to support his communication in various ways including the text-to-speech application, calendar application, photos, and Internet searches. The multifunctionality of his mobile devices clearly enhanced Kyle's communication and he relied heavily on the Internet to provide context to and supplement his written or spoken messages. For many people who rely on AAC, access to the Internet is indispensable. Web accessibility consultant, blogger, and AAC user Glenda Watson Hyatt described the way accessing the Internet enhanced her communicative interactions when she was able to pull up examples of her work and videos. Hyatt said, "The iPad allowed for a deeper level of communication that would not have been possible with a single-function AAC device" (Hyatt, 2011 p. 25). Research

## GROWING UP WITH AAC IN THE DIGITAL AGE

investigating the Internet and social media use of individuals who use AAC is limited (Hemsley et al., 2017), yet new research in this area indicates that the communication and social opportunities for people who use AAC can be enhanced through Internet access and by leveraging the capabilities of smart devices (Caron & Light, 2016, 2017; Grace et al., 2019; Hynan et al., 2014). For example, Hynan et al. interviewed 25 young people with cerebral palsy who used AAC about their social media and Internet use. The participants reported that accessing the Internet and social media enriched their friendships and increased their self-representation and self-determination. Kyle's case contributes to this growing body of research and highlights how multifunctional speech-output technologies can be integral to communicative interactions.

### **Clinical Implications**

Kyle's case demonstrates that language development is challenging for children with speech and language impairments even when they have high levels of academic support, SLP services, family support, and access to the latest AAC technologies. Despite the support Kyle received throughout his life, his language skills at age 15 were significantly below average on standardized assessments. From this perspective, it seems that children who use AAC face seemingly insurmountable challenges to achieve communication parity with their peers. Yet, Kyle's case can also be viewed in terms of what he has accomplished and by evaluating his communication skills in the context of his environments. As a 15-year-old, Kyle communicated independently using a variety of aided and unaided AAC modalities. He was able to read and write proficiently, repair messages and communication breakdowns independently, had close friendships and a social-life with his peers at school, and many friends with whom he chatted in online forums. Overall, he is a well-adjusted and happy teenager. By focusing on his strengths,

## GROWING UP WITH AAC IN THE DIGITAL AGE

Kyle's case can be used to inform clinical practice for other children who use AAC. Achieving communicative competence occurs through a combination of factors, and in Kyle's case several stand out: (a) not assuming prerequisite cognitive or other skills are required to use AAC; (b) early intervention to support communication through AAC; (c) literacy instruction beginning in kindergarten; (d) family involvement; (e) high expectations for success; and (f) flexibility in using AAC systems.

### **Limitations and Future Directions**

Several limitations of this research are important to discuss. First, although Kyle's case presents an interesting example of longitudinal development, generalizability of these findings is limited by the case report design. Kyle's case may not accurately represent the population of all children and adolescents who use AAC. This study also lacked Kyle's own voice. Even though it was his choice not to continue the interview about his experiences and perspectives on using AAC, Kyle's voice would have added a personal perspective to the narrative.

Internal validity establishes trustworthiness in the cause-and-effect relationship between independent variables and outcomes. Although the questions asked in the current case report were exploratory, internal validity is important to ensure the soundness of the findings from the standardized assessments and parent interview. Several threats to the internal validity of this study are important to mention, including history, maturation, and instrumentation. History refers to events that occurred between the data collection time points that were not accounted for or measured and may have influenced the findings. Similarly, maturation is a concern because developmental changes (e.g., growing older, changing attitudes and abilities) may have effected Kyle's performance on standardized assessments as well as his mother's perceptions of his communication challenges and abilities over time. Regarding instrumentation, a limitation was

## GROWING UP WITH AAC IN THE DIGITAL AGE

that assessments were administered by different professionals across the various time points and given the retrospective design of the study, it was not possible to establish reliability.

Furthermore, except for the PPVT-4 and EOWPVT-4 that were both administered at ages 8 and 10, different standardized assessment measures were used at various ages. Thus, any trends in language, cognitive, and adaptive functioning abilities must be interpreted with caution, keeping in mind that they may have assessed distinctive skills. Another limitation was that formal measures of literacy at age 15 were not available. It is also possible that threats to internal validity interacted (e.g., history-maturation, instrumentation-maturation). Despite possible threats to internal validity, the current study employed both quantitative (standardized assessments) and qualitative (parent interview) methods to create a rich narrative describing Kyle's journey with AAC. The combination of different methods and techniques, or triangulation, can strengthen the validity of case study research (Jonsen, 2009).

To advance clinical research in the field, longitudinal studies are needed to systematically investigate how key factors such as early AAC intervention, literacy instruction beginning in kindergarten, family involvement, expectations for success, and flexibility in AAC systems impact the long-term outcomes of individuals who use AAC. Large-scale longitudinal studies are necessary to tease apart these variables and investigate their relative importance in predicting long-term outcomes. Future research should investigate how these factors interact and can be manipulated to promote positive outcomes for individuals who use AAC.

Kyle's case also illustrates how standardized assessments of language and cognitive abilities and adaptive functioning may not be sensitive measures for predicting long-term outcomes in terms of AAC success. Despite consistently low performance on standardized measures across all time points, at 15 Kyle successfully used multimodal AAC across home,

## GROWING UP WITH AAC IN THE DIGITAL AGE

school, and community environments. Factors that influence long-term outcomes in AAC are likely influenced by environmental variables that are not measured using skill-based assessments of individual performance. Currently, there are few, if any, measures that are available to assess performance from early childhood through adolescence, and continuity across assessments is lacking. Future research should examine the sensitivity of assessment tools to predict broad-based outcomes for individuals who use AAC. These broad-based outcomes may be identified through investigations into the social validity of AAC use (Schlosser, 1999), that is, systematically examining the perspectives and opinions of people who use AAC and their caregivers and communication partners regarding their satisfaction with AAC and communication goals and outcomes. Tools used in this study, such as the Social Networks survey (Blackstone & Hunt Berg, 2003) and the Parent Perception of Language Disorder (Ronski et al., 2011), are examples of measures that can provide a starting point for investigating social validity of AAC. Finally, as our society becomes ever more reliant on digital technologies and virtual connections, future research studies should continue to investigate how social media and smart devices can be leveraged by children and adults who use AAC to support communication and social connections.

### **Conclusion**

This case report is the first to document the developmental and communication challenges and successes of an adolescent who used AAC from early intervention to adolescence. The snapshots of communication development and context form a compelling narrative that occasionally defies expectations and reflects both the accomplishments and eventual challenges of a teenager's struggle with communication.

## GROWING UP WITH AAC IN THE DIGITAL AGE

## References

- Adamson, L. B., & Dunbar, B. (1991). Communication development of young children with tracheostomies. *Augmentative and Alternative Communication, 7*, 275–283.  
doi:10.1080/07434619112331276013
- Barker, R. M., Akaba, S., Brady, N. C., & Thiemann-Bourque, K. (2013). Support for AAC use in preschool, and growth in language skills, for young children with developmental disabilities. *Augmentative and Alternative Communication, 29*, 334–346.  
doi:10.3109/07434618.2013.848933
- Blackstone, S., & Hunt Berg, M. (2003). *Social Networks: A communication inventory for individuals with complex communication needs and their communication partners*. Augmentative Communication Inc.
- Blischak, D. (1995). Thomas the writer: Case study of a child with severe physical, speech, and visual impairments. *Language Speech and Hearing Services in Schools, 26*, 11–20.  
doi:10.1044/0161-1461.2601.11
- Brady, N. C., Thiemann-Bourque, K., Fleming, K., & Matthews, K. (2013). Predicting language outcomes for children learning augmentative and alternative communication: Child and environmental factors. *Journal of Speech, Language, and Hearing Research, 56*, 1595–1612. doi:10.1044/1092-4388(2013/12-0102)
- Calculator, S. N., & Black, T. (2009). Validation of an inventory of best practices in the provision of augmentative and alternative communication services to students with severe disabilities in general education classrooms. *American Journal of Speech-Language Pathology, 18*, 329–342. doi:10.1044/1058-0360(2009/08-0065)

## GROWING UP WITH AAC IN THE DIGITAL AGE

- Caron, J., & Light, J. (2016). "Social media has opened a world of 'open communication:'" experiences of adults with cerebral palsy who use augmentative and alternative communication and social media. *Augmentative and Alternative Communication*, 32, 25–40. doi:10.3109/07434618.2015.1052887
- Caron, J. G., & Light, J. (2017). Social media experiences of adolescents and young adults with cerebral palsy who use augmentative and alternative communication. *International Journal of Speech-Language Pathology*, 19, 30–42. doi:10.3109/17549507.2016.1143970
- Dahlgren Sandberg, A. (2001). Reading and spelling, phonological awareness, and working memory in children with severe speech impairments: A longitudinal study. *Augmentative and Alternative Communication*, 17, 11–26. doi:10.1080/aac.17.1.11.26
- Dunn, L. M. (1997). *Peabody Picture Vocabulary Test* (3rd ed.). American Guidance Service
- Dunn, L. M., & Dunn, D. M. (2007). *The Peabody Picture Vocabulary Test* (4th ed.). NCS Pearson, Inc.
- Edwards, D. J. A., Dattilio, F. M., & Bromley, D. B. (2004). Developing evidence-based practice: The role of case-based research. *Professional Psychology: Research and Practice*. 35, 589–597. doi:10.1037/0735-7028.35.6.589
- Fenson, L., Dale, P., Reznick, J., Thal, D., Bates, E., Hartung, J., Pethick, S., & Reilly, J. (1993). *The MacArthur Communicative Development Inventories: User's guide and technical manual*. Singular Publishing Group, Inc.
- Georgia Department of Education. (2010). *Criterion Referenced Competency Tests*. Retrieved from <http://www.gadoe.org/Curriculum-Instruction-andAssessment/Pages/CRCT-Content-Descriptions.aspx>

## GROWING UP WITH AAC IN THE DIGITAL AGE

- Goldman, R., & Fristoe, M. (2015). *Goldman-Fristoe Test of Articulation* (3rd ed.). American Guidance Service, Inc.
- Goossens, C. (1989) Aided communication intervention before assessment: A case study of a child with cerebral palsy. *Augmentative and Alternative Communication*, 5, 14 - 26.  
doi:10.1080/07434618912331274926
- Grace, E., Raghavendra, P., McMillan, J. M., & Shipman Gunson, J. (2019). Exploring participation experiences of youth who use AAC in social media settings: Impact of an e-mentoring intervention. *Augmentative and Alternative Communication*, 35, 132–141.  
doi:10.1080/07434618.2018.1557250
- Granlund, M., Björck-Åkesson, E., Wilder, J., & Ylvén, R. (2008). AAC interventions for children in a family environment: Implementing evidence in practice. *Augmentative and Alternative Communication*, 24, 207–219. doi:10.1080/08990220802387935
- Hamm, B., & Mirenda, P. (2006). Post-school quality of life for individuals with developmental disabilities who use AAC. *Augmentative and Alternative Communication*, 22, 134–147.  
doi:10.1080/07434610500395493
- Harrison, P.L., & Oakland, T. (2003). *Adaptive Behavior Assessment System* (2nd ed). The Psychological Corporation.
- Hemsley, B., Balandin, S., Palmer, S., & Dann, S. (2017). A call for innovative social media research in the field of augmentative and alternative communication. *Augmentative and Alternative Communication*, 33, 14–22. doi:10.1080/07434618.2016.1273386
- Hoover, H.D., Dunbar, S.B., & Frisbie, D.A. (2001) *The Iowa Tests of Basic Skills* (Levels 5 – 14). Riverside Publishing.

## GROWING UP WITH AAC IN THE DIGITAL AGE

Hunt-Berg, M. (2005). The Bridge School: Educational inclusion outcomes over 15 years.

*Augmentative and Alternative Communication, 21*, 116–131.

doi:10.1080/07434610500103509

Hyatt, G. W. (2011). The iPad: A Cool Communicator on the Go. *Perspectives on Augmentative*

*and Alternative Communication, 20*, 24–27. doi:10.1044/aac20.1.24

Hynan, A., Murray, J., & Goldbart, J. (2014). “Happy and excited”: Perceptions of using digital

technology and social media by young people who use augmentative and alternative communication. *Child Language Teaching and Therapy, 30*, 175–186.

doi:10.1177/0265659013519258

Jonsen, K. (2009). Using triangulation to validate themes in qualitative studies. *Qualitative*

*Research in Organizations and Management: An International Journal, 4*, 123–150.

doi:10.1108/17465640910978391

Koppenhaver, D. A., Evans, D. A., & Yoder, D. E. (1991). Childhood reading and writing

experiences of literate adults with severe speech and motor impairments. *Augmentative and Alternative Communication, 7*, 20–33.

<https://doi.org/10.1080/07434619112331275653>

Letto, M., Bedrosian, J., & Skarakis-Doyle, E. (1994). Application of Vygotskian developmental

theory to language acquisition in a young child with cerebral palsy. *Augmentative and Alternative Communication, 10*, 151–160. doi:10.1080/07434619412331276860

Light, J. C., Beesley, M., & Collier, B. (1988). Transition through multiple augmentative and

alternative communication systems: A three-year case study of a head injured adolescent. *Augmentative and Alternative Communication, 4*, 2–14.

doi:10.1080/07434618812331274557

## GROWING UP WITH AAC IN THE DIGITAL AGE

- Light, J., McNaughton, D., Beukelman, D., Fager, S. K., Fried-Oken, M., Jakobs, T., & Jakobs, E. (2019). Challenges and opportunities in augmentative and alternative communication: Research and technology development to enhance communication and participation for individuals with complex communication needs. *Augmentative and Alternative Communication, 35*, 1–12. doi:10.1080/07434618.2018.1556732
- Lund, S. K., & Light, J. (2006). Long-term outcomes for individuals who use augmentative and alternative communication: Part I - What is a “good” outcome? *Augmentative and Alternative Communication, 22*, 284–299. doi:10.1080/07434610600718693
- Lund, S., & Light, J. (2007a). Long-term outcomes for individuals who use augmentative and alternative communication: Part II - Communicative interaction. *Augmentative and Alternative Communication, 23*, 1–15. doi:10.1080/07434610600720442
- Lund, S. K., & Light, J. (2007b). Long-term outcomes for individuals who use augmentative and alternative communication: Part III - Contributing factors. *Augmentative and Alternative Communication, 23*, 323–335. doi:10.1080/02656730701189123
- Mandak, K., O’Neill, T., Light, J., & Fosco, G. M. (2017). Bridging the gap from values to actions: A family systems framework for family-centered AAC services. *Augmentative and Alternative Communication, 33*, 32–41. doi:10.1080/07434618.2016.1271453
- Martin, N. A., & Brownell, R. (2011). *Expressive One-Word Picture Vocabulary Test* (4<sup>th</sup> ed). ATP Assessments.
- McNaughton, D., & Light, J. (2013). The iPad and mobile technology revolution: Benefits and challenges for individuals who require augmentative and alternative communication. *Augmentative and Alternative Communication, 29*, 107–116. doi:10.3109/07434618.2013.784930

## GROWING UP WITH AAC IN THE DIGITAL AGE

- Medeiros, K. F., Cress, C. J., & Lambert, M. C. (2016). Mastery motivation in children with complex communication needs: longitudinal data analysis. *Augmentative and Alternative Communication, 32*, 208–218. doi:10.1080/07434618.2016.1179789
- Molteni, B., Sarti, D., Airaghi, G., Falcone, C., Mantegazza, G., Baranello, G., Riva, F., Saletti, V., Paruta, N., & Riva, D. (2010). Language abilities and gestural communication in a girl with bilateral perisylvian syndrome: A clinical and rehabilitative follow-up. *Neurological Sciences, 31*, 471–481. doi:10.1007/s10072-010-0309-2
- Mullen, E. M. (1995). *Mullen Scales of Early Learning*. American Guidance Services.
- National Joint Committee for the Communication Needs of Persons With Severe Disabilities. (2003). *Position statement on access to communication services and supports: Concerns regarding the application of restrictive “eligibility” policies* [Position Statement]. Available from [www.asha.org/policy](http://www.asha.org/policy) or [www.asha.org/njc](http://www.asha.org/njc).
- O’Brien, A. M., Schlosser, R. W., Yu, C., Allen, A. A., & Shane, H. C. (2020). Repurposing a smart watch to support individuals with autism spectrum disorder: Sensory and operational considerations. *Journal of Special Education Technology*. doi:10.1177/0162643420904001
- Roid, G., Miller, L., Pomplun, M., & Koch, C. (2013). *Leiter International Performance Scale* (3rd ed.). Stoelting
- Rackensperger, T. (2012). Family influences and academic success: The perceptions of individuals using AAC. *Augmentative and Alternative Communication, 28*, 106–116. doi:10.3109/07434618.2012.677957
- Romski, M. A., Sevcik, R. A., Adamson, L. B., Cheslock, M., Smith, A., Barker, R. M., & Bakeman, R. (2010). Randomized comparison of augmented and non-augmented

## GROWING UP WITH AAC IN THE DIGITAL AGE

- language interventions for toddlers with developmental delays and their parents. *Journal of Speech, Language, and Hearing Research*, 53, 350-364. doi: 10.1044/1092-4388(2009/08-0156)
- Romski, M. A., Sevcik, R. A., Adamson, L. B., Smith, A., Cheslock, M., & Bakeman, R. (2011). Parent perceptions of the language development of toddlers with developmental delays before and after participation in parent-coached language interventions. *American Journal of Speech-Language Pathology*, 20, 111–118. doi:10.1044/1058-0360(2011/09-0087)
- Romski, M. A., Sevcik, R. A., Barton-Hulsey, A., & Whitmore, A. S. (2015). Early intervention and AAC: What a difference 30 years makes. *Augmentative and Alternative Communication*, 31, 181–202. doi:10.3109/07434618.2015.1064163
- Romski, M. A., Sevcik, R. A., Robinson B., & Bakeman, R. (1994). Adult-directed communications of youth with mental retardation using the system for augmenting language. *Journal of Speech and Hearing Research*, 37, 617–628. doi:10.1044/jshr.3703.617
- Schlosser, R. W. (1999). Social validation of interventions in augmentative and alternative communication. *Augmentative and Alternative Communication*, 15, 234-247. doi:10.1080/07434619912331278775
- Schlosser, R. W., O'Brien, A., Yu, C., Abramson, J., Allen, A. A., Flynn, S., & Shane, H. C. (2017). Repurposing everyday technologies to provide just-in-time visual supports to children with intellectual disability and autism: A pilot feasibility study with the Apple Watch®. *International Journal of Developmental Disabilities*, 63(4), 221–228. doi:10.1080/20473869.2017.1305138

## GROWING UP WITH AAC IN THE DIGITAL AGE

- Semel, E., Wiig, E. H., & Secord, W. A. (2003). *Clinical evaluation of language fundamentals* (4th ed.). Psychological Corporation.
- Sevcik, R. A., & Ronski, M. (2007). Children, families, clinicians, and AAC. *Perspectives on Augmentative and Alternative Communication*, 16, 5-7. doi:10.1044/aac16.3.7
- Shane, H. C., Laubscher, E., Schlosser, R. W., Flynn, S., Sorce, J. F., & Abramson, J. (2012). Applying technology to visually support language and communication in individuals with ASD. *Journal of Autism and Developmental Disorders*, 42, 1228-1235. doi:10.1007/s10803-011-1304-z
- Sigafoos, J., O'Reilly, M., Ganz, J. B., Lancioni, G. E., & Schlosser, R. W. (2005). Supporting self-determination in AAC interventions by assessing preference for communication devices. *Technology and Disability*, 17(3), 143-153. doi:10.3233/TAD-2005-17302
- Sparrow, S., Cicchetti, D., & Balla, D. (2005). *Vineland adaptive behavior scales* (2nd ed.). Pearson.
- Sparrow, S., Cicchetti, D., & Saulnier, C. (2016). *Vineland adaptive behavior scales* (3rd ed.). Pearson.
- Udwin, O. (1990). Augmentative communication systems taught to cerebral palsied children - a longitudinal study. I. The acquisition of signs and symbols, and syntactic aspects of their use over time. *British Journal of Disorders of Communication*, 25, 295-309. doi:10.3109/13682829009011979
- von Tetzchner, S., Brekke, K.M., Sjøthun, B., & Grindheim, E. (2005). Constructing preschool communities of learners that afford alternative language development. *Augmentative and Alternative Communication*, 21, 82-100. doi:10.1080/07434610500103541

## GROWING UP WITH AAC IN THE DIGITAL AGE

Wechsler, D., & Naglieri, J.A. (2006). *Wechsler Nonverbal Scale of Ability*. Harcourt Assessment.

Wehmeyer, M. L., Palmer, S. B., Agran, M., Mithaug, D. E., & Martin, J. E. (2000). Promoting causal agency: The self-determined learning model of instruction. *Exceptional Children*, 66(4), 439–453. doi:10.1177/001440290006600401

Williams, K. T. (2007). *Expressive Vocabulary Test* (2nd ed.). American Guidance Service.

Zimmerman, I. L., Steiner, V. G., & Pond, R. E. (2002). *Preschool Language Scales* (4th ed.) Harcourt Assessment.

## GROWING UP WITH AAC IN THE DIGITAL AGE

## Endnotes

<sup>1</sup> Adaptive Behavior Assessment System™ is a registered trademark. For more information see <https://www.wpspublish.com/abas-ii-adaptive-behavior-assessment-system-second-edition>.

<sup>2</sup> Proloquo4Text and Proloquo2Go are products of AssistiveWare. See <http://www.assistiveware.com> for more information.

<sup>3</sup> Lexile is a copyright trademark of the Lexile Framework for Reading. See [lexile.com](http://lexile.com) for more information.

<sup>4</sup> Iowa Tests of Basic Skills® is a registered trademark of Riverside Assessments, LLC and its affiliates.

<sup>5</sup> GoTalk 8 and GoTalk 20 are products of Attainment Company. More information can be found at <https://www.attainmentcompany.com/>

<sup>6</sup> Picture Communication Symbols are a product of Boardmaker and Tobii-Dynavox. More information can be found at <https://goboardmaker.com/pages/picture-communication-symbols>.

<sup>7</sup> Dynavox Gateway® is a product of Dynavox, now now Tobii Dynavox. More information can be found at <https://www.tobiiDynavox.com>.

<sup>8</sup> Apple Inc. is a technology company whose products include Apple Watch, iPad, iPhone, iPod, iTouch and FaceTime. For more information see [www.apple.com](http://www.apple.com).

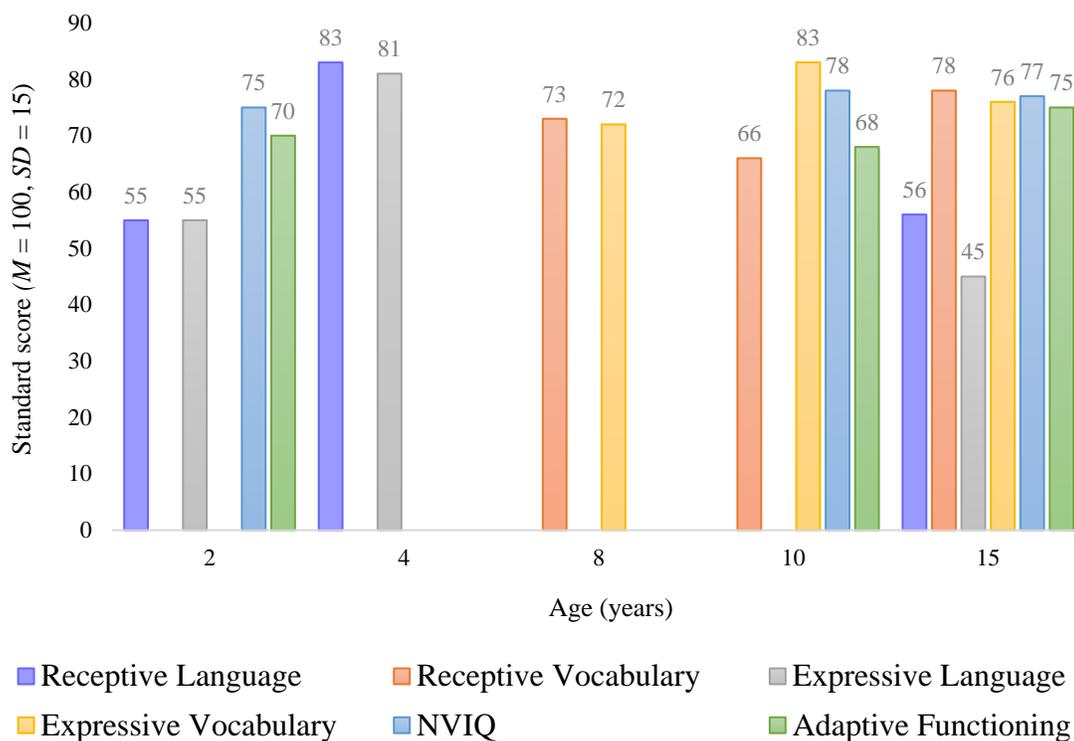
<sup>9</sup> SymbolStix is a dynamic symbol set created by News-2-You. More information can be found at <https://www.n2y.com/symbolstix-prime/>.

<sup>10</sup> Google Search is a web search engine developed by Google Inc. For more information see <https://about.google/products/>.

<sup>11</sup> LEGO® is a registered trademark of The Lego Group.

## GROWING UP WITH AAC IN THE DIGITAL AGE

Figure 1

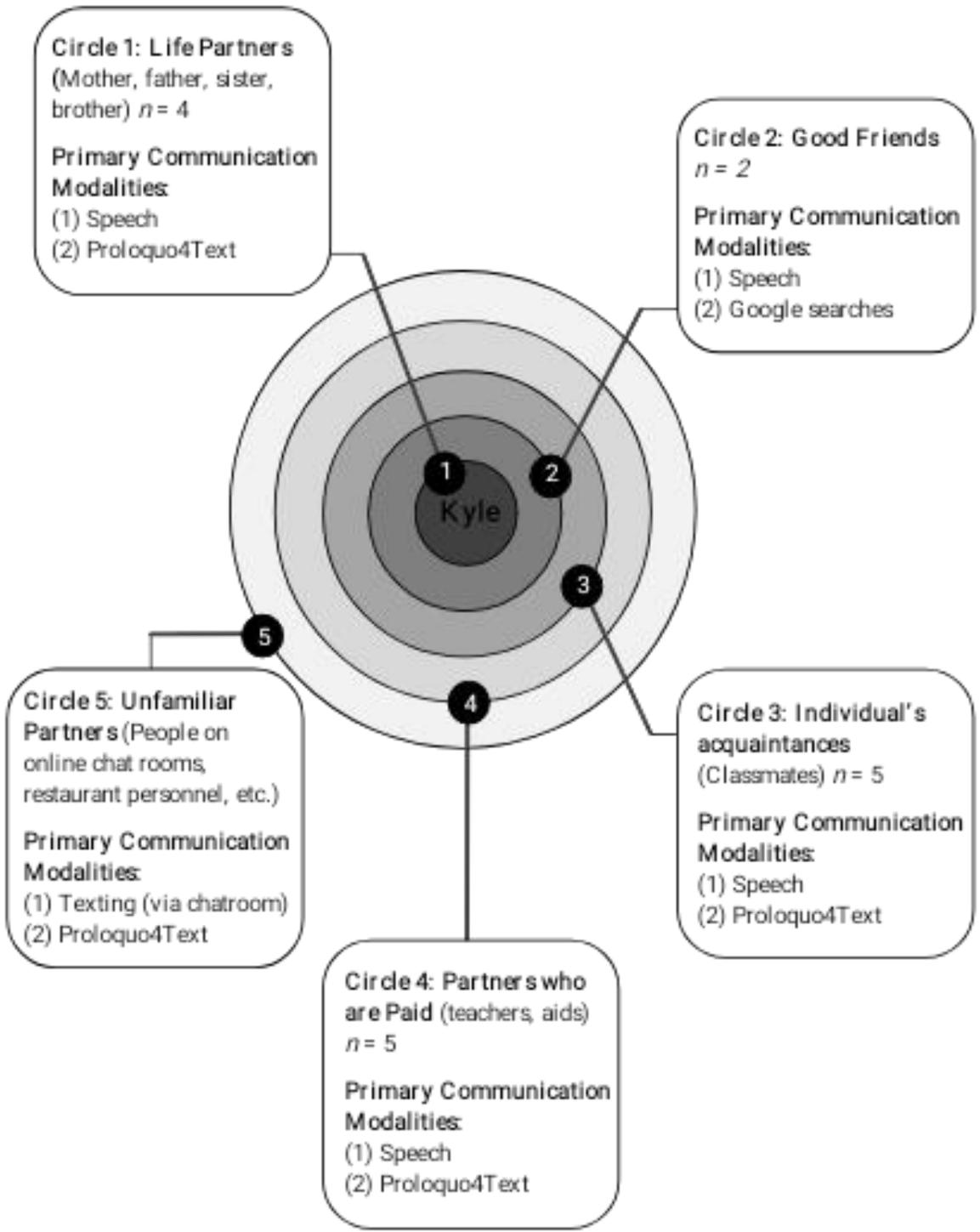
*Standardized Test Scores across Domains and Ages*

*Note.* Standard scores were obtained from the following assessments: Adaptive Behavior Assessment System, Second Edition (Age 10); Clinical Evaluation of Language Fundamentals, Fourth Edition (Age 15); Expressive One-Word Picture Vocabulary Test, Fourth Edition (Ages 7, 10); Expressive Vocabulary Test, Second Edition (Age 15), Leiter International Performance Scale, Third edition (Age 15); Mullen Scales of Early Learning (Age 2); Peabody Picture Vocabulary Test, Third edition (Age 4, 7, 10); Peabody Picture Vocabulary Test, Fourth Edition (Age 15), Preschool Language Scales, Fourth Edition (Age 4); Vineland Adaptive Behavior Scales, Second Edition (Age 2) Vineland Adaptive Behavior Scales, Third Edition (Age 15); Wexler Nonverbal Scale of Ability (Age 10). NVIQ = Nonverbal Intelligence Quotient;  $M$  = Mean,  $SD$  = Standard Deviation.

GROWING UP WITH AAC IN THE DIGITAL AGE

Figure 2

*Circles of Communication Partners and Communication Modalities*



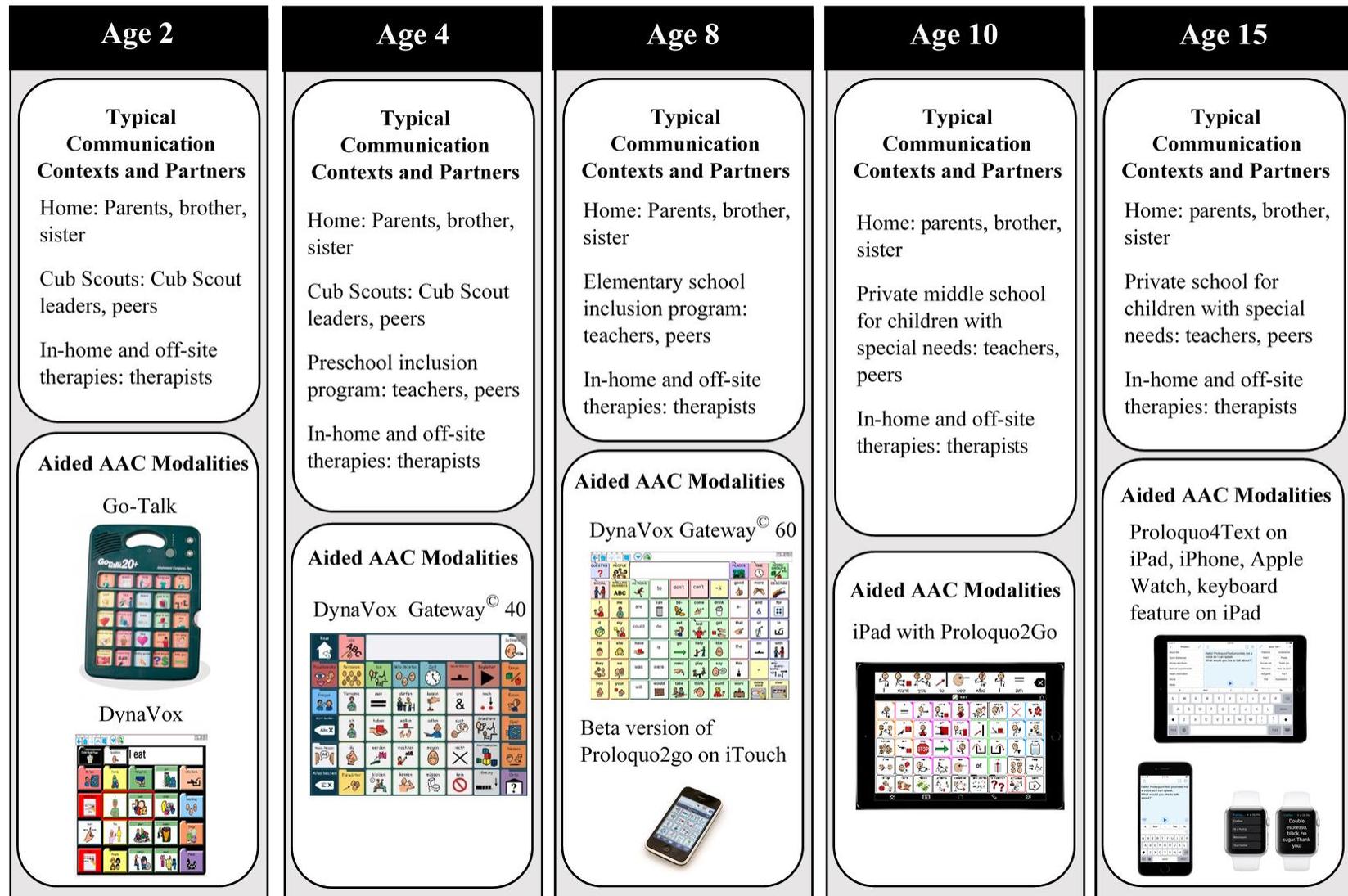
## GROWING UP WITH AAC IN THE DIGITAL AGE

*Note.* From *Social Networks: A Communication Inventory For Individuals with Complex Communication Needs and Their Communication Partners* (Blackstone & Hunt Berg, 2003).

GROWING UP WITH AAC IN THE DIGITAL AGE

Figure 3

*Aided AAC across Communication Contexts and Ages.*



## GROWING UP WITH AAC IN THE DIGITAL AGE

## Appendix

## Parent Interview Guide

1. What was Kyle's communication development like before he participated in the toddler study?
2. What were your initial impressions and understanding of AAC?

## Age 2

3. Can you describe a typical day for Kyle at age two?
4. How would you describe Kyle's communication at age two? What types of communication modalities did he use?
5. What kinds of services was Kyle receiving at age two?
6. What were your greatest challenges and concerns regarding Kyle at age two?

## Age 4

7. Can you describe a typical day for Kyle at age four?
8. How would you describe Kyle's communication at age four? What types of communication modalities did he use?
9. What kinds of services was Kyle receiving at age four?
10. What were your greatest challenges and concerns regarding Kyle at age four?

## Age 8

11. Can you describe a typical day for Kyle at age eight?
12. How would you describe Kyle's communication at age eight? What types of communication modalities did he use?
13. What kinds of services was Kyle receiving at age eight?
14. What were your greatest challenges and concerns regarding Kyle at age eight?

## Age 10

1. Can you describe a typical day for Kyle at age ten?
2. How would you describe Kyle's communication at age ten? What types of communication modalities did he use?
3. What kinds of services was Kyle receiving at age ten?
4. What were your greatest challenges and concerns regarding Kyle at age ten?

## Now (Age 15)

5. Can you describe a typical day for Kyle now?
6. How would you describe Kyle's current communication? What types of communication modalities does he use?
7. What kinds of services is Kyle currently receiving?
8. Currently, what were your greatest challenges and concerns regarding Kyle?
9. What are your long-term goals for Kyle?