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Growing Up With Technology
Does the Device Go in the Middle?

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The increasing integration of technology into the daily events and social interactions of our society present incredible opportunities for children with complex communication needs (CCN) who rely on augmentative and alternative communication (AAC) strategies. Children with CCN who utilize high-tech AAC options at an early age are essentially growing up with a technology that is inserted into interactions across multiple contexts for communication. An aided system can potentially create additional demands, serve a complementary role, or even be a platform to create a collaborative space for social interaction. This article discusses the impact of technology on contexts for communication and presents a progression from unaided AAC strategies to the use of aided systems for fostering expressive language skills and supporting participation. Augmentative and alternative communication strategies offer many possibilities in terms of access to communication; however, where a device is placed both physically and figuratively can make an important difference. **Key words:** *augmentative and alternative communication (AAC)*, *complex communication needs*, *language development*, *modeling*, *technology*

THE INTEGRATION of technology in our digitally connected world with the daily lives of people continues to increase (Miranda et al., 2015). Integration creates interactive causes and effects that can be difficult to predict and track (Mcmillan & Morrison, 2006). As technology continues to develop and expand, new tools are introduced with applications promising to improve an individual's life by making things "easier" or "better." The extent to which a piece of technology or technology application can achieve changes in quality or efficiency is an important part of understanding its success (DeLone & McLean, 1992). In many cases, the "thing" that technology is aiming to improve is often known in advance. This prior knowledge allows the technology to be uniquely designed to be of assistance (Institute of Medicine, 2007). In the case of language, there are technologies to aid note-taking, writing, organization, memory, reading, and communication (Forgrave, 2002). Technologies that directly support communication allow individuals to connect and exchange ideas or information and to build social relationships that can add layers of intricacy and ripples of lasting impact to people's lives (Boyd, 2015). Technology can give individuals access to a large amount of information very quickly. There are now so many options that sorting from among the range of potential technology tools can be more difficult than the problem of having no options (Jarvenpaa & Lang, 2005). Technology is mediating interactions in a myriad of new ways. It is important to consider "Is technology that is 'in the middle' of interactions creating a barrier or truly facilitating new and better relationships?" The question appears to be an open one or at least one in which one might say, "it depends" (Jarvenpaa & Lang, 2005).

For language and communication in particular, the fit between communication needs and technology is key to success

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(McNaughton & Light, 2013). This fit is particularly important when working to support individuals with complex communication needs (CCN) who rely on augmentative and alternative communication (AAC) to express their daily wants, needs, thoughts, and opinions. Individuals with CCN include children and adults who are unable to meet their communication needs with natural speech due to developmental disabilities (e.g., Down's syndrome, autism spectrum disorder), acquired disabilities (e.g., stroke, traumatic brain injury), progressive disorders (e.g., Lou Gehrig's disease), and temporary conditions (e.g., tracheostomy). When considering AAC, some needs are easily identified by looking around one's individual environment. Who are the people someone needs to talk with on a regular basis? What topics do they need to discuss? When and for what purpose? Via what modality? After an immediate set of communication needs is identified, ongoing needs are ultimately dynamic. Individuals move in and out of people's lives, social roles change, and the requirements for different words and sentence structures are altered on the basis of a variety of factors (Light & McNaughton, 2014). As such, it is necessary to consider how to continually assess and refine AAC technologies to meet the needs of children and adolescents with CCN who are growing up with technology. A truly "smart" piece of technology would respond to a person's needs not only defined at a single point in time but also based on changing needs in different contexts (Miranda et al., 2015). Contexts are critical considerations for technology, especially in the lives of young people with disabilities.

In this article, we consider how technology interacts with context, first, by examining contexts for communication and, second, by examining the implications of inserting a physical object used for communication purposes (i.e., an AAC device) into communication contexts. We consider the impact of an AAC device by looking at an interaction where no device is present but communication is augmented through other means, to interactions where a single device is introduced but in ways that could create a barrier, to a complementary context where an AAC device is used to achieve a single goal, and finally to a collaborative space where the technology itself becomes a part of the context. The discussion is aimed at considering what it means for technology to be "in the middle" of interactions.

THE PRESENCE OF TECHNOLOGY IN CONTEXTS FOR COMMUNICATION

Children develop language and social skills through interactions with others in their environment (Tomasello, 1999; Vygotsky, 1978). These interactions are in fact shaped by the surrounding context. Inspired by Vygotsky, Light (1997) proposed five interrelated contexts for communication to occur: physical, functional, language, social, and cultural. Briefly, the physical context is the objective environment that surrounds a child and the functional context is the structure of a child's regular activities and interactions with others. The language context is the linguistic code used in the child's environment. The social context is created by the interactions between the child and others, and, finally, the cultural context is the family, community, and social values in which the child lives (Light, 1997).

As technology has continued to advance, it can be argued that it has become increasingly integrated into each of these contexts. For example, with increased access to technology around the world, it has a greater presence in the physical environment of many children and is often incorporated into their functional context as well (e.g., a routine of watching videos in the car on the way to school). The capabilities of digital tools, such as the smartphone, have grown to include not only audio but also text, photographs, graphic animated images, and video communication capabilities. Young children are reading and writing on the screens part of mobile, and touchscreen devices (Neumann & Neumann, 2013) and learning to browse, view, navigate, and interact with digital technologies as they are exposed to a broad range of technological

devices (Burnett & Merchant, 2013). Research is now being conducted to explore the emergence of children's digital literacy practices and collaborative play in virtual worlds (Black, 2010; Wohlwend, VanderZanden, Husbye, & Kuby, 2011). These interactions with technology contribute to development of early digital literacy skills (i.e., tapping images, swiping to navigate, etc.), which are an aspect of language context. Technologies also have become increasingly connected to social media platforms for sharing of digital content and supporting interactions between individuals worldwide. These devices are now also capable of augmenting reality and opening contexts within virtual worlds. Culturally, interactions with technology are more frequent and often expected in a range of environments. Multiple languages can now be accessed, learned, or translated. As such, children may observe and be a part of interactions that include a range of communication modalities that were not available 20 years ago. As technology will likely continue to insert itself into interactions in society, it is necessary to consider how to leverage these tools to support children with CCN in developing language and participating in meaningful social interactions. The baseline for understanding communication interactions and AAC is an examination of the context when there is no additional physical object (i.e., communication boards, AAC device).

NOTHING IN THE MIDDLE: NO ADDITIONAL PHYSICAL DEVICE PRESENT

Figure 1 displays some different possibilities with communication between two boys. In Figure 1A, there is no technology and communication is face-to-face. When communicating through natural speech in face-to-face interactions, speech signals are amplified, dampened, nuanced, or otherwise altered by facial expressions, gestures, and body positions (proxemics) in a concert of activity for simultaneous visual and auditory processing by a communication partner. Such augmenting techniques are classified as "unaided" AAC because they do not require any external equipment. Unaided AAC is an important part of AAC, as it assists someone in effective communication. Facial expressions and gestures are immediately in-line with attention to a person's face as speech is processed. Because there is no external equipment, there is no additional object to draw attention during an interaction. A focus on signals is a key building block for early communication development.

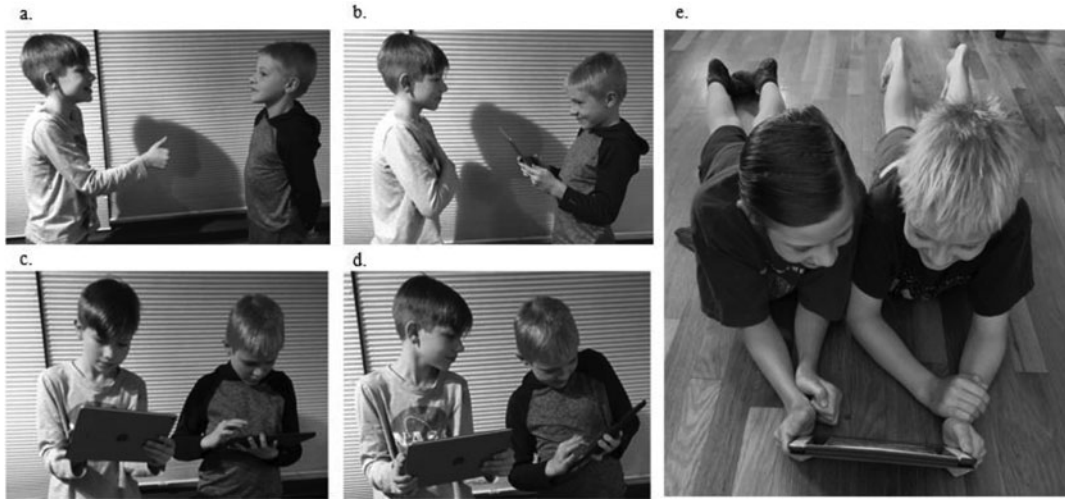

Figure 1. Five different interactions with different levels and placements of technology.

Paul (1997) suggested that for beginning communicators, an emphasis should be placed on pragmatics and engagement in interactions with others. Early pragmatic targets include eye contact, turn-taking, and joint attention. Joint attention in particular is important for language learning and includes skills such as sharing, following, and directing attention. These skills lay the foundation for language learning and typically emerge during a child's first 2 years (Tomasello, 1999). In working with beginning communicators, it is critical to coordinate team expectations and responses relative to early signals from children who are at risk for communication challenges (Cress & Marvin, 2003).

Unaided skills are frequently a given priority with beginning communicators who experience difficulties in speech and/or language development. Interventions including Joint Attention Symbolic Play Engagement and Regulation (JASPER; Kasari, Paparella, Freeman, & Jahromi, 2008) and Enhanced Milieu Teaching (EMT; Kaiser, Hancock, & Neitfeld, 2000) are often utilized to target unaided skills. Unaided AAC is not replaced by aided (ones that require some kind of external equipment) AAC. The type of AAC modality used must fit the situation, needs, and resources (McCarthy & Hajjar, 2017). Just because unaided AAC may provide useful foundations for beginning communicators, there is no need to abandon supports when children grow older. In some cases, forcing aided AAC into certain situations is inadvisable. For instance, there are states that prohibit the use of a cell phone with anything but a hands-free interface while driving. The activity of driving demands attention and errors create safety issues. Communication is not banned while driving, but the use of communication devices that distract the driver significantly from driving are. The device cannot go in the middle of driving, but other communication modalities are used. As another example, Hajjar, McCarthy, and Hajjar (2018) discussed the need for utilizing aided AAC before and after an adapted horseback riding program but emphasized the usefulness of unaided AAC while riding. For example, the idea of watching a person's natural signals such as facial expressions and vocalizations to indicate happiness or wariness was already a part of adaptive sports for volunteers who knew their participants well; it was finding ways to communicate outside of the riding ring that held more promise for expansion (McCarthy & Hajjar, 2017). Other adapted recreational activities such as skiing and kayaking also demonstrated the same need for considerations of communication modalities fitting different phases of the activity (Hajjar, McCarthy, Benigno, & Chabot, 2016). Participants could use a head nod or head shake when skiing, but it was not possible to activate a high-tech device while in motion down the hill. On the contrary, there were ample opportunities for communication in the lodge before a downhill run or even on the ski lift (McCarthy & Hajjar, 2017).

TECHNOLOGY IN THE MIDDLE: ADDING TO DEMANDS

In Figure 1B, consider the example where one boy has an AAC device and the other boy does not. This is a traditional and typical case for current face-to-face interactions involving AAC. In studies of attitudes of children toward other children using AAC, this traditional paradigm of a child using a device that goes between a child not using one is the given situation to which attitudes are evaluated (Beck, Fritz, Keller, & Dennis, 2000; McCarthy & Light, 2005; Smucker, McCarthy, Benigno, & Boster, 2018). Generally, the type of AAC system (aided or unaided, shorter messages or longer messages) is not as influential in shaping attitudes as previous experience with individuals with disabilities or with the respondent's gender, but type of AAC does interact with other factors (McCarthy & Light, 2005). Aided AAC occupies physical space and its presence between the two communicators makes the device become an object of focus (Benigno & McCarthy, 2012).

The extent to which the AAC device becomes an object of focus can impact the

ability of beginning communicators to coordinate their attention between their communication partner and objects in the environment (Benigno & McCarthy, 2012). Typical joint attention interactions involve a communication partner and a target object. Children who use AAC, however, must coordinate their gaze not only with their communication partner and the target object but also with the aided communication system. This results in a quadratic rather than triadic interaction episode (Benigno & McCarthy, 2012). This additional gaze point can place additional cognitive demands on children. These demands may be mediated by adjusting the type of joint attention—passive or coordinated—targeted as well as how an AAC device is oriented in the environment. Bakeman and Adamson (1984) proposed that joint attention could be passive or coordinated. In passive joint attention, an individual attends to an object at the same time as another individual without attempting to interact. Coordinated joint attention involves shifting attention between an object and an individual who also is attending to the target object. Passive joint attention emerges earlier and is less demanding, so this may be the kind of interaction episode in which to first introduce an AAC device for young children with CCN.

Joint attention with an AAC device can be facilitated by modifying its location in an interaction (Adamson, Bakeman, & Deckner, 2004; Benigno & McCarthy, 2012; Smith, McCarthy, & Benigno, 2009). Smith et al. (2009) specifically explored the impact of AAC device location and the frequency and duration of children's passive and coordinated joint attention episodes during a shared book reading activity. Participants in the study included 16 children ranging from 9 to 14 months of age who were able to participate in joint attention routines with caregivers. The study presented (a) an aligned condition in which the child was seated across from the researcher at eye level while the researcher held the AAC device under his or her face to align with his or her gaze and (b) a divided condition where the child was seated at eye level with the AAC device to the side on the floor. Results of the study indicated a significantly greater frequency of coordinated joint attention during the aligned condition, though there were no differences in duration. The findings suggested that pairing an AAC device with adult gaze could support joint engagement for beginning communicators. Additional tools for supporting early social interactions with AAC include the use of switch-activated toys, single-message systems (e.g., BigMack switch with a single programmed message), and visual scene displays (VSDs; AAC interface that utilizes a photograph with embedded hotspots that produce a message). Pairing a device with an adult's eye gaze helps move the device out of the middle of interactions by sharing physical space with the person who models use of the AAC system by talking and activating key messages on the device to show how generated messages match the spoken contribution.

It is important to note that the presence of an AAC device does not make the system unwelcome or unsuccessful. Providing aided AAC early across contexts has been found to play a critical role in language development (Kasari et al., 2014). Kasari et al. (2014) specifically compared intervention approaches with combinations of JASPER, EMT, and speech-generating devices (SGDs) in a sequential multiple assignment, randomized trial of 61 minimally verbal children, aged 5–8 years, with autism spectrum disorder. Results indicated that beginning intervention with SGDs resulted in more spontaneous communicative utterances than those beginning only with spoken language (Kasari et al., 2014). Based on these findings, it is necessary to begin to explore how to incorporate aided strategies, such as SGDs, early in interactions for children with CCN.

Provision of an AAC device does not need to wait for some magical threshold so that a child is "ready" for handling more complex attention dividing episodes, but understanding the demands placed on children's sensory, cognitive, and linguistic skills can help find the best match in developing AAC solutions (O'Neill & Wilkinson, 2019). There has been a focus

on careful design of AAC devices in terms of their interface (Light, Wilkinson, Thiessen, Beukelman, & Fager, 2019), but it is also important to consider the location and function of a device within the physical space of interactions. Unless the progression is through formal sign language, which is its own rule-based language, aided AAC is required to transition to use of more complex syntax, morphology, and writing. As AAC devices are introduced, it is important for speech–language pathologists (SLPs) to not only target current goals but also continue to assess and prepare for progression. Early experiences with AAC can provide SLPs and other educators (e.g., special education personnel, occupational or physical therapists) with opportunities to begin to evaluate individual characteristics that may impact future decisions about AAC devices as a child grows. These characteristics can include a child's motor skills, hearing, vision, and cognition (O'Neill & Wilkinson, 2019). Attention to potential barriers from early stages of AAC implementation can allow for planning relative to future alternative access needs and device selection. For example, young children with cerebral palsy may initially spend time on the floor and access switches that are within their reach, but access to these technologies will likely need to change as seating and positioning is improved (Costigan & Light, 2010) or as they obtain appropriate mobility aids.

THE DEVICE AS A COMPLEMENT: MODELING LANGUAGE SUPPORTS COMMUNICATION GROWTH

In Figure 1C, both boys are using AAC devices. In this interaction, there are several possibilities: both could use the devices to communicate expressively to each other via voice output exclusively; both could use the devices to communicate by sending messages from one device to another without voice output; one could use the system to communicate exclusively and the other could communicate with both natural speech and the system; both could be doing completely independent actions and just happen to be next to each other; or any combination of the aforementioned. The situation in this panel is more similar to traditional language learning paradigms. Both children are using the same mode of communication. Because there are a number of possibilities within this situation, including the possibility that the boys are engaged in independent activities, Figure 1D represents a clearer situation where one of the boys appears to be offering assistance or commentary. The possibilities offered through a person with access to natural speech modeling the use of aided AAC is of particular interest, because it creates the role of a device as a complement to interactions. In Figure 1D, both boys have access to a device. This is sometimes the case and may be the ideal one from the perspective of language learning. In other cases, there is only a single device and the partner who wants to provide assistance needs to manage a face-to-face interaction, while still trying to assist.

Modeling interventions are critical in supporting children with CCN in their use of aided AAC to result in gains across social and linguistic domains (Sennott, Light, & McNaughton, 2016). While children without disabilities receive consistent spoken models from their communication partners that facilitate the development of speech and language, children using aided AAC receive spoken input with the expectation of producing language via an AAC device (Smith, 2015). This results in input–output asymmetry (Smith & Grove, 2003) and that is problematic from a traditional language development point of view (Light, 2003; Smith, 2015). Modeling the use of AAC is a technique to reduce input–output asymmetry and can involve a communication partner simultaneously pointing to symbols and speaking a target word. Similar to second language acquisition, a partner would not speak in English but expect responses in Spanish without any models. The idea of AAC modeling is to provide input in both linguistic areas (the environmental language to learn receptively and the linguistic code of the AAC system to produce expressively). Although not well explored, modeling may still assist

individuals with motor impairments who use AAC because the linguistic codes are still being analyzed, even though the method of access is different (Boster & McCarthy, 2017a, 2017b).

Modeling interventions lead to more of a bridge between spoken input and the expected output with an aided system, in contrast to the role shown in Figure 1B. Modeling techniques can include imitating, labeling, expanding, and extending children's utterances (Sennott et al., 2016). Various types of models exist and can be adapted for teaching vocabulary (Solomon-Rice & Soto, 2014), multiword messages (Binger & Light, 2007), and grammatical morphemes (Binger, Maguire-Marshall, & Kent-Walsh, 2011). Solomon-Rice and Soto (2014) compared two modeling techniques, focused stimulation and augmented input, as methods for increasing expressive vocabulary of three toddlers beginning to use AAC. The techniques were used to explore increasing expressive production of words when the children already understood the meanings of the spoken words. Focused stimulation consisted of providing 10 models of a target word within an activity, contrasted to the augmented input condition, in which 10 models of the target word were provided while activating the child's AAC device. Models were provided in the context of child-centered activities. Results indicated that both modeling approaches increased autonomous production of target vocabulary for two of the three participants but that more significant benefits were seen from augmented input for the one participant who did not reach criterion. The findings support further investigation of the benefits of both approaches as methods for increasing vocabulary for children using aided AAC. The approach highlights a particular issue related to modeling that emphasizes single words, modeling to address language comprehension, and modeling as a way to scaffold more extensive syntactic forms (Allen, Schlosser, Brock, & Shane, 2017).

In addition to developing vocabulary, modeling strategies can support communication growth by increasing utterance length and complexity. For example, Binger and Light (2007) specifically explored the use of aided AAC modeling as a technique for increasing multisymbol messages for five preschoolers who used AAC. As part of the intervention, aided AAC models were provided by touching a combination of two symbols on the child's device. The symbols were labeled and then a spoken model for the combination was provided. Results indicated an increase in multisymbol messages for four of the five preschoolers, supporting the effectiveness of AAC modeling. In a study by Binger, Kent-Walsh, Ewing, and Taylor (2010), teaching modeling skills to educational assistants was also an effective strategy to increase multisymbol productions. The strategy taught to assistants involved learning to execute three different two-symbol models before prompting a student to try. Although multisymbol messages provide additional depth in communication exchanges, it is necessary to continue to expand children's lexical and grammatical skills and reduce telegraphic messages with provision of grammatical morphemes. Binger et al. (2011) used aided AAC models in addition to recasting and contrastive targets to teach grammatical morphemes to three children using AAC. The intervention utilized story reading activities to provide models and recasts of targets including plural *–s*, past tense *–ed*, and possessive *–s*. During intervention sessions, children were provided with at least 10 aided AAC models and recasts. In the initial intervention phase, children were presented with sequential targets and results indicated that all three children reached proficiency, but their skills were not maintained. In the second phase of the intervention, children were provided with the opportunity to contrast two different grammatical morphemes. This allowed children to learn the difference between markers and use them correctly. These findings highlight the need to provide opportunities for children using aided AAC to develop skills in discrimination that further refine their expressive communication skills.

In addition to increasing expression, aided input has been used to effectively support language comprehension (Drager et al., 2006; O'Neill, Light, & Pope, 2018). Interventions that include aided input with SGDs have yielded greater effect sizes than those with non-SGDs, which are likely due to the added source of input (O'Neill et al., 2018). The success of modeling interventions has been attributed to factors such as increased emphasis or stress on target words, slowed rate of communication that allows a listener more time to process interactions, and the ability to embed targets in child-directed activities (Binger & Light, 2007; Solomon-Rice & Soto, 2014). Despite the evidence for the benefits of modeling, a limitation of these interventions to date is the demand it places on the communication partner. Strategic teaching can help reduce the demands. A meta-analysis by Kent-Walsh, Murza, Malani, and Binger (2015) revealed that partner training was effective in teaching modeling techniques to a range of communication partners including caregivers, educational assistants, parents, peers, and teachers. The meta-analysis indicated that partner training was particularly beneficial when a strategic approach to partner instruction was undertaken. As technology continues to advance, there may be additional methods to explore for providing models using the device itself.

Managing AAC device location both during interactions and interventions is critical for interventionists working with children with CCN (e.g., SLPs, special educators). Like the communicators in AAC interactions, the interventionist must manage multiple points of focus that the AAC systems must support if an individual is to progress and thrive as a communicator in the world. As discussed previously, situating an AAC device in the middle of an interaction may be beneficial for supporting joint attention and potentially reducing additional demands with an added gaze point (Smith et al., 2009). Although the specific physical location of the AAC device is not often explicitly defined in the current literature on modeling interventions, SLPs and other interventionists should consider situating devices in a way that supports an individual's attention. For modeling interventions to be effective, it is important for children with CCN to attend to the concept that is serving as the referent and the associated model provided by the SLP or communication partner. Future research is needed to continue to explore the impact of device location on facilitation of joint attention and the success of modeling interventions.

THE DEVICE AS A COLLABORATIVE SPACE: ENHANCING A FACE-TO-FACE RELATIONSHIP

In Figure 1E, the boys are next to each other using a single AAC device. The suggestion is of working together jointly and equally toward some common goal. The ubiquity of digital devices and the use of mainstream technologies in AAC have created a potential equalizing force capable of bringing children together (McNaughton & Light, 2013). Visual scene displays are interfaces that utilize photographs to further blend real-life and digital contexts to create a collaborative space for communicative interactions.

Visual scene displays have been utilized with beginning communicators with CCN to increase turns in exchanges and express a variety of linguistic concepts (Drager et al., 2017; Holyfield, Caron, Drager, & Light, 2019). In a VSD, a picture that represents an environment in its entirety is used. Language is contextualized within the scene. Scenes that provide a representation of a familiar routine and/or demonstrate clear relationships and activities between the participants are preferred (Light, McNaughton, & Caron, 2019). Within these rich images, certain elements (e.g., people or salient objects) can be designated as "hotspots." The hotspots act as markers to retrieve messages associated with participation in the activity depicted in the scene. For example, an image of two children rolling a ball back and forth might have hotspots for each participants as well as the ball. Instead of labeling the people and the ball, the messages

would be phrases such as "Ready, set, go!" or "Don't miss it" or "Get a new ball."

Research suggests that VSDs are easier for children without disabilities as young as 2.5 years of age to use and learn compared with grid displays (Drager et al., 2004; Fallon, Light, & Achenbach, 2003). The results of several studies (Drager et al., 2004; Drager, Light, Speltz, Fallon, & Jeffries, 2003; Light et al., 2004) revealed that children without disabilities performed better when using a VSD to locate vocabulary than a grid display. These studies have suggested that VSDs reduce working memory demands by allowing young children to perceive the representations as part of an integrated scene rather than processing each symbol separately (Thistle & Wilkinson, 2015). Visual scene displays can be utilized in a range of shared contexts that support language learning including play and shared book reading.

Previous research has suggested that technology can provide a shared space for communicative interactions and support participation for children with CCN (Boster & McCarthy, 2016; 2018; Therrien & Light, 2016). Therrien and Light (2016) utilized an iPad to facilitate shared book reading between two children with CCN and three of their peers between the ages of 3 and 6 years. As part of the intervention, children were taught to take turns reading a book together with an iPad featuring a VSD with speech output. Children selected a book and were prompted to work through it together by accessing programmed hotspots on VSD pages. Increased symbolic communicative turns were noted throughout the intervention for both children with CCN; however, the intervention package was only determined to be effective for one of the two participants with CCN. Performance of the second child with CCN was inconsistent, with limited gains made across peers. Researchers attributed this to the age of peer participants who were older (aged 4 years 10 months to 5 years 5 months) and began to lack enthusiasm with presentation of the same 10 books for the study (Therrien & Light, 2016). Overall findings indicated that participation in interactions could be supported with technologies such as VSDs on an iPad. Ultimately, the success in blended real and digital worlds to collaborate requires an ability to move quickly from the real world into the digital one. The process needs to happen "just in time" to support such interactions (Schlosser et al., 2015).

Just-in-time programming

Just-in-time programming involves providing appropriate supports to an individual in the moment of need (Jakobs, 2009; Schlosser et al., 2015). This largely involves utilizing technologies that can be programmed quickly and efficiently in order to provide supports in the context of interactions as they occur (Light, McNaughton, et al., 2019). Research exploring the benefits of just-in-time programming in AAC interventions continues to demonstrate positive results (Drager et al., 2017; Holyfield et al., 2019; Light et al., 2016). Light et al. (2016) investigated the impact of just-in-time programming in combination with a VSD app for five children with CCN between 15 and 33 months of age and found increases in their frequency of communication turns, number of unique concepts expressed, and range of communicative functions (i.e., requests, comments, greetings, etc.). The positive impacts of this kind of programming with VSDs also have been replicated with beginning communicators between the ages of 9–18 (Holyfield et al., 2018) and 8–20 months (Drager et al., 2017) as a means to increase communicative turns in interactions. Similar to modeling interventions, just-in-time programming places demands on communication partners to be actively involved in providing appropriate support to the child using AAC. Although evidence shows that communication partners and SLPs are able to quickly learn how to use such programming (Caron, Light, Davidoff, & Drager, 2017; Caron, Light, & Drager, 2016), it may be necessary to continue to explore methods to reduce demands on communication partners while also providing timely supports for children using aided AAC. Finding ways to incorporate such methods for

scaffolding utterances within AAC interfaces and to create opportunities for interactions that support speech and language skills can help children with CCN become successful communicators. Just-in-time programming represents a potential safeguard against putting a device in the middle of interactions where it detracts rather than supports.

A noted benefit of just-in-time programming is the ability to involve children in the process of vocabulary selection (Holyfield, Drager, Light, & Caron, 2017). Children as young as 10 months have been included in programming interventions and have been able to participate in at least some aspects of the process (Holyfield et al., 2017). Involving children with CCN in the development of their language and vocabulary selection is paramount. Although VSDs provide beginning communicators with access to early language concepts, it is necessary to continue to move children toward interfaces that provide them with access to additional concepts and opportunities to increase their expressive communication skills.

Transitioning focus to social participation

Across all stages of development, it is necessary to provide opportunities for social participation. Despite the provision of AAC, children with CCN face additional challenges in social interactions. Evidence has shown that parents, teachers, and peers frequently dominate interactions with children who use AAC (Calculator & Dollaghan, 1982; Chung, Carter, & Sisco, 2012). Interactions with peers are particularly important to foster as they provide children with opportunities to test their hypotheses about language without direct mediation by adults (Wilkinson, Heibert, & Rembold, 1981). As children with CCN develop communicative skills, it is necessary to create shared contexts for communication. Interventions focused on participation can directly provide children with CCN and their communication partners with skills and contexts for meaningful interactions. Research has assessed the impact of participation interventions on the quantity of interactions between communication dyads (Carter & Maxwell, 1998; Chung et al., 2012; Garrison-Harrell, Kamps, & Kravits, 1997; Hughes et al., 2011), frequency of initiations (Cosbey & Johnston, 2006; Hughes et al., 2011; Hughes, Rung, Wehmeyer, Agran, & Copeland, 2000), and frequency of communicative acts (Hunt, Alwell, Goetz, & Sailor, 1990; Trembath, Balandin, Togher, & Standcliffe, 2009; Trottier, Kamp, & Mirenda, 2011).

The arts can offer a milieu for interactions that avoid right and wrong responses while also focusing on new, fun, and creative forms of expression (Blackstone & McCarthy, 1997). A digital puppetry application was explored by Wohlwend (2015) as a means to explore young children's digital literacy skills. Three children simultaneously interacted with digital characters on an iPad in which they were able to manipulate the characters to create simple stories. The girls in the study were observed to demonstrate a range of early digital literacy skills (i.e., swiping, tapping, etc.) as well as to collaborate with each other's on-screen characters. This exploratory project demonstrates how technology may serve as a shared context for collaboration and communication.

Photography also can be a particularly motivating and meaningful context for children with CCN who are already utilizing pictures as a mode of communication. Boster and McCarthy (2016) specifically explored photography in the context of a storytelling activity between a child with CCN and a same-age peer. Results of the study indicated an increased number of communicative utterances between the children following the intervention in which clear roles were established (Boster & McCarthy, 2016). Establishing clear roles is a frequently used strategy for creating positive interdependence in collaborative learning activities (Johnson, Johnson, & Holubec, 1994). Collaborative learning approaches utilize small groups or pairs to encourage students to work together to maximize their own and each other's learning (Johnson et al., 1994) in the context of a shared goal. As such, Boster and McCarthy

(2017b, 2018) continued to develop photography interventions designed to explore the inclusion of elements of collaborative learning. These elements included positive interdependence (i.e., the need to complete a task together), face-to-face interaction, individual accountability, collaborative decision-making, and group processing (Johnson et al., 1994). Results of a single-subject withdrawal design study with two dyads of children with CCN and same-age peers indicated increased reciprocal social interactions during collaborative art and collaborative photography activities (Boster & McCarthy, 2018). During the intervention activities, children captured photographs and looked at them together on the camera. As such, interventions that incorporate onboard cameras of AAC devices may allow the AAC device to play a meaningful role in the middle of interactions.

The AAC device itself can serve as a platform for sharing content and expressing ideas and may also draw other communication partners into an interaction. In addition to serving as an immediate context for interactions, capturing photographs and sharing them to social media sites can provide additional opportunities for social participation. Mobile technologies, including AAC devices, continue to develop onboard cameras, embedded editing features, and options for sharing to a variety of social media platforms. However, children with CCN may not be able to easily navigate to their camera or be able to utilize it to independently capture meaningful images. Further research is necessary to continue to develop interventions that explore the benefits of photography as a context for interaction and source of engaging others beyond immediate communication circles.

Using technology requires continued refinement

The world of technology is not static and heavily affects the realm of AAC. It continues to change and prompts users to continue to change with it. New technologies are often pursued when more efficient tools are available and the old are made obsolete, when there are new needs to be met, or when new options are presented. Despite which technology is selected or why, there remains a period of initial setup and customization. Although a majority of products come out of the box with preselected features and programs, many users still go through a process of tailoring features to their liking. This process involves making decisions about the look, feel, ease of use, and additional features desired to allow the tool to accomplish its purpose. These decisions should not end following the initial setup. Mobile technologies provide individuals with the ability to continually update their devices. For example, it is unlikely that an individual keeps all the same applications on his or her smartphone as he or she did when he or she first purchased it. It is also unlikely that an individual keeps the same smartphone, as new and updated features are available with different devices that meet his or her needs. Although some individuals may have been happy with their original device, changes in technologies may have led to a need to update because the device became obsolete. The decisions individuals make with their own technologies are not so different from the ones required in AAC. Clinically, the continual introduction of new AAC technologies into the therapy space can present an overwhelming challenge. Speech–language pathologists must possess both an understanding of changing technologies and the changing needs of the individuals they serve. Making decisions in AAC requires an understanding of the available products, their features, and their functionality. It may be difficult to make decisions about which AAC device is appropriate or how it should be set up, particularly for children with CCN whose needs will change over time.

Although most AAC devices essentially come ready to be used as is, it is necessary to continue to explore which features (e.g., voice, vocabulary) need to be customized for an individual. For children who begin with AAC technologies at a young age, it is necessary to plan early on how a child will essentially "grow up" with the technology.

Nevertheless, it is important for SLPs to remain focused on foundations of language development and evidence-based strategies for supporting communication for individuals with CCN across their life span. Technology will likely continue to advance with heads-up displays, virtual reality, smart glasses, and wearable technology. Advances aimed at augmented reality (Carmigniani et al., 2011) are ones to blend technology, information, and real life and not to provide an additional entity demanding focus and attention. Augmented reality overlays additional information on top of what is being viewed through a mobile device's camera or a display on a backup camera of a car. Information about distances, potential collisions, or identifying information can be conveyed along with the real-world object(s). However, a downside to augmented reality is that the digital experiences are no longer shared. Reality is enhanced for the individual using AAC, but the communication partner is not allowed in to co-construct understanding. The question of what goes in the middle still remains.

CONCLUSION

Does the device go in the middle? The best answer sounds a little Zen. The middle goes in the middle. The device is there to support the interactions in the middle. In the worst-case scenario, the device is a distraction to the interaction happening in the middle. In the best case, the device enters into the middle and transforms it into something even better. The device, as always, is a tool to help accomplish things in the real world. If the device takes over "the middle" and there is no "middle" remaining, then it is a barrier. If the device becomes a part of "the middle" and is indistinguishable from it, then it becomes a collaborative space. In Figure 1E, the device creates a space where the boys come together. Even the most compelling technology can turn into a passive experience without some purpose, some ultimate goal of the interaction. Meaningfully growing up with AAC means that a device supports interactions because it (a) represents items and people in familiar and engaging action routines; (b) can be updated easily to incorporate new events and changing circumstances; (c) supports learning of functional words defined by not just their frequency of use but also clear distinctiveness boundaries marking important semantic differences; (d) allows for growth in understanding orthographic systems; and (e) is introduced into activities with multiple opportunities for meaningful, cooperative communication interactions.

Using AAC with children with CCN requires thoughtful decision-making with an eye toward future needs. Professionals should not become so focused on keeping up with the features of the technology that known strategies for supporting language development, facilitating social interaction opportunities, and promoting participation are forgotten. Following transitions that occur in typical child development can support choices for designing appropriate AAC interfaces and incorporating AAC devices into social interactions. Technologies will continue to advance and play an important role in providing supports for children who require AAC. Advances in technology are promoting an increasingly digitally connected world for children with CCN to interact with in new ways. These technologies provide exciting opportunities to leverage in the service of supporting children with CCN and their development of language skills. Inherent to all stages of AAC for children with CCN is the potential inclusion of photographs, whether as full visual scenes or individual representations within a customized grid display. Photographs can provide contexts for supporting language development and participation. The shift toward communication with digital media involving photographs, video, and images opens a new realm of communication opportunities as children with CCN grow up with technology.

Even photographs or the most promising directions of tomorrow cannot take over "the middle." Photographs provide useful platforms because they help ground language

in context. Not all photographs are created equal (Beukelman, Hux, Dietz, McKelvey, & Weissling, 2015). Photographs that do not launch conversations or help support a rich context for interaction become additional burdens in an interaction. Figure 1E must be functionally the same as Figure 1A. Ideally, Figure 1E enriches the interaction and becomes something more. Although often thought of as a dichotomy, the best device is both augmentative and alternative by enhancing interactions through new technologies.

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