

## EDITORIAL

# The iPad and Mobile Technology Revolution: Benefits and Challenges for Individuals who require Augmentative and Alternative Communication

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### Abstract

The iPad and other mobile technologies provide powerful new tools to potentially enhance communication for individuals with developmental disabilities, acquired neurogenic disorders, and degenerative neurological conditions. These mobile technologies offer a number of potential benefits, including: (a) increased awareness and social acceptance of augmentative and alternative communication (AAC), (b) greater consumer empowerment in accessing AAC solutions, (c) increased adoption of AAC technologies, (d) greater functionality and interconnectivity, and (e) greater diffusion of AAC research and development. However, there remain a number of significant challenges that must be addressed if these benefits are to be fully realized: (a) to ensure the focus is on communication, not just technology, (b) to develop innovative models of AAC service delivery to ensure successful outcomes, (c) to ensure ease of access for all individuals who require AAC, and, (d) to maximize AAC solutions to support a wide variety of communication functions. There is an urgent need for effective collaboration among key stakeholders to support research and development activities, and to ensure the successful implementation of mobile technologies to enhance communication outcomes for individuals who require AAC and their families.

**Keywords:** *Developmental disabilities; Acquired disabilities; iPad; Mobile technology; Communication*

### Introduction

Recent developments in mobile technology, including the introduction of the iPad and other smartphone and tablet devices, have provided important new tools for communication. The wide availability of these portable, powerful, networked technologies has changed how we work, learn, spend our leisure time, and interact socially. The impact has been rapid and widespread: Within 90 days of the release of the iPad™<sup>1</sup>, over 50% of Fortune 500 companies were using this technology (Dignan, 2010); by 2012, Apple had sold over 2.5 million iPads to schools in the United States (Uhlig, 2012). Mobile technology use is now ubiquitous: Smartphone users spend over 4 hours a day using their devices (Barrabee, 2013); and teenagers send over 30 text messages a day (Lenhart, Ling, Campbell, & Purcell, 2010). Although the iPhone and the iPad™ garnered the most attention initially, there are now a wide variety of mobile technology devices, using iOS, Android, and Windows operating systems. Around the world, nearly three-quarters of the world's population has access to mobile technology, and over 30 billion mobile applications (“apps”)

were downloaded worldwide in 2011 (World Bank, 2012).

The mobile technology revolution has not only impacted the daily lives of individuals without disabilities, but also has had dramatic effects on the lives of many individuals with complex communication needs, including those with developmental disabilities (e.g., autism spectrum disorders, Down syndrome, cerebral palsy); those with acquired neurogenic disorders (e.g., resulting from stroke, traumatic brain injury); and those with degenerative neurological conditions (e.g., amyotrophic lateral sclerosis, or ALS; primary progressive aphasia) (Fager, Bardach, Russell, & Higginbotham, 2012; Flores et al., 2012; RERC on Communication Enhancement, 2011). These new mobile technologies are frequently smaller and cheaper than traditional augmentative and alternative communication (AAC) devices, and provide access to a wide range of mainstream smartphone applications (e.g., texting, browsing the internet, GPS navigation). In recent years, there has been an explosion of specialized software applications to support communication for those who require AAC (Dolic, Pibernik, & Bota, 2012; Gosnell, Costello,

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& Shane, 2011a; Hershberger, 2011; Higginbotham & Jacobs, 2011).

### Potential Benefits of Mobile Technologies

The introduction of the iPad and other mobile technologies has offered many potential benefits to individuals with complex communication needs who require AAC, including increased awareness and social acceptance of AAC in the mainstream, greater consumer empowerment in accessing AAC solutions, increased adoption of AAC technologies, greater functionality and interconnectivity, and greater diffusion of AAC research and development.

#### *Increased Awareness and Social Acceptance of AAC in the Mainstream*

First and perhaps most importantly, the iPad has brought AAC into the mainstream. Rather than being restricted to the use of specialized dedicated speech-generating devices (SGDs), many individuals who require AAC are now able to use mainstream technologies to meet their communication needs. AAC apps are available for purchase from the same app store that provides other business, educational, and social apps, thus increasing general public awareness of AAC. Furthermore, generalized public interest in the iPad and its applications has led to increased media attention to AAC applications on the iPad, with a wide range of stories appearing in many major news outlets in recent years (e.g., Sughrue, 2012; Vance, 2009).

Access to AAC through mainstream technologies has provided not only increased visibility of AAC in society, but also increased social acceptance. Mobile technologies are socially valued; they are free of the stigma sometimes associated with the use of assistive technologies (Kagohara et al., 2013). Hyatt, a web accessibility consultant who uses AAC, summed up the positive impact of the iPad on social acceptance and self image:

...someone was having trouble figuring out what I was saying and she asked, 'Where's your iPad?' In that moment, I felt a sense of normalcy and acceptance. Using an iPad, Blackberry or iPhone ... is not another thing that makes me different. It wasn't using a strange, unfamiliar device to communicate with this group. People were drawn to it, because it was a 'recognized' or 'known' piece of technology, rather than being standoff-ish with an unknown communication device. (Hyatt, 2011, p. 25)

Rummel-Hudson, a parent of a teenager who uses AAC, also emphasized the positive effects of mobile technologies on social acceptance:

...[the iPad] provides a rather elegant solution to the social integration problem. Kids with even the

most advanced dedicated speech device are still carrying around something that tells the world 'I have a disability.' Kids using an iPad have a device that says, 'I'm cool.' And being cool, being like anyone else, means more to them than it does to any of us. (Rummel-Hudson, 2011, p. 22)

#### *Greater Consumer Empowerment in Accessing AAC Solutions*

The wide availability of mobile technologies, the ease of purchasing AAC apps, and the relatively low cost of these devices (compared to traditional SGDs) have resulted in substantial changes to the ways in which individuals with complex communication needs and their families access AAC solutions. Historically, SGDs were typically provided through a clinical model of service delivery, including AAC assessment by licensed professionals, prescription of an SGD as determined by the clinical team, and a range of follow-up supports to enhance communication outcomes.

In many ways, this traditional clinical model has been replaced by a new consumer model for identifying AAC solutions (Hershberger, 2011). The wide availability of iPads and other mobile technologies has resulted in a democratization of access to AAC technology (RERC on Communication Enhancement, 2011), with consumers making their own decisions about AAC solutions, no longer tied to what was sometimes a lengthy multi-step process of clinical assessment, system prescription, and funding requests. As Rummel-Hudson (2011) noted:

Like any other technological game-changer, the appearance of affordable touchscreen technology paired with robust system architecture and socially appealing design has met with a wide range of reaction. For parents, however, it has opened the door to a level of real decisive autonomy, the likes of which we dared not dream of even a few short years ago. (Rummel-Hudson, 2011, p. 22)

One key factor in this new consumer-driven model is the price of AAC apps, iPads, and other mobile technologies. The relatively low cost of these solutions means that more families, school districts, and other agencies are able to consider the purchase of AAC technologies on their own; third party funding may not be necessary:

Parents who are unsure if AAC is the right step now have an affordable option for trying it with their kids; families who struggle to get access to AAC technology or who have difficulty affording the extended warranties ... now have possibilities as close as their nearest Apple Store. (Rummel-Hudson, 2011, p. 23)

In fact, recent surveys have found that the majority of individuals (68–73%) using an iPod or iPad for AAC

acquired it through parent/family purchase (Meder, 2012; Scherz, Dutton, Steiner, & Trost, 2010, as cited by McBride, 2011). Almost 30% of families reported that affordability was the single most influential factor in their decision to purchase an iDevice as an AAC solution (Meder, 2012).

#### *Increased Adoption of AAC Technologies*

With greater consumer empowerment and increased social awareness and acceptance of AAC has come increased adoption of AAC by individuals with complex communication needs and their families, including many who may not have previously considered AAC. Beukelman (2012) described the changing demographics of the AAC field, with the increased numbers of individuals using AAC representing a wider array of disabilities and a greater range of ages than ever before. The iPad revolution is responsible, at least in part, for the increased adoption of AAC and the resulting changes to the demographics in the field. Shane and colleagues described the increased adoption of iPad apps for communication by families of individuals with autism:

Currently, we are in the midst of a potential paradigm shift in AAC for people with ASD, in large part due to the growing adoption of handheld media devices along with applications acquired via a consumer-oriented delivery model that are not only affordable but also transportable, socially acceptable, and ubiquitous. (Shane, Laubscher et al., 2012, p. 1228)

The increased uptake of AAC solutions no doubt reflects not only the greater affordability, availability, and social acceptance of the iPad and other mobile technologies, but also the general familiarity with iPads/mobile technologies and the relative ease of operation of AAC apps running on these technologies. Traditional dedicated SGDs often required parents and clinicians to learn new technical operations that utilized menus, commands, and layouts that differed substantially from mainstream technologies, thus imposing new learning demands on communication partners (Light & McNaughton, 2012). In contrast, the operational requirements of AAC apps for the iPad may be more familiar to parents and clinicians because they resemble those used in other iPad apps. In fact, ease-of-use was reported to be the single most influential or helpful factor in the purchase of an iDevice or the purchase of AAC apps by 33% and 37% of families, respectively, in the survey by Meder (2012). Shane, Laubscher, and colleagues (2012) noted that individuals with little or no technical background can now develop personalized content for AAC and language intervention with relative ease, due to the familiarity and the ease of operation of iPads and other mobile technologies.

#### *Greater Functionality and Interconnectivity*

Perhaps the most exciting potential benefit of mobile technologies is that of increased functionality and interconnectivity. These technologies are not simply speech prostheses; rather, they are multi-purpose devices that offer access to a wide range of functions. The very nature of communication in society has changed. Individuals who require AAC "...have a need for, and a right to, the same range of communication options available to everyone else" (RERC on Communication Enhancement, 2011; p. 3), including access to speech output to support face-to-face interactions, written output to respond to educational demands, the Internet for information gathering, multimedia (e.g., photos, videos) to enhance presentations, texting and cell phones to promote social relationships, social media to connect with friends, and so forth (Williams, Krezman, & McNaughton, 2008). Multi-function mobile technologies offer the potential to meet these diverse communication needs more easily and seamlessly than dedicated SGDs. According to a recent survey, families reported that more than 90% of individuals with complex communication needs used their iPads/iPods not only for AAC, but also for non-AAC purposes, especially entertainment (85% of those surveyed) and learning (70%); almost 50% of the families reported that the iDevices were used for behavioral supports (e.g., social stories, scheduling, reinforcement) as well (Niemeijer, Donnellan, & Robledo, 2012). Hyatt (2011) described the expanded communication possible as a result of the greater functionality of mobile technologies:

The cool thing was ... I had Internet access. When asked what I had been up to, I responded 'problogging and ghost writing,' and I was able to show what I had written. I also shared the video of me ziplining across Robson Square in downtown Vancouver during the Winter Olympics. The iPad allowed for a deeper level of communication than would have been possible with a single-function AAC device. (Hyatt, 2011, p. 25)

#### *Greater Diffusion of AAC Research and Development*

As the iPad has brought AAC into the mainstream and AAC apps are as accessible as the nearest iTunes connection, the field has witnessed not only greater consumer empowerment accessing AAC, but also greater diffusion of AAC research and development. No longer is AAC research and development restricted to traditional assistive technology manufacturers, but rather there is now increased development by a wide range of programmers such as family members, students, clinicians, and mainstream programmers. For example, Hewlett Packard's Hacking Autism website, <http://www.hackingautism.org/>, provides a venue where families and professionals post ideas for apps for individuals with autism and programmers respond to these ideas by developing apps that are then made available free of charge. Given the



relatively small size of the AAC field and the complexity of the needs of individuals who require AAC, it is exciting to see a greater number of resources, and especially the involvement of mainstream companies focused on programming solutions to some of these complex problems. This model offers the potential for more rapid and cutting-edge technical development, but it is not without risk.

### Potential Challenges of Mobile Technologies

Despite the potential benefits offered by iPads and other mobile technologies in meeting the complex communication needs of individuals who require AAC, there remain many challenges that must be addressed if these benefits are to be fully realized. With the increased visibility of AAC in all sectors of society has come increased scrutiny of these new approaches (Kagohara et al., 2013). It is important to maximize this opportunity to demonstrate the positive impact of effective AAC interventions so as to support future adoption of AAC by individuals with complex communication needs and their families. Four challenges must be addressed to ensure that the potential benefits of mobile technologies are realized for these individuals: (a) to keep the focus on communication, not just technology, (b) to develop innovative approaches to AAC assessment and intervention, (c) to ensure ease of access to AAC for all individuals with complex communication needs, and, (d) to maximize AAC solutions to support a wide variety of communication functions.

#### *Keep the Focus on Communication*

Perhaps the greatest danger in the iPad/mobile technology revolution is that the excitement over these new technologies will result in an isolated focus on the technology alone, to the neglect of the true end goal – communication. An iPad or other mobile technology is simply a tool; there is no inherent value in the procurement or operation of the tool in and of itself, but only in the power of this tool to facilitate effective communication and fuller participation in society (Simeonsson, Björck-Åkesson, & Lollar, 2012). Hershberger (2011) cautioned:

...the greatest pitfall is for us to focus too much on the technology. Providing an AAC solution is a complex process. An AAC device is only a tool, one of the many components of a solution. ...Rather than focusing on a particular technology, we should focus on finding the best total solution for the individual who needs speech augmentation. (Hershberger, 2011, p. 33).

With a misplaced focus on technology, there is a danger that devices will be purchased for children or adults with complex communication needs without a clear sense of how the technology will be used or

supported to enhance communication. According to Gosnell, Costello, and Shane (2011b) "...Many speech language pathologists are now faced with iDevices suddenly showing up in the office of their assessment center or school with the question: 'What apps do we use?' followed by a demand to 'make this work'" (Gosnell et al., 2011b, p. 7). Purchasing a device or downloading apps without careful consideration of the individual's skills and needs may produce a mismatch between the end goals of communication and the mobile technologies purchased, and may result in frustration for consumers, families, and clinicians.

Individuals with complex communication needs should have access to a wide range of strategies and techniques to enhance their communication (Williams et al., 2008). Even those who report extensive use of the iPad describe it as just one piece of a multi-component communication system (Hyatt, 2011; Niemeijer et al., 2012; Rummel-Hudson, 2011). Disturbingly, Beukelman (2012) noted that many individuals who had appropriate AAC solutions are now being directed to switch to iPads due to the decreased cost and the belief that "one size fits all." This type of forced technology change may be difficult for many people, especially those who have difficulty learning new operational skills or who do not have access to facilitators to customize and support the learning of the new technology. Rather than following best practice, in which the AAC system is selected and developed to meet the needs and skills of the individual (Beukelman & Mirenda, 2013), the individual is forced to adapt to the requirements of the technology. The mobile technologies are the focus rather than maximizing the individual's communication.

AAC interventions, including those incorporating mobile technologies and apps, must be based on the individual's needs and skills, with the goal of supporting a broad range of communication activities and fuller participation in society. In order to attain the promise of mobile technologies, it is essential to keep the focus on communication, not technology.

#### *Develop Innovative Approaches to AAC Assessment and Intervention*

The shift to a consumer-oriented model of accessing AAC solutions has some important advantages in terms of the uptake of AAC and the empowerment of families, but it also has a significant downside. In many cases, this paradigm shift in service delivery has resulted in bypassing AAC assessment and intervention completely (Gosnell et al., 2011a). In fact, recent surveys found that mobile technologies and AAC apps are often purchased without input from knowledgeable professionals: Scherz and colleagues (as described in McBride, 2011) reported that only 54% of individuals who used an iPod/iPad for AAC had received an AAC evaluation to determine the most appropriate communication system; and Meder (2012) found that only

38% of families reported that professional opinions about AAC apps guided their decision making at all, with only 4% reporting that professional support was the most influential factor in determining which AAC apps to purchase. Too often AAC tools and strategies are selected based on "...media coverage, public testimonials, or recommendations from well meaning friends and family" (Gosnell et al., 2011b); rather than careful AAC assessment to identify the individual's needs and skills. In many cases, bypassing AAC assessment results in the purchase of AAC apps and technologies that do not match the needs and skills of the individual, thus jeopardizing outcomes (Gosnell et al., 2011a; McBride, 2011).

Even if the technology has been carefully selected for the individual, the mere provision of an iPad does not guarantee its successful use to enhance communication and participation (Shane, Laubscher et al., 2012). It is rare that the simple provision of an AAC system will result in effective communication for a person with complex communication needs; supports for customization and learning are almost always needed (Gosnell et al., 2011a; Shane, Laubscher et al., 2012). It is well documented in the AAC field that concerted intervention is required to build communicative competence (Beukelman & Mirenda, 2013). Unfortunately, many individuals who use AAC apps on mobile technologies do not receive the intervention required to maximize their communication and participation. Meder (2012) reported that 75% of the parents who were surveyed did not feel effective in helping their child to use the iDevice and/or communication app; 59% wanted help in supporting their child in using the device for communication. Niemeijer et al. (2012) also reported a lack of implementation support; less than 10% of the adults who used iDevices and less than 25% of the families who responded to their survey reported that they received professional support to effectively implement AAC.

Many individuals with complex communication needs and their families require technical support. Historically, AAC assistive technology manufacturers have provided significant technical support to consumers who use their technologies and their families, including live hot lines; repair services; device loans; support to complete the funding application process; and equipment demonstrations, set up, and training (Hershberger, 2011). Traditionally, the cost of this technical support has been included in the cost of the device itself, making traditional AAC devices much more expensive, but also ensuring a level of technical support not realized with AAC apps on mobile technologies. Most AAC apps available through iTunes or other app stores provide little, if any, technical support for the consumer. Ironically, few parents consider the availability of technical support when purchasing AAC apps; in fact, none of the parents surveyed by Meder (2012) reported that they did so. However, once AAC apps and mobile technologies are in place, families report that they want technical support (Meder, 2012).

There may be additional factors contributing to the lack of professional and technical support for mobile technologies. As noted earlier, many families make decisions independently of existing service delivery systems when choosing AAC solutions. Furthermore, when families seek support, they may have difficulty accessing professionals with the necessary competencies in AAC and mobile technologies. Many speech-language pathologists lack knowledge and skills in AAC generally (Binger et al., 2012; Costigan & Light, 2010) and in AAC apps for mobile technologies specifically (Niemeijer et al., 2012). In a recent survey, less than 20% of speech-language pathologists reported that they had received training on use of iPads in any type of therapy, and not just AAC (Fernandes, 2011). It is challenging to keep pace with the rapid changes in mobile technologies and the proliferation of AAC apps (RERC on Communication Enhancement, 2011), and there are few guidelines for clinical decision-making (McBride, 2011).

The advent of mobile technologies has created new challenges for the development of appropriate AAC assessment and intervention support mechanisms. Careful consideration needs to be given to new personnel roles (Binger et al., 2012), and innovative ways to share information among stakeholders (McBride, 2011). Now is the time to develop new models of service delivery that bring together the best of both worlds: effective AAC assessment and intervention spearheaded by knowledgeable teams, working in close collaboration with consumers who require AAC and their families, to empower them with the knowledge and skills to make appropriate decisions to maximize communication and participation.

#### *Ensure Ease of Access for All Individuals*

Although there have been some recent developments in alternative access to mobile technologies (Fager et al., 2012), the options are still very limited and, as a result, there remain many individuals with complex communication needs who cannot access these mobile technologies accurately or efficiently. Concerted efforts are required to ensure that the widespread adoption of mobile technologies does not result in the marginalization of those individuals who have the most complex needs and are unable to access mainstream technologies. Chapple (2011), an expert user of AAC, summed up the impact:

If the introduction of integrated devices is a major step in the evolution of AAC devices, the lack of alternative access for these systems can be likened to stepping back into the Stone Age. ...[T]hese technologies must incorporate alternative access if they are to meet their fullest potential as AAC tools. (Chapple, 2011, p. 36)

The development of mobile technologies is driven by the needs and preferences of the mass market; as

a result, these technologies are often not designed in ways that meet the needs and skills of many children and adults with complex communication needs (Beukelman, 2012). Many of the new mobile devices require an array of highly coordinated fine-motor movements for access (e.g., pinching, swiping left to right, touching), and they provide few affordances to denote what movement to use when (Light & McNaughton, 2012). These access demands may exceed the skills of many individuals who require AAC, thus limiting their access to communication. The iPad/ mobile technology revolution has resulted in a large number of AAC apps, but the vast majority of these require significant motor, cognitive, and sensory perceptual skills (Kagohara et al., 2010). These apps are often not accessible by those individuals who have complex motor, cognitive, and sensory perceptual impairments.

Future research and development is urgently required to ensure that there is a wide range of options available to meet the needs and skills of the many different individuals who require AAC, as well as to seamlessly accommodate changes in these needs and skills resulting from gains or loss of function over time (e.g., Fried-Oken & Light, 2012). Unfortunately, the future of AAC research and development to meet the needs of those that have the most complex motor, cognitive, and sensory perceptual impairments is very much at risk. Traditionally, assistive technology manufacturers have wrapped some of the cost of research and development for products with a small market share into the costs of those products that held a larger market share. With the shift to a consumer-driven model of low-cost AAC apps, there are significantly fewer financial resources available for research and development, especially for those products that may have only a small market. Hershberger (2011) cautioned that, with limited financial resources available, developers may be tempted to follow the status quo, simply reiterating existing features in apps, rather than forging new ground to enhance communication for individuals with complex communication needs; furthermore, developers may be forced to develop products for the “average” user rather than investigate techniques to improve access for individuals who have more complex needs. Although it is exciting to see the involvement of an increased number and range of programmers addressing the complex challenges faced by many individuals who require AAC, too often these programmers (e.g., family members, students, programmers with mainstream technology companies) have limited knowledge of the AAC field and its evidence base.

The design of AAC apps substantially affects performance. Most of the existing AAC apps are not based on research evidence and may be poor fits with the needs and skills of individuals with complex communication needs. As a result, anticipated benefits may not be realized for many of these individuals, not because they cannot benefit from AAC, but

rather because of the poor design of the AAC apps (RERC on Communication Enhancement, 2011). If individuals with complex communication needs do not demonstrate the ability to use these AAC apps/mobile technologies effectively, then we erroneously conclude that they do not have the necessary “prerequisite skills” to use AAC or that they are “too low functioning” or “too disabled” to use mobile technologies (Kagohara et al., 2010). Now is the time to forge new partnerships among researchers, developers, clinical/educational teams, and consumers who require AAC and their families to lead concerted research and development efforts to redesign AAC apps and mobile technologies to better meet the needs and skills of individuals with complex communication needs and to better support their participation, communication, language and literacy development.

#### *Maximize AAC Solutions to Support a Wide Variety of Communication Functions*

Perhaps what is most disappointing about the current state-of-the-science is the failure to capitalize on the functionality of mobile technologies for individuals with complex communication needs. Too often, AAC interventions using mobile technologies are limited to simple requests for preferred items and labeling pictures (Kagohara et al., 2013). To date, there is limited information on the use of mobile technologies as multi-purpose devices that offer access to a wide range of activities, including education, social networking, entertainment, gaming, and accessing information (Williams et al., 2008). Furthermore, there have been no efforts to truly integrate communication access for individuals who require AAC so that they can more effectively utilize the various functions, rather than having to toggle between programs as they use apps to communicate, use the Internet, watch a movie, or play a game with friends. The tremendous potential of mobile technologies for individuals with complex communication needs has not yet been fully realized; rather, these technologies are currently implemented primarily as limited speech prostheses in a restricted range of activities (Kagohara et al., 2013). Now is the time to embrace a broader definition of communication access that will include, but not be limited to, speech output to support face-to-face interactions, writing to address educational needs, multimedia (e.g., photos and videos) to share experiences, the Internet to rapidly access a wide array of information, social media to network with others, texting and cell phones to connect with friends, Twitter to share opinions and reactions, and blogging to build communities with like interests (Williams et al., 2008). Now is the time to capitalize on the increased functionality provided by mobile technologies, in order to investigate strategies to enhance communication access for individuals who require AAC.



## Directions for Future Research and Implications for Practice

Clearly there is much work to be done to ensure that the potential benefits of mobile technologies are truly realized for children and adults who require AAC, including future research to determine the effectiveness of mobile technologies, research and development to enhance ease of access and functionality of mobile technologies, and translation of this research to evidence-based practice to ensure successful outcomes for individuals with complex communication needs.

### *Research on Impact*

There is a small, but growing, research base documenting the impact of iPads /mobile technologies on the communication of individuals with complex communication needs. Research to date has focused on use of these technologies by a relatively small number of individuals with autism spectrum disorders and/or intellectual disabilities to communicate a very narrow range of functions (i.e., simple requests and labeling pictures) that have typically been fulfilled successfully by other AAC systems as well. Kagohara et al. (2013) recently conducted a systematic review of the research on the use of iPods and iPads with individuals with developmental disabilities. They located a total of 15 studies involving 47 participants with autism spectrum disorders and/or intellectual disability; the studies addressed five different domains: communication, academic, employment, leisure, and transitioning across school settings. Eight of the studies targeted improving communication with individuals with complex communication needs, but the skills that were targeted were limited, with seven studies targeting requests for preferred items and one study targeting picture naming. The results of the studies were largely positive, suggesting that these technologies are viable assistive technology options for individuals with ASD and/or intellectual disability.

While there is some initial evidence of the potential positive impact of these devices, research is urgently required to investigate the effects of mobile technologies with a wider range of individuals who require AAC. These investigations should address the use of mobile technologies across the life span, and examine their use by persons with developmental disabilities as well as those with acquired neurogenic disorders. This research must consider not just the effects on simple requests and labeling, but also the impact on a much broader range of communication purposes, such as social closeness and information exchange. This research also must consider a much broader range of outcomes, including the effects on the language, literacy, and communication skills of individuals with complex communication needs, as well as their overall participation in society. Future research also is required to determine the relative effectiveness of mobile technologies compared to other AAC systems, including issues associated with acquisition, long-term use, and the development of communication skills. For

example, van der Meer et al. (2012) compared acquisition, maintenance, and preference for three different AAC techniques – iPad as an SGD, Picture Exchange Communication, and manual signs – with four children with developmental disabilities. The results suggested that children’s mode preferences can be identified early in intervention and that these preferences may influence acquisition and maintenance.

Furthermore, research should consider the effects of iPads and other mobile technologies not just on individuals who require AAC, but also their facilitators: family members, teachers, employers/co-workers, personal care attendants, and so on. How do these mobile technologies impact the uptake of AAC interventions by families and other facilitators? What knowledge and skills do the facilitators require to effectively support communication using AAC? How is this information best delivered to facilitators to ensure their effectiveness as communication partners?

### *Research and Development*

If the potential benefits of the iPad and mobile technology revolution are to be realized by individuals who require AAC, substantial research and development work also is required. As noted earlier, most of the current AAC apps available for the iPad and other mobile technologies are not research-based; many simply replicate the approaches to representation and organization of vocabulary items seen with traditional AAC systems. As such, they often are not good fits with the motor, language, cognitive, and sensory perceptual skills of children and adults who require AAC (Light & McNaughton, 2012). Research is required to investigate how to design AAC apps to reduce learning and processing demands and to increase appeal. For example, basic research is required to determine the visual-cognitive processing demands of different approaches to vocabulary representation, organization, and layout utilized in AAC displays, with a view to reducing the visual cognitive load and thus increasing resources available for the communication process – the true end goal (Fried-Oken & Light, 2012; Wilkinson, Light, & Drager, 2012). Research and development work is also required to ensure accurate and efficient access to mobile technologies by the range of individuals who require AAC, including those with the most complex needs. This work should address issues of traditional alternative access (e.g., scanning, eye gaze, head mouse, etc.) as well as new innovative multimodal approaches to access that capitalize on a range of motor acts and learned patterns of selection for individuals (Light & McNaughton, 2012).

With recognition of the increased scope of communication needs that must be addressed in AAC interventions, future research and development is required to ensure that individuals with complex communication needs have access to greater functionality and interconnectivity through mobile technologies (Shane,

Blackstone, Vanderheiden, Williams, & DeRuyter, 2012). In addition, research and development is required to realize the full integration of communication into the multiple functions provided by mobile technologies. It is well understood that communication is not a separate isolated function, but rather one that overlays and permeates all daily activities (e.g., Simeonsson et al., 2012). Research and development is required to truly integrate communication seamlessly, across an increasingly diverse and complex array of functions, and thus maximize the power of these mobile technologies.

### *Evidence-based Practice*

If the potential of mobile technologies is to be fully realized, it is critical that applications of these technologies are guided by what we already have learned in the field of AAC (Bryen & Ervin, 2012). There is an increasingly strong evidence base that delineates factors that result in successful implementation of AAC to improve communication and enhance participation for individuals with complex communication needs (e.g., Beukelman, Fager, Ball, & Dietz, 2007; Bopp, Brown, & Mirenda, 2004; Branson & Demchak, 2009; Fried-Oken, Beukelman, & Hux, 2012; Ganz et al., 2011; Machalicek et al., 2010; Schlosser & Sigafos, 2009; Wendt, 2009). It is critical to ensure that the foundations of evidence-based practice are in place regardless of the technology platform used: (a) effective AAC interventions require careful assessment, by a knowledgeable team, of the individual's needs and skills as well as of the opportunity supports and barriers within the environment; (b) AAC systems must be selected based on the needs and skills of the individual and must be customized accordingly to meet these needs and skills; (c) simply providing access to AAC apps does not ensure effective communication; rather, concerted intervention is required to build the individual's linguistic, operational, social and strategic skills to further his or her communicative competence; and (d) in order to be optimally effective, intervention must extend to the communication partners, to ensure that they have the knowledge and skills required to effectively support the individual who requires AAC. These fundamental principles of evidence-based practice apply even when the AAC intervention utilizes the iPad or other mobile technologies.

### **Conclusion**

The AAC field is clearly at a crossroads. The iPad and mobile technology revolution has rocketed AAC into the mainstream, offering new options for meeting a breadth of communication needs, increasing public awareness, enhancing adoption by consumers and their families, democratizing access to AAC technologies, and transforming the model of service delivery to one that is consumer-driven. But the revolution has also brought into sharp focus a number of critical challenges. How will we respond as a field? This time of

fundamental change provides an opportunity to galvanize our research and development, and to maximize our service delivery to ensure evidence-based practices are implemented. Meeting these challenges, however, will take concerted work from a wide range of stakeholders representing multiple perspectives and disciplines, including individuals with complex communication needs and their families, education/rehabilitation professionals, researchers, software/technology developers, mainstream technology companies, assistive technology manufacturers, and policy makers.

Diamandis and Kotler (2012) proposed that the current rapid dissemination of new technologies, coupled with dynamic collaborations among innovative thinkers, has given us the tools to solve the most complex problems and to truly transform the lives of people who face significant challenges. Individuals and small groups are now empowered to effect changes that could only be realized in the past by governments and large corporations. We have already seen the beginning of the transformation of the field of AAC (Hyatt, 2011; Kagohara et al., 2013; McLeod, 2011; Niemeijer et al., 2012; RERC on Communication Enhancement, 2011; Rummel-Hudson, 2011). To take full advantage of the potential of iPads and mobile technologies as supports for communication, however, we must use the best of what we have learned to shape our decisions about the future of AAC (Williams et al., 2008). With effective collaboration and innovative problem solving in the AAC field, we will be able to improve the designs of AAC technologies/apps, determine the most effective approaches to intervention, enhance the translation of research to practice, and maximize communication and participation for children and adults who require AAC.

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### **Note**

1. The iPad is a registered trademark of Apple Inc., 1 Infinite Loop, Cupertino, CA, 95014, USA.

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