

# Augmentative and Alternative Communication Technology Innovations to Build Skills and Compensate for Limitations in Adolescent Language

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Adolescents with intellectual and developmental disabilities (IDD) who also possess limited speech capabilities often display poor language and academic skills in adolescence. However, as with all adolescents, they have personal goals and should have equal access to participation across facets of life including but not limited to education. Augmentative and alternative communication (AAC) technologies can support individuals with IDD and limited speech in achieving those goals and experiencing greater participation more like their peers without disabilities in adolescence. Augmentative and alternative communication technologies can be applied in intervention with 2 distinct but complementary guiding priorities. First, technology can be applied to compensate for limitations in language form, content, and/or use to support immediate participation in adolescent pursuits for individuals with IDD. Second, technology can be used as a tool to build skills in language form, content, and/or use that have long-term implications for participation and success in adolescence and adulthood. This article outlines applications of AAC technologies within those guiding priorities. In addition, the article outlines case examples in which adolescents with IDD and limited speech have benefited from AAC technologies to compensate for linguistic difficulties and build their language and communication skills. **Key words:** *adolescence, augmentative and alternative communication, autonomy, education, intellectual and developmental disability, interpersonal relationships, language, participation, self-expression, transition*

**A**DOLESCENCE is a formidable stage of life filled with new challenges and pitfalls as well as new joys and opportunities. It is a transitional period as individuals move from the safety and restrictions of childhood to the responsibilities and freedoms of adult-

hood. It is a time where goals involve successful participation and growth. Particular facets of life in which adolescence may hold these goals include educational/vocational, interpersonal, autonomous and independent living, and self-expression (Carroll, Durkin, Hattie, & Houghton, 1997).

Adolescence is an experience that varies across individuals. Individuals with intellectual and developmental disabilities (IDD) with limited speech and language face their own unique challenges in adolescence. Given the central role language plays in adolescent participation and success (Smith, 2015), limitations in language form (i.e., phonology, morphology, and syntax), content (i.e., semantics), and use (i.e., pragmatics) can be severely restrictive for adolescents with IDD. Despite their unique experiences and

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language limitations, adolescents with IDD and limited speech share the same goals as all adolescents—enjoying the period of life and transitioning successfully into adulthood (McNaughton & Kennedy, 2010).

Adolescents with IDD and limited speech are a heterogeneous group but often rely on augmentative and alternative communication (AAC) technology to bypass or supplement limited speech and language skills to support communication. Throughout this article, the language demands and contexts typical adolescents encounter will be considered. Also considered will be a range of language limitations that any given adolescent with IDD and limited speech who likely uses AAC technology may or may not face. Innovative AAC technology options to address the disconnect created by speech and language limitations experienced by an adolescent with IDD and the language required to participate fully in adolescence also will be offered. However, it is important to note that, depending on their language profiles, only select limitations and technology options may be relevant to any given adolescent with IDD and limited speech. In addition, it should be noted that although this article focuses on language, other domains (e.g., motor, cognitive, motivation) are important when considering technological supports. This article ends with highlighting the cases of two adolescents with IDD and limited speech—Anthony and Cecilia (composite cases)—who have very different language profiles. The AAC technology to support them is different as a consequence. Anthony is literate and has a large vocabulary; Cecilia is a beginning communicator learning to communicate intentionally and attach meaning to symbols. It is the hope of the authors that, through considering a range of language needs and supports for adolescents, readers can inform their overall approach to using AAC-supported intervention for adolescents with IDD and limited speech in addition to considering specific technologies and how they might support specific language limitations.

## **LANGUAGE AND LITERACY LIMITATIONS AND IMPLICATIONS FOR ADOLESCENCE**

Successful use of language, and its continued refinement, is critical to adolescent success (Smith, 2015). Because language and literacy learning develop through a synergistic relationship, discussion of the interplay of literacy will be infused within the framework of language form, content, and use. As Sturm and Clendon (2004) described, “Reading, writing, listening, and speaking are interconnected yet independent language systems that develop in overlapping parallel waves. For children who use AAC, the critical role of language as a foundation for spoken and written communication cannot be underestimated” (p. 76). Note, for this article, that we are defining literacy as a term that typically encompasses the ability to read and write, with a focus on literacy as used in most education contexts (i.e., a narrow view, with a focus on specific components such as letter-sound correspondence, decoding, and encoding). Because many communication demands in adolescence involve reading and writing, we focus much of our commentary on literacy specifically.

Understanding language development, as well as limitations and implications common to adolescents with IDD and limited speech, is an important foundation for AAC considerations. More specifically, limitations in language form, content, and use that adolescents with IDD and limited speech may experience are outlined. Although these aspects of language are integrally related and influence one another, it may be useful to consider each area and limitations in each area distinctly in regard to identifying needs and supports. See Table 1 also for an outline of potential challenges in language form, content, and use across facets of adolescent life for adolescents with IDD who experience limited speech and language. These include educational/vocational, interpersonal, autonomy, and self-expression facets.

**Table 1.** Potential challenges in language form, content, and use across facets of life for adolescents with intellectual and developmental disabilities

Facet of Adolescent Life	Possible Challenges Resulting From Limited Language Form	Possible Challenges Resulting From Limited Language Content	Possible Challenges Resulting From Limited Language Use
Educational and vocational	Limited reading and writing skills for academic or vocational texts and tasks Limited skills for understanding and producing informational genres required in most adolescent educational and vocational contexts Low utterance length for social communication	Limited background knowledge to bring to the learning task Limited academic knowledge and vocabulary Lack of vocational knowledge and vocabulary	Low participation within in-class discussions and activities Low participation in peer group work Limited social interaction skills required for many vocations
Interpersonal	Limited receptive and expressive writing skills for texting or e-mail Limited or no literacy skills required for many social media features (e.g., commenting) or accessing popular cultural content (e.g., in books, on the Internet)	Limited knowledge and vocabulary related to popular culture references Little knowledge about the lives and experiences of peers Limited slang vocabulary Restricted or unique interests may not be of interest to many peers	Low awareness of classroom learning expectations and norms Limited skills for building social closeness Low awareness of social expectations and norms Limited skills for using language for social etiquette
Autonomy	Limited literacy skills for understanding legal text Limited persuasive abilities orally or in writing	Limited knowledge and vocabulary related to self-advocacy and self-determination concepts (e.g., rights, consent) Limited understanding and expression of “yes” and “no”	Lack of equal participation in conversations with others Limited use of language for self-advocacy Limited use of language for protesting Low expression of opinions Limited choice making
Self-expression	Limited writing skills for journaling, writing poetry, or creating song lyrics Limited literacy skills and low utterance length for providing rich descriptions, orally or in writing	Limited knowledge and vocabulary related to emotions and internal states Limited knowledge and expression of exclamatory vocabulary	Limited use of language for sharing with peers and family about self and life

## Form

### *Typical adolescent language*

The syntax and morphology required for adolescence include a large mean length of utterance, understanding and productive use of morphological structures (Scarborough, 1990), and understanding and use of a broad range of subtle, sophisticated syntactic forms (Nippold, 2000). Relative to literacy, adolescents require near-automatic decoding and encoding skills with a large number of words recognized at immediate sight or generated without much cognitive effort. These skills—narrowly defined as literacy (Kamhi, 2009)—also must be accompanied by strong syntactic, morphological, semantic, and pragmatic knowledge in order for literacy to be functional and fully developed. Furthermore, a growing knowledge of a variety of morphological structures creates opportunities for the learning of new words within new syntactic categories (Nippold & Sun, 2008).

### *Limitations and implications common to adolescents with IDD and limited speech*

Individuals with IDD and limited speech who require or would benefit from AAC often (a) demonstrate delays in phonology; (b) have difficulty with the production of morphemes; (c) rely on one- to two-word utterances with simple clause types (Sturm & Clendon, 2004); and (d) have limited skills related to decoding and encoding (Light & McNaughton, 2013). These language challenges impact reading and writing development. For example, phonological skills are foundational to reading and writing, so phonological limitations can severely restrict literacy outcomes. Furthermore, an individual with IDD and limited speech who has limited understanding and use of syntactic structures is at a disadvantage when processing the range of sentence types encountered in text. That individual also is at a disadvantage for successfully writing text that requires the use of a variety of syntactic forms (Binger & Light, 2008). The lack of a functional language system and

limited literacy skills create significant challenges for adolescents who use AAC (Light & McNaughton, 2013; Sturm & Clendon, 2004).

*Educational/vocational:* In classrooms, language is the mechanism for communication, reading, and writing (Sturm & Clendon, 2004). Typical adolescents are primarily expected to learn via text (Ehren & Lenz, 1989). Limitations in skills related to form can significantly restrict reading and writing, which in turn restricts learning. The reading and writing of academic expository texts that require understanding and use of sophisticated syntactic forms (Scott & Windsor, 2000) can be particularly challenging for adolescents with IDD and limitations in language form. With the proliferation of technology within pedagogical approaches (e.g., Web searching, classroom discussion boards), reading and writing skills are relied on increasingly in academics. Furthermore, many career opportunities require at least proficient reading and writing skills, and accurate grammar use may be one way in which the competence of a potential employee or current employee is judged.

*Interpersonal:* Furthermore, these limitations in language form previously discussed can have negative interpersonal consequences, as lack of use of these sophisticated language forms may cause listeners to consider the adolescent with IDD as “child-like” (Todman, Alm, Higginbotham, & File, 2008). In addition, much of adolescent communication now occurs via use of orthographic representations for e-mail, text messaging, and social media posting and responding (Caron, 2016). For individuals who use AAC, limited language and literacy skills restrict the modalities over which adolescents with IDD can communicate with peers, particularly at a distance.

*Autonomy:* In relation to their developing autonomy, language and literacy skills allow for wider independence in adolescence. A lack of functional literacy skills limits independence in accessing entertainment and resources over the Internet; financial independence (e.g., transferring money on

an app, obtaining employment); independent navigation of the community (e.g., using a map app); and independent decision-making requiring reading, from basic decisions throughout the day such as ordering from a restaurant menu to major life decisions such as legal ones involving contractual paperwork.

*Self-expression:* Relative to self-expression, many adolescents keep journals, create song lyrics, or write poems to express their feelings. They also are experiencing a more heightened sense of self and of sharing that self with others (Carroll et al., 1997). For adolescents with IDD, limited language form and literacy skills can restrict outlets for self-expression (e.g., journaling) and means for sharing that self-expression (e.g., online blogs).

## Content

### *Typical adolescent language*

Through a culmination of interactions, life experiences, and reading, adolescents have accumulated large vocabularies (Nippold, 1993). Adolescents are required to know and use a range of vocabulary, including content-specific vocabulary that is situational in its relevance, such as academic vocabulary. Vocabulary is central to content generation, both in written and spoken forms (Sturm & Clendon, 2004). Adolescents also have developed an understanding and use of figurative language in its various forms to communicate abstract concepts and interpret and use sophisticated humor (e.g., metaphors, proverbs; Nippold, 2000).

### *Limitations and implications common to adolescents with IDD and limited speech*

Many adolescents with IDD and limited speech may experience limitations in semantics. Receptive and expressive vocabulary and conceptual understanding of ideas may be limited (McNaughton & Bryen, 2007; Nippold, 1993). Restricted experiences and background knowledge contribute to limited

vocabulary that is needed in order to effectively understand texts, communicate with a range of people across contexts, and retrieve content to share thoughts (Light, 1997). Understanding of figurative language may be particularly limited in some adolescents with IDD and limited speech, given its abstract nature (Nippold, 2000).

*Educational/vocational:* Educationally, knowledge and use of words specific to academic content are essential to academic growth and performance. Limited vocabularies are a huge academic disadvantage (Nagy & Townsend, 2012) and limited semantic knowledge in a particular content area also may restrict access to future opportunities for learning in that area. Individuals who use AAC and are not literate rely on others to provide them access to vocabulary. Predicting needed vocabulary for a future situation is a difficult task (Holyfield, Caron, & Light, 2019). Acquiring new knowledge is challenging for adolescents with IDD and limited speech who cannot participate fully in classroom discussions due to limited access to or knowledge of relevant vocabulary (Chinman & Linney, 1998). As vocational opportunities become increasingly specialized, highly specific content knowledge and related vocabulary are required for many careers.

*Interpersonal:* Interpersonally, adolescents discuss topics with which they are familiar using words they know. Particularly, adolescents may have popular culture knowledge and vocabulary important to peer interpersonal relationships. Adolescents with IDD and limited speech who do not know all of these social vocabulary terms may struggle to fit in socially or participate in interactions with same-aged peers. In addition, words can quickly move from “in” to “out” of fashion for use by adolescents, increasing the complexity of effective peer interpersonal communication.

*Autonomy:* Relative to autonomy, vocabulary affects thinking and actions around one’s own self-determination and decision making (Carter, Owens, Trainor, Sun, & Swedeen, 2009). For example, concepts of fairness,

rights, and legal status of decision making all require additional vocabulary and nuanced relational meaning development (e.g., exceptions to rules; how rules change situationally). Adolescents with IDD and limited speech who have not developed semantic knowledge of such concepts are restricted in making well-informed, major life decisions.

*Self-expression:* In relation to self-expression, adolescents have increasingly robust vocabularies to describe their emotions and inner states. Articulating and understanding emotional states and motivations are important components of building intimate relationships. Adolescents also increasingly use exclamatory vocabulary to express strong emotions. Figurative and idiomatic language use increases. Adolescents with IDD and limited speech who possess limited topic and associated vocabulary knowledge are therefore limited in all these aspects of adolescent life. Even while some adolescents with IDD, such as those with autism, may have an extensive vocabulary related to a particular area of interest, this semantic knowledge may not be relevant to interactions in the classroom or community. It also may not be regarded as interesting or appropriate by peers (Humphrey & Symes, 2011).

## Use

### *Typical adolescent language*

Adolescents use language masterfully to interact across settings, communication partners, and situations (Nippold, 2000). Adolescents also use pragmatic skills to understand others and form their own spoken and written identities (Soto, 2006). Also, adolescents spend a significant amount of time interacting with peers to build friendships (Nippold, 2000). To interact successfully with peers, adolescents employ pragmatic strategies such as choosing conversational topics of interest to peers and using repair strategies during conversational breakdowns (Reed, Bradfield, & McAllister, 1998).

### *Limitations and implications common to adolescents with IDD and limited speech*

Many adolescents with IDD and limited speech struggle with the use of language. Adolescents with IDD and limited speech often play a subordinate role in communicative interactions, serving primarily as responders and taking fewer conversational turns (Lund & Light, 2007). They may have less awareness about social norms and expectations (McCarthy, Light, & McNaughton, 2007). In addition, adolescents with IDD—particularly autism—may have fewer opportunities or less support in communicating a full range of communicative functions (Holyfield, Drager, Kremkow, & Light, 2017). Pragmatic skills are required to support literacy development and learning from text through relating to authors' and classmates' intentions and expectations. These and other language use limitations can severely restrict participation across adolescent life for individuals with IDD and limited speech.

*Educational/vocational:* Educationally, participation within classroom interactions promotes adolescent learning (Chinman & Linney, 1998). Furthermore, understanding of and adherence to classroom norms ensures freedom from retribution both in regard to teacher admonishments and peer negativity. Limited pragmatic skills surrounding classroom interactions and norms can restrict academic opportunities and success. Limited academic success can have negative consequences on vocational activities. Furthermore, the same pragmatic skills expected in the classroom are likely equally critical to success within many vocational settings.

*Interpersonal:* Interpersonally, understanding and use of language to form social bonds and maintain social etiquette are crucial to building peer friendships and social status. Using language for this purpose is central to adolescence (Light, 1988). During adolescence, peers offer little forgiveness for social misunderstandings despite social cues becoming less explicit and more subtle and complex.

Limited understanding of social etiquette and peer expectations of language use can restrict the ability of adolescents with IDD and limited speech to build and grow meaningful peer relationships.

*Autonomy:* In relation to autonomy, adolescents use language for self-advocacy, protesting, expressing opinions, and making choices. Rules for when to assert one's autonomy become more complex. The rules for interaction with an individual may change when communicating with groups of people. Interacting with groups means tracking the subtle cues of multiple people at once. Adolescents with IDD and limited speech who experience limitations in these skills may have difficulty asserting themselves or keeping themselves safe in interactions with strangers or large groups.

*Self-expression:* Relative to self-expression, adolescents use language to share with peers and family about themselves and their lives. Identifying with particular values may be broadcast through actions and adoption of styles of dress and conduct as much as language. Adolescents with IDD and limited speech may have limited opportunities for self-expression if they do not have the skills to use language to express their inner thoughts, feelings, and beliefs.

## AAC TECHNOLOGY

Given the risk individuals with IDD and limited speech and language face for restricted participation and success in adolescent life, intervention is critical. Augmentative and alternative communication technology and instruction is one intervention approach that can benefit adolescents with IDD and limited speech. Although originally applied to compensate for speech limitations specifically (Zangari, Lloyd, & Vicker, 1994), AAC technology also can be applied to support language in those who experience limitations in both speech and language (Sturm & Clendon, 2004).

Regardless of how little success with language learning an adolescent may have experienced in the past, no one is ever too old or

too limited in skills to benefit from AAC intervention for building language (Cress & Wood, 2001). However, a major goal of adolescence is participation in education/vocation, interpersonal interactions, autonomous living, and self-expression (Carroll et al., 1997). There is an urgency, then, in AAC intervention for adolescents to support such participation as efficiently as possible without waiting for the adolescent to acquire any prerequisite skills that might typically be required for participation. This urgency may be compounded by a widened gap between peer language skills and the language skills of adolescents with IDD that lengthens the skill-building trajectory.

Therefore, speech-language pathologists (SLPs) may approach intervention for adolescents with IDD and limited speech and language with two distinct but complementary overarching priorities. One of those priorities is to use AAC technology to compensate for or bypass limitations in language form, content, and use with the goal of promoting immediate success in adolescent life, particularly its educational and vocational, interpersonal, independent living, and self-expression facets. The goal of AAC intervention technology, instruction, and tasks guided by this priority is to create immediate opportunities for successful participation using whatever language skills the adolescent brings to the participation context. The other of these priorities is to use AAC technology to build language skills in form, content, and use. Although the goal of this priority is increasing language skills, skills should be prioritized on the basis of their potential to positively impact daily life and to be taught through contexts representative of real life to promote eventual generalization. Ultimately, the true goal is integrated use of these skills across life contexts and facets to participate fully in meaningful interactions (Nelson, 1992). See Table 2 for example applications of AAC technologies guided by each of these priorities.

These priorities are not mutually exclusive. Speech-language pathologists can (and should) hold both priorities for the

**Table 2.** Potential applications of AAC technology to support compensation for or building of skills in language form, content, and use

<b>Priority for Intervention</b>	<b>Example Application of AAC Technology to Support Language Form</b>	<b>Example Application of AAC Technology to Support Language Content</b>	<b>Example Application of AAC Technology to Support Language Use</b>
Compensating for language skills as they are developing	Word-level selection for writing without requiring encoding skills Utterance-level selection for using syntactically complex communication without requiring syntax and morphology skills Platform and Internet interfacing to allow remote written communication (e.g., texting, posting on social media) through word- and utterance-level selection without requiring encoding skills	Contextualized visual representation of vocabulary (e.g., visual scene displays, video visual scene displays) to allow for selection using recognition without requiring decontextualized understanding and use of the word or word recall Photographs, videos, and access to Internet content to provide communication partners with vivid information for rich interactions without requiring the words for rich linguistic descriptions	Communication opportunities embedded within an interaction context (e.g., hotspots throughout a movie clip) to prompt participation within the context (e.g., turn-taking) without requiring the pragmatic skills to identify and capitalize on times for communication Photographs and videos for communication partner supports to recognize and interpret idiosyncratic communication without requiring increased language use to convey messages
Building language skills	Text and auditory feedback and keyboard access to teach encoding Text and audio-paired output (i.e., the Transition-to-literacy feature) to teach word recognition Access to online resources to teach literacy skills Word-level selection for isolating teaching of expository and narrative skills in writing (bypassing encoding) Access to morphological structures on device to teach syntax and morphology	Contextualized visual representation of vocabulary (e.g., visual scene displays, video visual scene displays) to teach word meaning Access to online resources to teach concepts and increase background knowledge Access to words to learn through AAC technology activation and then a contingent communication partner response Onboard camera interfacing for just-in-time programming of content to promote event-based word learning	Internet interfacing to allow for online interactions without the time demands of face-to-face interactions Visual representation of choices and auditory feedback to responses to build choice-making skills Access to online resources to teach self-advocacy, social norms, and social etiquette Access to communication to learn its use through selection of AAC technology and contingent communication partner responses to it

*Note.* AAC = augmentative and alternative communication.



adolescents with IDD they support. Different goals and applications of AAC technologies, however, may be guided by one priority over the other. The priorities can be used in tandem to maximize outcomes by focusing both on immediate participation and long-term growth for increased opportunities. In addition, the priorities are not solely self-serving; targeting one may benefit the other. Given the social nature of language learning, increasing an adolescent's participation in life should increase his or her language skills over time (Grove, Bunning, Porter, & Olsson, 1999; Paul, 1997; Rogoff, 1990). Similarly, increasing language skills should, over time, result in increased opportunities for and success with social participation. In fact, it is the translation to everyday life against which the success of skill-building intervention should be measured. Speech-language pathologists also must continuously assess skills because, as skills increase, technology to promote immediate participation also will likely evolve.

### **Technology features for adolescent language support**

#### ***Compensating for limitations in form***

Augmentative and alternative communication technology has the potential to support social participation by adolescents with IDD and limited speech and language by compensating for limitations in language form. As writing (i.e., encoding) is language form that is limited for most adolescents with IDD and limited speech (Light & McNaughton, 2013), AAC technology compensating for this limitation can create an increase in opportunities for participation. Augmentative and alternative communication technology allows preliterate adolescents to communicate through the selection of whole words (e.g., use of an AAC software displaying pages of words in a grid). That is, rather than being required to type a message letter-by-letter, they can use whole-word selection to participate across facets of adolescent life (e.g., creating poetry to express inner thoughts and feelings by selecting from an array of words) despite

not yet having developed the encoding skills traditionally required to do so. Instead, the adolescent is required only to know the location of and/or recognize the symbol representing the word programmed on the AAC device. The cognitive load required to do so would vary situationally on factors including the location of the symbol on the device (e.g., a home page location would require only scanning for the symbol or memorizing the location of the symbol on the page, opposed to a word located on a page that requires the memorization or understanding of multiple navigational steps before the skills needed to find the symbol on the page are used) and the type of symbol representing the word (e.g., a written word representation would require single-word recognition or decoding whereas a color photograph representation of the word would require only recognition of the content in the photograph).

In addition to word-level selection, AAC technology also allows for utterance-level selection. That is, software may be programmed so that one selection activates the output of an entire phrase or sentence. This option allows for adolescents with limited skills in language form to communicate using syntactically and morphologically complete language without requiring the skills to generate the advanced syntax and morphology. Often, the button representing the entire phrase or sentence is represented using just a single word/icon/photograph, requiring the user only to recognize that single word/icon/photograph representation to produce the entire utterance. This can support adolescents with IDD and limited speech in interacting with peers and others using sophisticated syntax mirroring their own, which may make it more socially accepted or valued (Todman et al., 2008). For instance, an adolescent with IDD who communicates using only one- to two-word utterances when generating them word-by-word could have a page of movie quotes to select from when something funny happens (e.g., "and that's how the cookie crumbles"). Through just a single selection, the adolescent could speak

the quote, which would likely be valued by peers as adding humor to the situation more so than a single word (e.g., “uh-oh”).

Not only can adolescents with IDD write through word- and utterance-level selection but they also can use that writing across a range of platforms using AAC technology. Augmentative and alternative communication technology can interface with platforms such as texting, e-mailing, and social media to allow for written communication without requiring letter-by-letter encoding to generate such communication.

Augmentative and alternative communication technology also may be useful in compensating for literacy skills such as poor expository and narrative production. Some adolescents may have the vocabulary and knowledge to discuss past events but not the genre structure knowledge or conventions to construct those kinds of texts effectively (Soto, 2006). Augmentative and alternative communication technologies can be programmed to provide electronic outlines to structure more complex output by providing the structure of the text for the adolescent to complete. For instance, syntactic terms such as “first” followed by “then” or “the problem was” followed by “I solved it by” could promote an increase in text production skills by the provision of an external support structure.

### ***Building language form***

The literacy limitations of adolescents with IDD (Light & McNaughton, 2013) also can be addressed through AAC technology to build skills in language form. Empirical evidence shows that the text and auditory feedback features when using keyboards on AAC technology can assist with improving spelling in adolescents with IDD and limited speech (e.g., Schlosser, Blischak, Belfiore, Bartley, & Barnett, 1998). These increases in spelling can, over time, increase educational and vocational, interpersonal, independent living, and self-expression opportunities for adolescents with IDD and limited speech.

The “Transition to Literacy” (T2L) feature in AAC technology (Light, McNaughton, Jakobs,

& Hershberger, 2014) also can support increases in skills in language form. The feature displays text output paired with the usual voice output that occurs upon selecting a word in AAC technology. The goal of the feature is to build recognition of single words. Although only one small aspect of literacy, single-word recognition can still increase access to learning and interactions throughout life contexts. Empirical evidence shows that adolescents can increase their word recognition through exposure to the T2L feature (Caron, Light, Holyfield, & McNaughton, 2018; Holyfield, Light, McNaughton, Caron, Drager, & Pope, 2019). This feature is particularly powerful for adolescents with IDD who may be transitioning out of the educational setting as it does not require formal instructional time for gains to occur.

Narrative skills also may be increased through use of word-level selection on AAC technology. That is, an adolescent may be excluded from participating in storytelling if he or she does not have the literacy skills to create the narrative. However, adolescents who have limited literacy skills could still access opportunities for narrative creation through word-by-word or phrase-by-phrase selection of their narrative on an AAC device. Using this technology, adolescents have an avenue for active participation in intervention for building narrative language skills (Soto, 2006). For adolescents with IDD and limited encoding skills, this technology allows the opportunity to build narrative writing skills without first requiring the encoding skills needed for traditional writing without the technology.

### ***Compensating for limitations in language content***

Knowledge and use of words can be a limitation for adolescents with IDD and limited speech. Augmentative and alternative communication technology can be applied to compensate for limitations in language content. Two related technology features that can compensate for limited language content are visual scene displays (VSDs) and video visual scene displays (video VSDs). Visual scene

displays are photographs of people engaged in life events within which hotspots are programmed with language (Blackstone, 2004). Video VSDs are videos of life that have been spliced with still VSDs programmed with language (Light et al., 2014). These photographs and videos offer users, such as adolescents who are beginning communicators, with words to communicate that are contextualized within the event schemes in which they naturally occur. This can compensate for language limitations in beginning communicators by allowing them to recognize concepts within such contexts they may not have the skills to recognize in decontextualized tasks (Light, 1997) or recall from memory.

In addition to providing invaluable contextual information for adolescents with IDD, AAC technology also can provide vivid context cues to communication partners. Photographs, videos, and access to Internet content on an AAC device can provide a wealth of information to communication partners allowing for rich interactions with adolescents with IDD without requiring the language needed to create such rich descriptions linguistically. For instance, videos of past events can be shared with communication partners providing them with a great deal of information about those events nonlinguistically (Caron, Holyfield, Light, & McNaughton, 2018).

### ***Building language content***

Augmentative and alternative communication technology can be used to build skills in language content. For instance, VSDs and video VSDs can be used as an input modality to teach understanding and use of words (Shane, 2006). Such supports can be valuable to adolescents who are beginning communicators and struggle to develop understanding of words. Furthermore, empirical research has shown that AAC technology can be used as an intervention tool to teach academic vocabulary to adolescents with IDD and limited speech. For instance, Kagohara et al. (2012) used time delay, least-to-most prompting, and differential reinforcement to teach two ado-

lescents with autistic spectrum disorder to use AAC technology to label photographs representing content relevant to their academic curriculum.

Augmentative and alternative communication technology also allows access to Internet resources to teach concepts and increase background knowledge. Although vocabulary for adolescents with IDD may be limited from having fewer diverse experiences than a typical adolescent, Internet content (e.g., videos, Web posts) can allow them to build background knowledge and learn new words and concepts without necessarily requiring all the same experiences.

Words also can be learned incidentally using AAC technology. An adolescent can access words on an AAC device he or she may not yet know or of which he or she may only be developing emerging understanding. However, producing these words may elicit contingent responses from communication partners. This feedback may provide adolescents with IDD information that can allow them to build understanding of the meaning of these words (Grove et al., 1999; Paul, 1997). Of course, these words will be learned only if, in fact, communication partners are responsive to those communication turns, which is likely to require communication partner intervention from the SLP to create buy-in and successful use of conversational skills to build language.

In addition to communication partners, there are augmented reality applications that can superimpose words or contextual information on top of what an individual views in real life. Such technology is already in use in museums or public landmarks in certain cities (Bower, Howe, McCredie, Robinson, & Grover, 2014). This technology may have the potential for building vocabulary knowledge in adolescents with IDD and limited speech if it could provide additional, familiar information to which the adolescent can connect new experiences.

Another way AAC technology may be able to build language content skills is through the just-in-time programming of vocabulary for adolescents with IDD (Holyfield, Caron,

& Light, 2019). Using onboard cameras that interface with AAC apps, VSDs and video VSDs can be programmed with content of interest to adolescents with IDD just-in-time (Holyfield, Drager, Light, & Caron, 2017). By programming content just-in-time, or in the moment in which it is of interest to the adolescent (Schlosser et al., 2016), SLPs can capitalize on times of engagement that are so critical to language learning and can be infrequent in beginning communicators (Paul, 1997). By programming a word for a concept on AAC technology in the moment in which an adolescent demonstrates interest in the concept, it might support that adolescent in learning the associated vocabulary by using it. Research suggests that programming VSDs just-in-time can be used to increase single-word expression from adolescents with IDD who are beginning communicators (Holyfield, Caron, Drager, & Light, 2019).

### ***Compensating for limitations in language use***

One way to support participation in adolescent life for individuals with IDD and limited speech is by using AAC technology to compensate for limitations in language use. Navigating social interactions and taking an active role in those interactions can be a struggle for adolescents with IDD and limited speech (Lund & Light, 2007). In addition to serving as a communication modality, AAC technology also can serve as the communicative context. For instance, VSDs and video VSDs of life events can create a context about which an adolescent with IDD and communication partner can communicate. With VSDs and video VSDs serving as the interaction context, opportunities for communicative turn-taking can be built into the interaction. These built-in opportunities can prompt adolescents with IDD to take communicative turns without requiring them to rely on pragmatic skills for determining specific times and purposes of communication within an interaction. Evidence shows that such built-in opportunities with video VSDs can support adolescents with IDD in taking communicative turns

within educational and community contexts (Babb, Gormley, McNaughton, & Light, 2018; O'Neill, Light, & McNaughton, 2017). Such supports may be helpful for a range of adolescents including adolescents who are in the beginning stages of building symbolic language to adolescents with strong skills in language form and content who struggle primarily with pragmatics.

Augmentative and alternative communication technology also can compensate for limitations in language use by serving as a communication partner support. Adolescents with IDD who are beginning communicators may demonstrate low rates of communication (Iacono, Carter, & Hook, 1998). For these adolescents, the communication they do demonstrate may be highly idiosyncratic and difficult for others to interpret (Grove et al., 1999). For these adolescents, AAC technology can compensate for limited language use by housing photographs and videos to train communication partners about their idiosyncratic communication. Research suggests that AAC technology employed for this purpose is effective in teaching communication partners to appropriately interpret communication attempts (Holyfield, Light, Drager, McNaughton, & Gormley, 2018). In this way, AAC technology can support successful interactions between adolescent beginning communicators and their communication partners without requiring an increased use of formal language from the adolescents.

In addition, one demand of language use for in-person interactions is timing of communication turns, with which individuals with IDD struggle. Augmentative and alternative communication technology can compensate for this limitation in language use by interfacing with programs for online interaction (e.g., social media). Using language online can allow for success without requiring mastery of the rules of language use for in-person interactions (Caron, 2016) because it is often asynchronous.

Finally, one limitation to language use in adolescents with IDD and limited speech is that peers are less likely to interact with

them at school (Chung, Carter, & Sisco, 2012) where much social interaction typically occurs (Nippold, 2000). Photographs and videos in AAC technology may be viewed positively by and be of interest to peers, given these modalities' ubiquity in popular culture. Therefore, just by using such technology, it is possible that adolescents with IDD and limited speech will have more opportunities for meaningful interactions with peers.

### ***Building language use***

Augmentative and alternative communication technology also can build skills for language use in adolescents with IDD. An important use of language in adolescence is expressing opinions and choice making. Using AAC technology, visual representations of choices can be offered to adolescents who are beginning communicators and struggle with making choices. Upon selection of a choice, voice output provides auditory feedback and confirmation of a choice. Paired with responses from communication partners contingent on the adolescent's choice (Paul, 1997), the technology could be useful in building understanding and use of choices.

Skills for language use also involve social skills, social decision-making, self-advocacy, and understanding of social norms. For adolescents developing these skills, AAC technology can be beneficial by accessing online resources to teach them (e.g., videos for adolescents who are preliterate, short articles for those with functional literacy). Research suggests that online training can be useful in building social problem solving in adolescents with IDD and limited speech. McCarthy et al. (2007) completed a study with five adolescents and young adults who used AAC. Using an online instructional program, all five participants learned to apply problem-solving techniques to hypothetical social problems. This was a skill they both generalized to problems in their own lives and maintained months after completing the online program.

As language use is largely learned through participation in the contexts of life (Light, 1997; Rogoff, 1990), AAC technology to in-

crease access to language within real-life interaction contexts may be useful in increasing skills in language use. Evidence has shown that AAC technology can be useful in increasing adolescents' participation in peer interactions during leisure activities. For instance, Trottier, Kemp, and Mirenda (2011) used AAC technology and teaching to build communication between adolescents with IDD and limited speech and their typical peers during board game play. Augmentative and alternative communication technology may be a powerful tool for building skills in language use as it is difficult to learn to use language when one does not have access to a reliable modality.

Augmentative and alternative communication technology also can house and interface with video technology that may be useful in teaching language use. For example, although results are currently inconclusive, research suggests that point-of-view video modeling can support social communication and interaction in some individuals with autism (Lee, 2015). Such point-of-view videos could be easily incorporated into AAC technologies, for instance, through the use of video VSDs.

### **EXAMPLE CASE APPLICATIONS**

Below are two case examples of adolescents with IDD and limited speech benefiting from AAC technologies. The names in the cases are pseudonyms, and each case is based on one to two adolescents familiar to the authors who are using the described supports and thus represents a composite case. The adolescents have very different language needs, yet they share the experience of adolescence and the goals of participation and increased independence inherent therein.

#### **Anthony**

Anthony is a 14-year-old high school freshman with autism spectrum disorder. He lives at home with his parents and younger brother. Anthony spends his school day largely included in general education although he is in special education classes for

language and reading. One day a week Anthony attends martial arts classes with other adolescents with autism. The group of adolescents occasionally showcase their martial arts skills in public performances. They also get together monthly to do other activities, such as beginner woodworking projects. Most days after school, Anthony spends his free time on the Internet researching his favorite topic—plumbing. In particular, Anthony has a strong interest in faucets and asks everyone he meets, “How many faucets are in your house?” Anthony uses speech to communicate a set number of repetitive phrases such as this question. However, he also uses a tablet to communicate novel thoughts. Although he has a grid display AAC app on his tablet with many preprogrammed messages, Anthony’s literacy skills allow him to mostly use the keyboard on the app to generate messages by typing them. He averages 3.5-word utterances when communicating using his app. See Figure 1 for example screenshots from Anthony’s communication app.

### *Language form for the interpersonal*

Limited narrative skills placed large restrictions on Anthony interpersonally. Without strong narrative skills, Anthony struggled to provide rich descriptions to others about

his life experiences and his interests. Consequently, he struggled to build social bonds with others using language (Light, 1988).

Augmentative and alternative communication technology compensated for Anthony’s limitations in narrative language to increase the richness of his interactions with others. For example, Anthony and his family members capture video of fun and interesting events from Anthony’s life such as his martial arts classes. When used as video VSDs on his AAC device, the videos provide Anthony’s communication partners with vivid imagery of his participation in the classes. When interacting with the contextual support from the video VSDs (Light et al., 2014), a visual narrative is built into the interaction and does not have to be expressed using Anthony’s existing language skills. In this way, Anthony is able to lead and participate in lengthy and rich interactions with peers, friends, and family about an important aspect of his life despite having yet to develop the sophisticated narrative language skills adolescents typically employ to do so (Caron, Holyfield, et al., 2018).

Augmentative and alternative communication technology also has supported Anthony’s building of narrative skills. When given photograph and video prompts related to his interest in plumbing from his SLP, Anthony



**Figure 1.** An example of a custom high-tech augmentative and alternative communication display created to support an adolescent communicator with some orthographic knowledge and particular interests. This display corresponds to the case of Anthony, who uses a combination of a keyboard and grid display with preprogrammed phrases (image on left) and frequently communicated, personally relevant words (image on right).

practiced writing narratives using his AAC app—both through keyboard typing and word-by-word writing using his grid. The text he generated in the app prompt-by-prompt was copied into a text document within which Anthony could create a cohesive narrative with support from his SLP. In this way, Anthony used his AAC app to work toward building his narrative language skills.

### ***Language content for self-expression***

Limited receptive understanding and expressive use of words related to Anthony's inner thoughts and feelings restricted his self-expression. Despite having a strong personality and dry sense of humor, Anthony struggled to share that fully with others. It was mostly his closest family members who knew him very well who were familiar with his true self.

Augmentative and alternative communication technology compensated for Anthony's limited understanding and use of words to express his emotions. For example, Anthony has a frustration page on his AAC app, created and regularly updated by his siblings. This page contains alphabetically ordered exclamatory words for Anthony to use when he feels frustrated. Without the need to generate language about his emotions, when Anthony is frustrated he can navigate to this page and select any of the options to convey to his family or others the seriousness of his feelings. Alternatively, Anthony uses the page to showcase his humor when spending time with his martial arts friends group. Peers familiar with the page are always interested in hearing the inventive exclamatory words and phrases programmed within it and, in particular, the combinations of those words and phrases Anthony creates.

Augmentative and alternative communication technology also has been a useful tool in building Anthony's language content skills related to self-expression. His SLP uses clips from one of his favorite TV shows, the Big Bang Theory, to depict various dramatic scenarios. Anthony then views the clips in an AAC app as video VSDs and, using the keyboard for text output, engages in guided practice to program hotspots onto the videos

with emotion words describing the feelings of the various characters at different points in the clips. In this way, the AAC technology serves as a video-training modality (Holyfield et al., 2018) to build Anthony's knowledge and skills.

### **Cecilia**

Cecilia is an 18-year-old woman in her final year of school with multiple disabilities affecting her motor, perceptual, and cognitive profiles. She lives with a foster family but will soon age out of that service and will transition to living in a group home. At school, Cecilia spends her day in a self-contained special education classroom for individuals with multiple disabilities. After school, Cecilia spends time on the floor playing with sensory toys, listening to books being read by a foster parent, or watching TV. She also takes trips to the park or out into the community with her foster family and seems to really enjoy doing so. Cecilia does not use any speech. Her use of language is emerging through the occasional selection of single-message buttons on an AAC device that were preprogrammed with speech. However, this selection occurred at times when the button was placed in front of her by a classroom professional and she was prompted to do so. Much of her communication is done through prelinguistic behaviors including facial expressions, vocalizations, and body movements.

### ***Language content for education***

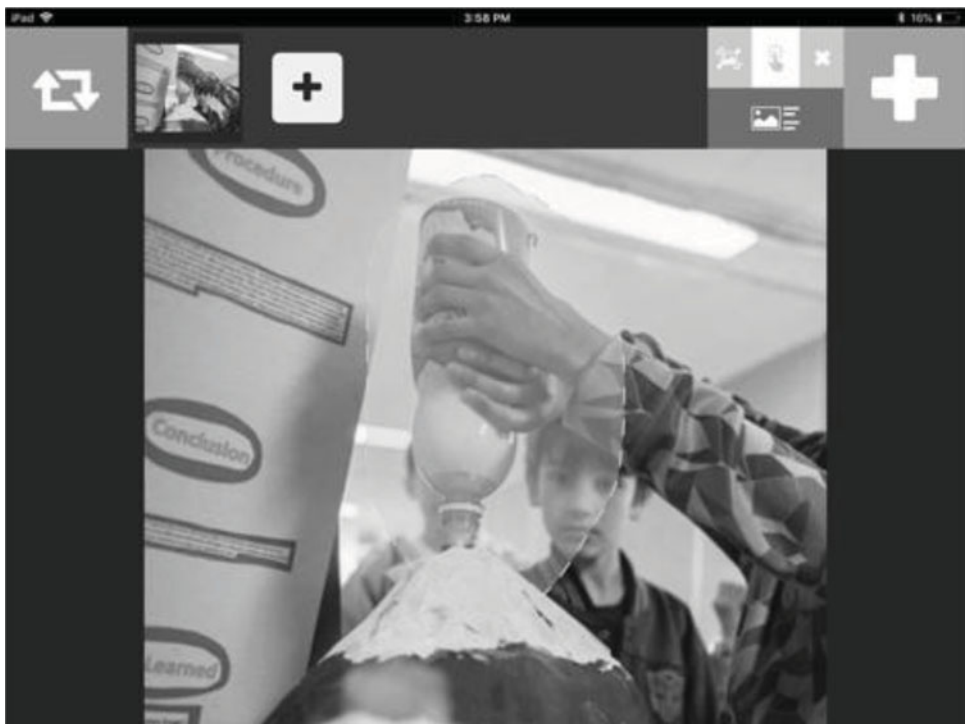
Cecilia appears to have a limited understanding of words and uses only a handful of words expressively with consistency. Also, she has had very different experiences in the world than most adolescents, spending more time receiving medical treatment in hospitals than relaxing on family vacations. These different experiences result in vastly different and limited background knowledge to bring to the educational setting.

Cecilia has benefited from AAC technology to compensate for her limitations in language content to participate educationally. She uses the technology to play integral roles in

small- and large-group classroom activities. For instance, if the class is completing a science experiment involving creating basic chemical reactions (e.g., combining baking soda and vinegar), the SLP can preprogram each step in the experiment as a photograph or video VSD model. This allows Cecilia to serve as the leader of the group activity, presenting each step to the rest of the group visually. In addition to the visual presentation, her selection of hotspots on the VSDs allows Cecilia to provide auditory instructions for her peers to complete the step. This role also suits Cecilia as her physical limitations make her manipulation of the materials difficult. However, with her AAC technology, Cecilia can participate meaningfully in these educational activities with peers even if she still may be working toward the receptive and expressive

vocabulary to do so without such compensation. This participation is valuable not only for Cecilia's social life but also for her learning (Chinman & Linney, 1998). Although disciplinary literacy, or curricular content literacy, is often seen as a last piece in literacy development, with appropriate supports, adolescents who are beginning communicators and in earlier stages of literacy development can still engage in these types of literate activities. See Figure 2 for an example screenshot of Cecilia's communication app to support her participation in this activity.

In addition, AAC technology has supported Cecilia in building language content. To teach Cecilia a new word from her educational program, her SLP gathers photographs and videos from the Internet and from Cecilia's life and imports them as VSDs and video VSDs on her



**Figure 2.** An example of a custom high-tech augmentative and alternative communication display created to support an adolescent at the beginning stages of communication. Specifically, this is an example of a visual scene display for Cecilia for use when participating in a classroom science activity. The circle represent a hotspot with a preprogrammed message. For example, this visual scene could be programmed to say “explode.”



AAC app. When capturing VSDs from academic contexts in which Cecilia is currently engaged (e.g., completing vocational tasks within the school), her SLP engages Cecilia in the just-in-time programming of those VSDs (Holyfield, Drager, Light, et al., 2017; Holyfield, Caron, & Light, 2019; Schlosser et al., 2016). This helps Cecilia see more explicitly the connection between the referent within her educational context and the word as it becomes programmed.

### *Language use for autonomy*

Cecilia experiences difficulty engaging and maintaining interactions with conversation partners who are not highly familiar with her idiosyncratic behaviors. The idiosyncrasy of much of her communication also makes it difficult for her to exert her will and influence those around her (Iacono et al., 1998). Given her physical limitations, these restrictions in language use severely limit Cecilia's ability to exercise the autonomy that is often expanding rapidly in adolescence (Carroll et al., 1997).

Augmentative and alternative communication technology has supported Cecilia in exercising autonomy by compensating for her limitations in language use. One important way the technology has done so is by serving as a communication partner support. Because of her language limitations, much of the onus of success in interactions with Cecilia falls upon her communication partners (Grove et al., 1999). Therefore, as is often a powerful approach to AAC intervention (Kent-Walsh, Murza, Malani, & Binger, 2015), educating and supporting her communication partners had a noteworthy impact on her equal participation in interactions and success in having her preferences and opinions known and addressed. For instance, Cecilia's family and SLP captured video examples on her AAC device of her showing a strong preference for a given activity and examples of her expressing preferences against activities. Those videos then served as training materials for communication partners (Holyfield et al., 2018). Using those videos, partners were taught how to recognize when Cecilia is using commu-

nicative behavior suggesting that she wants to continue an activity or when her behavior suggests that she would prefer switching activities. With this information, Cecilia's idiosyncratic behavior gained power over communication partners as they began making decisions based on her expressed preferences. In this way, AAC technology allowed Cecilia's autonomy to grow without requiring increased skills in language use to do so.

Augmentative and alternative communication technology also has supported Cecilia in building skills around language use for enacting autonomy. Within different areas of her classroom and rooms of her home, large printed photograph VSDs of Cecilia engaged in activities that occur within those areas were posted. For instance, in the "media" area of the classroom, photographs were posted of Cecilia dancing along to music, listening to an audiobook with headphones, and reading a book. Within this area of the classroom, Cecilia has learned to reach for or touch these large photographs to make choices about her leisure activities during free time.

### CONCLUSION

Positive social participation is critical to desired outcomes in and beyond adolescence (Chinman & Linney, 1998). All adolescents should be supported in such positive experiences, including adolescents with IDD and limited speech and language. Supporting language is one way to do so. Augmentative and alternative communication technology can be used as an intervention tool to compensate for limited skills in language form, content, and use. It also can be used as a skill-building tool. When approaching intervention through both avenues, SLPs can maximize success for adolescents with IDD, both immediately and in the long term.

To do so, SLPs should consider the following guiding principles. First, identify the adolescent's strengths and needs in language form, content, and use. Second, consider how those strengths and needs are impacting the adolescent's educational/vocational

participation, interpersonal relationships, autonomy, and self-expression. Third, identify and exploit opportunities—including the use of AAC technology supports—to promote an immediate increase in participation in each of those areas in ways that are meaningful and motivating to the adolescent. These opportunities will build on strengths and/or circumvent limitations in the adolescent's language form, content, and use. Fourth, identify skills in language form, content, and use that, if learned by the adolescent, would have a significant, meaningful impact on the adolescent's success relative to education and employment, interpersonal relation-

ships, autonomy, and/or self-expression in adolescent and/or adult life. Fifth, intervene to build those skills with the help of AAC technology. Finally, continuously judge the success of AAC intervention for the adolescent using observed increases in the adolescent's real-life educational/vocational pursuits, interpersonal relations, autonomous activity, and self-expression. Continue the iterative and recursive process of intervention implementation and data gathering and analysis until the adolescent's participation in each of these areas is maximized to an extent that is comparable with that of typical peers.

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