

THE STATE OF RESEARCH AND PRACTICE IN AUGMENTATIVE AND ALTERNATIVE COMMUNICATION FOR CHILDREN WITH DEVELOPMENTAL/INTELLECTUAL DISABILITIES

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Augmentative and alternative communication is a compilation of methods and technology designed to supplement spoken communication for people with limited speech or language skills, including children with developmental and intellectual disabilities. The field of AAC has evolved rapidly within the last 10 years, due to a combination of empirical advances from research as well as rapid changes in technology. This article reviews some of the most significant aspects of this growth as it relates to children with developmental disabilities. Major issues within the field, the evidence base available to practitioners and researchers, and promising areas of future growth are identified. ©2007 Wiley-Liss, Inc. MRDD Research Reviews 2007;13:58–69.

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The term “augmentative and alternative communication” (AAC) refers to a compilation of methods and technology designed to supplement spoken communication for people with limited speech or language skills. As stated in a technical report prepared by the American Speech-Language-Hearing Association, “AAC involves attempts to study and, when necessary, temporarily or permanently compensate for the impairments, activity limitations, and participation restrictions of individuals with severe disorders of speech-language production and/or comprehension” [ASHA, 2004, p. 3; also see Beukelman and Mirenda, 2005, for more detail on many of the issues discussed in this article]. Estimates suggest that perhaps as many as two million Americans “experience speech disability to the extent that they have significant difficulty being understood by others” [ASHA, 2005]. Among those who can benefit from AAC intervention are children with language limitations concomitant with intellectual and developmental disabilities such as cerebral palsy (CP), Down Syndrome, autism spectrum disorder, or intellectual disabilities of unknown origin.

Romski and Sevcik [1997] reviewed the state of the art in AAC for children with developmental disabilities. In the subsequent 10 years, the field has experienced an explosion in tech-

nology, new approaches to assessment and intervention, visibility within and outside the discipline, and the evidence base for clinical practice. For instance, a search of the *ComDisDome* electronic database (dedicated to scholarship in communication disorders) reveals that in the decade since Romski and Sevcik’s review, 285 journal articles were published that included the term “augmentative and alternative communication,” more than quadruple the 64 articles that had appeared in the entire 30 years prior (from 1965 to 1995). The growth is even more marked in publication of books on the topic, with 67 in the last decade as compared to a total of five in the three previous decades. In this article we survey some of the most significant aspects of this growth as it relates to children with developmental disabilities.

TECHNOLOGY AND THE AAC EXPLOSION

As a field we have begun to understand that multimodal approaches incorporating both gestures, vocalizations, sign, orofacial expressions as well as picture symbols, voice output devices, or other computer-based technologies (as well as speech) are most successful for meeting the complex needs of communicators across settings [Hustad and Shapley, 2003; Mirenda, 2003]. However, without doubt one of the major contributors to the explosion of interest in AAC is the rapid expansion of readily-available and user-friendly technologies. It is therefore critical both to recognize the valuable contributions of the entire spectrum of possible communication modes, and also to understand the impact of the currently available and powerful assistive technology on our clinical practices.

Levels of Technology Within AAC

A traditional distinction within AAC is made between “unaided” and “aided” modes. Unaided AAC modes are those

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in which no external device is required; generally, these include sign languages or gestural cueing systems. In aided AAC, an external aid is used to store and display symbols. These aids can have little to no technological component or they may involve substantial technological support; thus, we will also distinguish between light-technology and high-technology aided modes.

Unaided AAC modes

Because unaided AAC needs no external supporting device, the minimal access/production requirements are digit control sufficient to produce signs, gestures, or touch cues. With no external aid, unaided AAC has advantages of portability and speed of message preparation, as well as access to a potentially unlimited pool of messages. However, unaided modes also have some limitations. Signs requiring fine motor distinctions can be difficult to produce, and thus may not be the best productive mode for all children. Furthermore, many if not most unaided modes may have a restricted set of potential listeners, as idiosyncratic gestures are understood only by familiar partners and signed languages only by those who have learned the language.

Unaided modes have been shown to support language learning in children with developmental disabilities that can be associated with intellectual disabilities [like autism; Tincani, 2004; see Goldstein, 2002, for a review]. When considering intellectual disability more specifically, the literature is mixed. Although some studies report positive outcomes for sign intervention with children and adults with intellectual disabilities [e.g., Conaghan et al., 1992; Miller et al., 2002], some apparent failures to learn have also been reported, particularly among individuals with severe intellectual limitations [Kahn, 1996; Grove and Dockrell, 2000]. Unaided modes such as sign language have been studied across a number of disability groups and for many years [e.g., Rowski and Ruder, 1984; see Bryen and Joyce, 1985], and thus review of the extensive literature is impossible in this article. Consequently, for the purpose of the current review, we will focus primarily on aided modes.

Aided AAC modes: Light-technology

Light-technology aided AAC modes require little to no technology, but include external aids of some sort. These include alphabet boards, symbol-

based topic boards, communication books, and communication programs such as the Picture Exchange Communication Program [PECS; e.g., Bondy and Frost, 1994, 2001]. Media like dry erase boards or paper and pencil are also useful because they allow for expansion and modification of messages directly within an ongoing interaction, with little required preparation time or interference with the ongoing communication. These temporary handwritten and handdrawn displays can help communication partners create vocabulary specific to an ongoing conversation, vocabulary that may not be present on the more long-term or "permanent" display. Consider a conversation about a recent visit to a horse farm, in which the permanent display has only the symbol for HORSE. A child may indicate that the horse under consideration is small, perhaps through a gesture; the conversation partner may then use the dry-erase or pencil-and-paper medium to draw a mother horse and her foal, learning in the process details about the visit that could not be communicated with the limited, permanent vocabulary. In comparison, when using high-technology devices partners must momentarily take control of the electronic device in order to program a word or phrase, thus interfering with the flow of the conversation, as such devices typically can not be used for communication while being programmed. Although systematic research concerning efficacy of such approaches is currently limited to clients with aphasia [e.g., Lasker and Garrett, 2006], the possibilities for extension to children with intellectual disabilities are clear and warrant systematic evaluation as well.

Light-technology options do not provide voice output and typically require communication partners to speak the words and phrases that the child selects. In some ways, this can promote a highly interactive exchange. For example, single-meaning symbols often refer to more than one concept, such that if a child pointed to the symbol for birthday, he could be attempting to discuss his upcoming birthday, a sibling's celebration, or asking when is the cupcake party at school. For communication to be successful, either the AAC user must elaborate somehow or the communication partner must guess various options.

Because the partner is so involved in the process, the interactions tend to be rapid and approximate the back and forth nature of communication between speakers [Higginbotham and Wilkins,

2006]. Furthermore, light-technology options also lend themselves well to modeling by the partner, because the partner can readily augment his or her natural spoken input by pointing to symbols on the board. As a result, these options readily serve not only as an expressive mode for the child but also as a means for partners to provide models which, as we review below, support a child's comprehension. The success of this type of interaction, however, depends on a number of factors, in particular the familiarity of the partner with AAC user's communication style and personal experiences, the topics being discussed, and his or her own role in the interaction [Kent-Walsh and McNaughton, 2005]. Research clearly indicates that training of partners to become familiar with aided communication is one of the most critical contributors to the success of AAC intervention [Johnson et al., 2006]. Specific approaches to training are becoming available but as yet have undergone little systematic study; more research is necessary to build the evidence base in support of any one of these approaches [see Kent-Walsh and McNaughton, 2005, for a more detailed discussion].

Visual symbols often used in light-technology (as well as high-tech) include photographs, line drawings, letters, or other icons organized onto communication boards, schedule boards, color-coded educational materials and the like. Making minor changes on these boards is easily accomplished by printing and pasting symbols or temporarily attaching a post-it note to the display, however it is often time consuming to create, print, laminate, and organize a set of communication paper-based communication symbols. Even when symbols are stored where they are most likely to be used, as recommended by Goossens' et al. [1994], communication displays do get lost or misplaced and there are times when a symbol is unavailable when needed.

Aided AAC modes: High-technology

Electronics and computer technologies have changed markedly in the past 10 years. The general consumer market has driven increases in memory capacity, processing speed, and battery life while the weight, size, and price of computers and electronics have dropped. As digital cameras, digital video editing software, scanners, and color printing gain wider use in larger segments of the general population, these technologies are being integrated

to support communication. Digital photographs are emerging as means of representing objects, people, and places in a child's life and can rapidly be added to an AAC system. A recently introduced AAC product, the Tango™ from Able-Net, has taken this one step further and included a built-in camera that allows photographs to be incorporated as a symbol immediately. Similarly, video clips from a child's own life may facilitate the sharing of personal stories and computer-based video instruction show promise as a means to augment more traditional forms of instruction [Mechling and Cronin, 2006].

In years past, the memory demands of AAC files exceeded the capacities of existing data storage options and it was often difficult to impossible to share files between computers or users. If a computer stopped working, communication files were often lost forever. The emergence of NAND flash memory in consumer products such as USB keys, flash drives, and digital camera memory sticks has markedly eased the transfer of relatively large electronic files associated with AAC applications that utilize digital images, recorded sounds, and videos.

Although high-technology devices are appealing to many users, particularly given the advances we have described, they may not always be the mode of choice for a specific situation or individual. Electronic devices are more vulnerable to damage than light-technology; for instance, if a device will be used in a location with regular exposure to water (e.g., a dishwashing vocational placement; swim team) care would have to be taken in waterproofing the device. Devices placed in backpacks for travel to, from, and within school must not be overly sensitive to jolting. Low-technology systems are often far more portable and durable, and more easily replaced. Ideally, a mix of the two types may be most reasonable for individuals using aided modes.

ISSUES WITHIN AIDED AAC MODES

Because of the use of a physical, external device for symbol storage and display, aided AAC requires clear alterations both from speech and from unaided modes of communication. These alterations introduce some important challenges that do not exist in spoken or unaided communication. Although there are many, we have selected for review issues related to symbol access, display types, voice output, and symbol and display size.

Symbol Access

Aided AAC requires that the user select symbols from a book or electronic display. One means by which the user can access the symbols is through *direct selection*. In this case, the user either points directly to the symbol (either with a finger or through an alternative means like a head-mounted stick or laser pointer) or gives the symbol to the communication partner, as in the Picture Exchange Communication System [Bondy and Frost, 1994, 2001]. Another means of access is *scanning*. In scanning, each symbol in the display is highlighted one by one, either manually by a partner (light technology) or through a light or sound cursor (electronically). When the target symbol is reached, the user indicates the selection by whatever means is available to her: eye blink,

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head-switch, and so forth. Symbols can be scanned one-by-one in a linear fashion; however, this access method is quite slow for individuals with larger vocabularies. To enhance scanning speed, groups of symbols can all be highlighted at once. If the target is within the group the user selects that highlighted group, at which point scanning of individual symbols within the subset is begun.

In addition to being slow, scanning requires the user to inhibit overt responses to each and every symbol that is highlighted prior to reaching the target; this clearly taxes both attention and cognitive resources. Scanning also requires that the user be able to predict correctly the timing at which the target symbol will be reached by the cursor; if

the user errs, an incorrect symbol will be selected. Thus again, motor, attentional, and cognitive resources are necessary.

A final problem with scanning is that the traditional methods we have discussed can be difficult for some clients to understand. McCarthy et al. [2006] compared 20 two-year old children's selection performance under traditional and enhanced linear scanning. In the traditional scanning condition, each target stimulus was highlighted one at a time by a red square enclosing the stimulus' perimeter while a voiceover spoke the stimulus' name in a neutral intonation. In enhanced scanning, each target stimulus was highlighted one at a time by having the stimulus grow larger, by virtue of it appearing to "move in sequence from the selection array (the background) to the foreground," while a voiceover spoke the stimulus name in a question intonation. The toddlers who underwent the traditional scanning condition failed to demonstrate any learning (improvement in task performance) across sessions, selecting at no more than 20% accuracy in any of the three experimental sessions. In contrast, the group who underwent enhanced scanning condition also selected at 22% accuracy at session 1 but showed a statistically significant improvement to 48% accuracy by the third session (although some individual children did not show such improvement).

Because of the limitations in scanning as an access mode, direct selection is generally the first-choice access method, whenever possible. However, scanning is essential for children who do not have sufficient motor capabilities to perform direct selection. Without a scanning method, those children would have no independent voices. Although McCarthy et al. [2006] studies have not been conducted yet with individuals with intellectual limitations, it certainly seems possible that current scanning methods might well be inappropriate for other individuals who are functioning at developmentally early stages as well. Their study also suggests, however, that scanning may indeed be made a more viable access mode if structured appropriately. Clearly, studies on maximizing scanning as an access mode for individuals who have MR/DD will be a critically important area for further research and technical development.

Fixed and Dynamic Displays

Another aspect of aided AAC is the way in which symbols are presented

on the aid and related to one another. There are two primary methods for relating display pages: *fixed* (or static) and *dynamic* display. In fixed displays, pages containing symbols are constructed and maintained in an external location, such as a folder or book. Access to any given symbol is accomplished by finding the appropriate overlay page; this overlay is then placed in view or on a device for symbol selection. Fixed displays often require another person to switch between vocabulary pages if the AAC user cannot do it independently.

Although fixed displays are commonly associated with nontechnological aids like picture books or schedules, they are also available as part of a wide range of simple voice output communication aids (VOCAs). Some VOCAs have a single button to activate, while others have an array of symbols to select from. Often, the content of the message can be recorded by the communication partner for ready access and simple re-recording. An example of the use of such a display would be for “circle-time” participation. A child who was assigned to report on the weather one week could have the aid programmed each morning (by parent, peer, or teacher) with a simple weather-related phrase, with re-programming on an as-needed basis throughout the day. Empirical evidence supports the effectiveness of such simple means-ends goals as a method for introducing AAC to children even with the most severe intellectual and communication limitations. Cosbey and Johnston [2006], for instance, documented a successful intervention to teach the use of a single-switch VOCA as a means to gain access to preferred activities and peers in an included classroom setting, by three children with multiple severe disabilities.

The advantages of such simple fixed-display VOCAs include the relative ease of recording (press two buttons simultaneously and speak to record), natural-sounding speech intonation, ease of partner modeling, and their relatively inexpensive cost. On the other hand, symbols are not electronically stored and must be printed, cut out or drawn; overlays can be cumbersome to store and change; the user is often dependent on others to program and navigate between pages; and only a finite number of symbols are available at one time. These fixed displays limit both the number of vocabulary items and the number of word combinations possible. For a beginning communicator, simpler displays with few options may be beneficial as long as a

wide variety of overlays are presented and modeled throughout the child’s day. Clearly, however, for more advanced communicators such limitations would be undesirable.

The second type of display, dynamic display, typically involves specially designed communication software that is run on a modified computer. Typically communication symbols are arranged on electronic pages. Each location on the screen can be programmed to do a variety of functions. Symbols can speak words, phrases, or even sentences. Others link to different pages of symbols; activating a navigating button is similar to clicking on a link on a webpage that takes one to another page. Some of these devices include standard computer features, such as a word processing, electronic calendars, and web browsing, and others serve only as a communication tools (dedicated devices). Additional features on some devices include playing MP3’s, opening a web browser, or controlling the TV.

Dynamic displays can be used in similar ways to fixed displays, except now the user has potentially more independence in navigating and even programming the device. Because the symbols and their programmed messages are all stored internally on the device, issues of physically misplacing the fixed display overlay page no longer arise (although the challenge of locating the electronic page within the system remains). While storing and finding a very large number of symbols is cumbersome on fixed displays, dynamic displays allow for far larger and more readily accessed vocabulary. Furthermore, overlays and messages can be designed to promote deliberate vocabulary selections and creative combinations. For example, an overlay with several students’ names, the carrier phrase “your turn to,” and a series of motivating actions allows an AAC user and participating peers to create scripted phrases such as “Sarah + your turn to + clap” and “John + your turn to + make a silly noise.” For a student with more advanced skills, an overlay with many items and a wide range of parts of speech (pronouns, verbs, adverbs, adjectives, etc.) or carrier phrases could activate a series of buttons to compose full sentences to share information, comment, as well as ask and answer questions.

What is important to note, particularly for children with developmental disabilities, is the flexibility in how technology can be programmed to vary the demands placed on the student. If an AAC user has difficulty navigating between

pages or selecting symbols, cognitive and visual demands could be decreased by limiting the number of symbols per page, using a different page layout, and organizing vocabulary around a specific topic or situation to limit the need for navigating between unseen pages. For instance, Drager et al. [2003] and Light et al. [2004] have demonstrated that young preschool children can locate symbols more readily when they are presented as components of a larger visual scene (a photograph), rather than as individual components of a grid (these studies are described in more detail at the end of this article). Again, although currently the research is limited to nondisabled preschool participants, it seems reasonable to suggest that the logic might apply to older individuals with MR/DD whose cognitive and language functioning is within the preschool developmental range.

Preprogrammed sentences, phrases, and carrier phrases that supplement single word vocabulary can also help to reduce demands on a user of AAC, in this case linguistic demands, as well as to speed up the rate of aided message preparation. In their review of AAC for beginning communicators with severe disabilities, Wilkinson and McIlvane [2002] pointed out that preprogrammed messages not only allow for rapid conversations, but are components of typical language development and thus may enhance the developing repertoire on a number of levels. If the goal is to increase social interaction, preprogrammed scripts allow a student to focus on elements of communication such as initiating, use of facial expressions, and the timing of the communicative interaction. For example, the AAC user might only have to activate a screen sized symbol (field of one), which once selected speaks a message (e.g., “Simon Says”) and automatically open another page with one or more options (e.g., “touch your head”) that also automatically links to another page with another message that will continue the interaction. Research on preprogrammed messages as they relate to clients with intellectual disabilities will be an important addition to the evidence base upon which AAC practice is based.

Despite their advantages, dynamic systems have some costs. Users must be able to understand the relationship between the virtual pages on the display, between the symbols themselves, and to understand how the same physical space can be occupied by different symbols. In addition to operational demands, the task of locating a symbol within either fixed or dynamic displays is more complex than it might initially appear. Consider a

user who wishes to communicate about a snack food like POPCORN. She must generate a mental representation of this item and search for its icon in a multi-stimulus visual array. Furthermore, most users have more than one page of symbols, since limiting the vocabulary to what fits physically on a single page would necessarily restrict the size of the child's lexicon. Users must therefore often search through more than one display to access any given symbol. A user with a fixed display system must physically flip through different pages to locate the one on which POPCORN appears, examining and rejecting other potentially distracting pictures (or whole pages) before finding the correct one. In dynamic displays, the user must move sequentially or hierarchically through several electronic pages of symbol displays to access a given symbol. For example, a user might begin on a general "menu" page, on which selection of the icon for FOOD is necessary to prompt the computer to present a second menu page with further choices; the user might then have to select the icon for SNACKS on this second menu page before the display containing the actual POPCORN icon appears. Like the fixed display books, finding a symbol requires examining and rejecting picture distracters while searching for the desired target item. The dynamic access mode also requires the user to deliberately select other pictures (in our example, the FOOD icon, then the SNACKS icon) before even getting to the final target. This task thus involves both memory and attention, because recall must maintain not only across delay but across the intervening symbol selections. Thus, memory and attentional skills present different considerations for aided communication than those required for speech, and may be particularly difficult challenges for individuals with intellectual disabilities and any concomitant memory or attentional limitations.

Voice Output

The voice output afforded by technology is a key component of the AAC experience, particularly for children with MR/DD [Goossens', 1989; Schlosser et al., 1995; Ronski and Sevcik, 1996; Schlosser, 2003a]. The feedback from and communicative power enabled by voice output appears to offer advantages not only for outcomes for learners themselves but also in terms of communication partners' perceptions of and responses to AAC [Schlosser, 2003a]. These advantages are reported across a variety of different studies, including

those with true experimental control [see Millar et al., 2006, for a review].

Within voice output devices, there are different types of speech available that have different characteristics [see, e.g., Venkatagiri, 1996]. Digitized speech is speech that is converted into the digitized format then reconverted back into speech output; played back, it sounds like recorded speech. Digitized speech easily and accurately captures the intonation of speech. Synthesized speech is computer-generated from specific input, based on various acoustic/phonetic algorithms. Synthesized speech sounds as if it was generated by a computer and is generally harder to understand than natural speech, particularly for children [e.g., Mirenda and Beukelman, 1987, 1990].

Digitized speech is more adept at capturing the meaningful inflections of human speech, and has been found to be more intelligible than synthesized speech in children as young as 3–5 years of age [Drager et al., 2006]. However, in addition to requiring significant memory space, digitized speech also conveys information on gender and age that may or may not be appropriate depending on the characteristics of the person recording the speech and the AAC user. Furthermore, the generativity of digitized messages is constrained to whatever is prerecorded, unlike synthesized speech in which new messages can be generated directly [see Drager et al., 2006, for a clear discussion of these issues].

Bedrosian et al. [2003] and Hoag et al. [2004] have recently documented some of the functional repercussions of messages whose content is not quite accurate on the process of communication. Scripted scenarios were videotaped of AAC users as they attempted to purchase a book in a bookstore. In one condition, the user produced a preprogrammed message that was only tangentially related to the context. Because it was preprogrammed, it was produced within 4 sec of the AAC user's turn onset; however, its content was not quite relevant. In the two other conditions, the AAC user/actor followed a script in which s/he typed a directly relevant message, by hand. Because it had to be hand-typed, the message took 90 sec to complete. Its content was quite relevant, however. In one of the "slow" rate conditions, the AAC user stated directly "please wait while I prepare my message" (using what the authors called a floorholder), in the other, the AAC user simply began to prepare the message.

Sales clerks who viewed the videotapes were asked to rate their attitude toward the target communicator. Ratings were significantly more positive when the message was accurate, despite the lowered rate of message preparation, and particularly when the floorholder message was presented. This behavioral rating was confirmed by self-report in which clerks were asked directly if they would rather that a message be fast, if a little off-topic, or if they would rather the message be accurate even if it takes longer. The rapid, slightly off-topic condition was ranked lowest in 90% of the responses, while the slower but accurate condition, in which a warning or floorholder is provided, was most preferred. Clearly, precision in content of message appeared to matter more to listeners than speed of message delivery, in this one experimental context. While once more this research has not been extended systematically to users with MR/DD, the possibility exists that inaccurate messages produced by such individuals might be perceived in a similarly negative light. This possibility seems particularly salient in light of studies, suggesting that individuals with MR/DD already face a challenge of negative perceptions and stereotyping associated with their intellectual disability [e.g., Pittock and Potts, 1988; Shafer et al., 1989; Handler et al., 1994]. Further research with this population is clearly warranted to determine how perceptions about MR/DD may interact with or alter perceptions of aided AAC communication.

This issue of the relative advantages of digitized versus synthesized speech (and thus generativity) may change as technology advances. Previously voice output devices only had the capacity for either digitized or synthesized speech. Some newer devices incorporate both types of voice output, potentially allowing users to reap the benefits of each as appropriate. In addition, despite their advantages, there are also some drawbacks to voice output systems. Systems with large storage capacities and highly intelligible speech can be more expensive and difficult to learn to program than light- or low-technology ones. As with high-technology more generally, devices that include speech output are necessarily prone to potential damage from being dropped or exposed to water. Unlike a low- or no-tech device, when a device with voice output breaks it can be time-consuming waiting for repairs. In that case, the child's entire voice can be silenced until a replacement can be

obtained (unless there is a low-tech backup system in place). Again, a judicious mix of voice output and other lower-technology modes may be key.

Symbol and Display Size

A final issue concerns the physical dimensions of aided displays. All aided AAC requires a physically defined and limited space upon which symbols are presented. Imagine an AAC display that was 12 by 12 inches. If we place symbols that are 2 inches square onto the display, we would be limited to 36 symbols. If we wanted to increase the number of symbols displayed, we would either have to reduce their size (trading off vocabulary size with symbol size) or increase the size of the actual display (trading off vocabulary size with aid size).

There is evidence to suggest that size of the symbol display affects behavioral outcomes. Mizuko and Esser [1991] and Mizuko et al. [1994] studied the impact of two factors on memory tasks in nondisabled preschoolers. One factor was the method by which children accessed the symbols (e.g., direct selection or scanning), and the other was the number of symbols in the array. They found that memory for sequences was better when access was simpler, particularly among younger children faced with large symbol arrays. Ratcliff [1994] studied children's ability to find a target symbol within an array of 128 symbols. Again, performance under two access methods was contrasted. However, she also manipulated the complexity of the instructions. Four levels of complexity were presented, ranging from "find a big green circle" (Level 1) to "Find the black circle to the left of the white square" (Level 4). Given 128 stimuli from which to choose, this task likely required a search in which the child had to retain the target instructions in mind while searching through distracters. Errors increased with difficulty level, and older children performed better than younger children. Both sets of studies suggested that AAC symbol discrimination and recall were sensitive to motor access, array size, and instructional difficulty. As Rowland and Schweigert [2003] summarize, although little research exists the relationship of these intellectual abilities to AAC remains an important area for further study.

SOME IMPORTANT ISSUES IN AAC AND THEIR CURRENT EVIDENCE BASE

Although there are many important issues within AAC, we have selected for review four areas that have

longstanding repercussions in AAC and which have a developing evidence base. These include the functions served by AAC, the relation of AAC to development of speech, eligibility and exclusion criteria, and the role of partners and communities in supporting AAC users.

Roles of AAC as a Communication Mode

One of the most immediate roles of AAC is to enhance the expressive skills of individuals who have relatively good understanding of speech but who have some barrier to producing it. For these individuals, AAC serves primarily as the output mode for expressing the ideas and thoughts of the individual user. Yet equally important is the use of AAC as not just an output channel, but indeed as the medium for both expressive and receptive communication [Ronski and Sevcik, 1993, 1996]. Some disabilities can interfere not just with speech production but also with the ability to understand the speech of others. In that case, AAC modes provide the basis for both output and input channels and therefore form the entry-point into both nonverbal forms of communication as well as more advanced or symbolic language.

A second role of AAC is to enable the child to express a range of communication functions, across settings, with a variety of people. The goal is to use current cognitive, motoric, social, and linguistic skills to meet the child's needs utilizing whatever technology or strategies may be appropriate. For this to occur, particularly with children, Light [2006] has suggested that communication modes (including aided ones) need to be appealing to users, versatile, and easy to learn. Furthermore, users of AAC must be able to do more than request, protest, and answer questions; they must also comment, ask questions, express emotions, and build relationships [Light, 1989; Light et al., 2003]. A competent communicator should meaningfully impact and make sense of the world. As Light [2006] recently stated, "there is no inherent value in the use of AAC technologies in and of themselves; their value lies only in their power to maximize communication and participation" (p. 2).

A third role of AAC is as a tool for reducing challenging behaviors such as aggression, self-injury, or unwanted social behaviors. Extensive research has documented the role of AAC in reducing challenging behavior in children with developmental disabilities, includ-

ing autism and severe mental retardation. Some evidence-based strategies include instruction on specific communicative acts such as requesting or rejecting [e.g., Johnston and Reichle, 1993; see Johnston et al., 2004], implementing positive behavior support plans that include AAC [Durand, 1993; Hetzroni and Roth, 2003; Bopp et al., 2004], altering input from partners to include use of the aided modes by partners ["aided input"; Peterson et al., 1995; Sevcik et al., 1995], and creating schedule boards or other planning aids [Bopp et al., 2004]. Goldstein's [2002] review of interventions in autism illustrates that these advantages hold for unaided modes such as sign languages as well. For example, a child might be taught to sign to request help in situations where the child previously became frustrated, producing unwanted or challenging behavior. Reviews of these and other communication alternatives to challenging behavior can be found in Mirenda [1997] or an edited book by Reichle and Wacker [1993].

Finally, AAC plays a fourth important role as a bridge to later linguistic development. At its earliest stages, single-meaning symbols provide the entry point for many individuals with MR/DD into a new level of symbolic behavior [Ronski and Sevcik, 1996; see Mollica, 2003]. These symbols also provide their users with access to all of the functions associated with symbolic communication, from the ability to reference people or events that are not present through important social-regulatory functions [Adamson et al., 1992]. Single-meaning symbols can serve as the building blocks for early symbol combinations [Wilkinson et al., 1994]. However, AAC can also support more complex linguistic functioning as well, through the use of traditional orthography or other generative symbols [Sturm and Clendon, 2004]. In these systems, the generative and syntactic features that characterize linguistic spoken systems are realized within aided AAC.

Relation of AAC to Spoken Communication Modes

One misconception about AAC is that it *replaces* spoken communication. As Hustad and Shapley [2003] have pointed out, this is in fact rarely the case. Even when AAC serves as the primary communication mode (for instance, for individuals with extremely limited speech skills due to oral-motor apraxia or degenerative motor disease), there is always a role for whatever vocal

production skills the communicator brings. Furthermore, as noted above, AAC can serve as a supplement to functional speech abilities for many users. For instance, individuals with moderate speech intelligibility might use AAC as a cue when a spoken message is not understood, or they might bring an AAC aid when they anticipate meeting strangers who would have difficulty understanding them, such as at a restaurant or sporting event.

One question often encountered by service providers is whether AAC intervention will inhibit a child's development of speech. The concern is that if the child is offered a nonspeech mode of communication, she will have no motivation to develop speech. This concern is often raised with younger children, and is one reason why some parents or service providers resist AAC implementation at very young ages. There is mounting evidence, described earlier, that aided modes of communication, especially those with voice output, in fact enhance existing speech skills among children with developmental/intellectual disabilities [Schlosser et al., 1995; Romski and Sevcik, 1996; Schlosser, 2003a; Millar et al., 2006]. As noted earlier, this is true of unaided AAC modes as well [see e.g., Goldstein, 2002].

Eligibility and Exclusion Criteria Related to Chronological or Developmental Age

One of the longstanding challenges to providing AAC intervention with children with MR/DD has been the implementation of "candidacy" or "eligibility" criteria for service provision. These criteria essentially involved a double-edged sword. On the one hand, as reviewed recently by Rowland and Schweigert [2003], children have been excluded from AAC services because they fail to demonstrate so-called "prerequisite skills" that were thought necessary to successful AAC communication. Many of these prerequisite skills were cognitive in nature, including Piagetian constructs like means-ends play or object permanence. Children who did not meet the candidacy criteria were not considered able to benefit from AAC intervention, and thus explicitly denied those services. However, another aspect of the eligibility issue involved children with some existing or potential speech skills. In part because of the concern discussed earlier that AAC implementation might impede speech development, AAC was perceived as a "last resort" approach,

implemented only when it appeared that spoken communication might not ever be able to fully serve the range of an individual's communication needs. This meant that young children with severe communication support needs often did not receive AAC intervention until they were older and, of course, correspondingly more delayed. In both cases, the result has been to restrict access to functional communication modes.

Unfortunately the use of candidacy criteria like cognitive level or chronological age as the basis for exclusion from services can still be seen in practice, although it has been rejected explicitly by the American Speech-Language-Hearing Association [ASHA, 2004, 2005] and the National Joint Committee for the Communication Needs of Persons with Severe Disabilities [2002, 2003]. In its place is the understanding that AAC reflects a continuum of communication that can range from simple social or turntaking routines through more sophisticated use of symbols. AAC intervention goals for someone who is not yet "ready" for symbolic communication should be appropriate to where that person is on the continuum; thus, a client's short-term AAC goals may include using aided modes simply to establish and maintain simple turntaking routines like peekaboo games, while her long-term goals include more advanced symbolic behavior.

The mounting evidence supporting the mutual benefits of AAC for development of speech, as well as the appreciation for the value of multimodal communication has reduced both the use of "cognitive prerequisites" for as inclusion/exclusion criteria for services as well as the fear that AAC will impede spoken language development. As a result, there is an increasing focus on best practices for AAC intervention with young toddlers [Cress and Marvin, 2003; Sevcik et al., 2004; Romski and Sevcik, 2005]. Extensive research now focuses on such topics as how to make aided communication more appropriate or transparent for toddlers and preschoolers [Light et al., 2004], how to maximize vocabulary selection for youngsters using aided symbols [Fallon et al., 2001], how preschoolers with developmental delays learn symbols within the aided AAC mode [Barton et al., 2006], how to teach early literacy skills [Fallon et al., 2004], and how to facilitate collaborations among professionals serving very young children to enhance their inclusion in educational programs [Hunt et al., 2004].

The Role of the Partner and the Community in Supporting AAC

While speaking children theoretically have access to any words they have previously learned, children who use voice output devices either must spell words themselves or rely on others to record, print, or program specific vocabulary for them. Because many children with MR/DD do not have ready access to literacy skills, a main role of communication partners in aided AAC is to help generate vocabulary and assist with programming. It is therefore important that partners and professionals provide AAC users with adequate, relevant, and motivating vocabulary to support a wide range of communicative functions. For example, a list of foods primarily fosters requesting, possibly commenting, but little else. In contrast, a diverse set of vocabulary items including verbs, exclamations (*oh no!*), jokes, adjectives, as well as nouns related to topics such as dress up, school gossip, or recent trips is more likely to promote a richer social interaction with multiple conversational turns.

Romski and Sevcik [2003] have argued convincingly that another key role of the conversational partner is to model the use of the technology, in the same way that partners model the use of speech to children learning oral/aural communication. Ideally, partners use devices and symbols to supplement their own speech to teach new concepts, demonstrate the use of the device as a communicative tool, and decrease stigma while discovering for themselves any problems with vocabulary or organization that need to be addressed. Unfortunately, modeling may not be used as often by partners as it should [e.g., see Smith and Grove, 2003], even though the benefits of what is called "augmented input" have been documented consistently. Some of the earliest programs incorporating partner input include Goossens' [1989] *Aided Language Stimulation* (ALS) and Romski and Sevcik's [1996] *System for Augmenting Language*. These programs revealed the importance of the modeling in language outcomes of a school-aged child with CP [Goossens', 1989] and 13 children and adolescents with mixed sources of developmental disability [Sevcik et al., 1995; Romski and Sevcik, 1996]. More recently, the effectiveness of variants on the ALS program for symbol comprehension and production outcomes have been documented in three preschool children with cognitive delays [Harris and Reichle, 2004] and two preschoolers with autism [Drager et al., 2006].

Light et al. [2002] have noted that conversation partners also serve a scaffolding role for social closeness and social interaction for children with developmental disabilities at any level of symbolic capabilities. With assistance and thoughtful use of technology, even presymbolic communicators can experience meaningful social interaction and participation in a variety of activities. For example, a person who has difficulty understanding and discriminating between symbols is unlikely to independently navigate and select symbols successfully as part of a complex interaction. Given an array of symbols, either high or low tech, selections likely will be random and unrelated to the activity at hand. In this case, the partner may need to provide additional assistance, such as hand-over-hand prompting. However, it is also possible to design activities that do not require symbol discrimination. Such an "errorless" approach would be one in which the partner acknowledged and accepted all communication attempts. In this case, the goal may be to teach the user to independently initiate turns with others during motivating contexts. Sample activities could include choice boards with symbols representing motivating songs, portions of motivating songs (e.g., clap your hands, shout hooray, stomp your feet), or even prompts to tell a favorite story about the individual (e.g., tell me again about my birthday party, tell me the story about the firetruck). As noted before, research has supported the use of AAC as a means of teaching such social-interaction goals with children with severe disabilities [Cosbey and Johnston, 2006].

Finally, no discussion of the role of partners in AAC would be complete without recognition of the critical importance of cultural, familial, and linguistic factors. In its early history, AAC interventions were implemented with little attention to cultural–familial input. However, recently it has become clear that as in all areas of service delivery, it is essential to consider AAC within the context of the individual, his or her family, and their social and community supports [Hetzroni and Harris, 1996]. One way to do this is to understand AAC service provision over time and in different countries and cultural–linguistic communities [e.g., see Zangari et al., 1994; Hourcade et al., 2004]. Another avenue is to examine the effects of AAC intervention not just on clients, but on their families [Angelo et al., 1996; Parette and Angelo, 1996;

Parette et al., 2000]. Recent discussions have emerged concerning the cultural appropriateness of different symbol types [Huer, 2003; Nigam, 2003] as well as how AAC practice or research can be conducted in culturally sensitive ways [Huer and Saenz, 2002; Vanbiervliet and Parette, 2002]. McCord and Soto [2004] have examined the role of cultural–familial experiences in influencing perceptions of AAC among Mexican–American families. As that ethnographic study pointed out, implementing AAC can be complex when

Practitioners and researchers have already recognized the critical importance of evidence-based practice in AAC assessment and intervention . . . However, despite the appreciation of its importance, the actual base of evidence itself is still at its inception. . . This is particularly true in the area of MR/DD, as evidenced by the many areas in our review above in which we are only currently at the stage of extrapolating from research on other populations.

the language of the school and the language of the home differ; for instance, questions of which language should be programmed into the voice output arise immediately. The ability to program boards in multiple languages addresses this operational concern, but introduces additional cognitive/linguistic demands on the user of AAC. Although AAC is only at the very beginning of this complex area, the recognition of cultural–linguistic factors promises to make this an area of significant activity in the upcoming years.

SUMMARY AND NEW DIRECTIONS IN AAC FOR USERS WITH INTELLECTUAL DISABILITY

The field of AAC has evolved rapidly within the last 10 years. The evolution represents a combination of the empirical advances from research as well as rapid changes in technology. The upcoming years promise to bring yet more theoretical, empirical, and clinical advances. Although predicting the future of a field that is undergoing such rapid transformation is risky, we conclude with a brief overview of several directions that likely will be of importance over the next few years.

Evidence-Based Practice in AAC

Practitioners and researchers have already recognized the critical importance of evidence-based practice in AAC assessment and intervention [Light, 1999], and clear recommendations have emerged for critical analysis of evidence [see, e.g., Schlosser, 2003b; Schlosser and Raghavendra, 2004]. However, despite the appreciation of its importance, the actual base of evidence itself is still at its inception [Schlosser et al., 2005]. This is particularly true in the area of MR/DD, as evidenced by the many areas in our review above in which we are only currently at the stage of extrapolating from research on other populations (nondisabled children, or those with other disabilities) or from current clinical practices. More research is clearly necessary to evaluate AAC intervention in individuals with severe disabilities and to allow practitioners to access evidence in support of their practice. This is clearly one of the most important directions in the field now and in the immediate future.

Adapting AAC to the Communication Support Needs of Children with Developmental Disabilities

Drager et al. [2003], Light et al. [2004], and Fallon et al. [2003] have noted that AAC devices have been developed primarily by and for adults. Several new lines of research have sprung up to examine the extent to which systems created by adults without communication disabilities (researchers and practitioners) match to the needs and skills of children, particularly those with cognitive and language learning disabilities.

One such line of research examines how the design features of AAC displays correspond to the preferences

of young children. As an initial step in this direction, Light et al. [2004] explored the role played by design features of the devices themselves as child-oriented systems. They analyzed similarities and differences in aided AAC devices to the electronic products marketed by toy manufacturers. Clear discrepancies were found in the basic features of the AAC devices, which lacked color, spontaneous and age-appropriate noises (farmyard noises, for instance) or lights, and readily manipulated items. Perhaps the drab grey, square AAC devices, with adult-programmed phrases accessed by pressing a square, were simply not appealing to young children, making their use an academic exercise rather than an empowering one. It remains to be seen, of course, whether more child-friendly alterations would enhance the appeal of AAC devices or instead distract from their functional use, but this is clearly an important direction to follow up.

Another line of research is examining how the organization of symbols on a display might be maximally effective for communication. Adults tend to organize items taxonomically; “dog” would be placed together with “cat,” since they are both animals. It has been argued that children organize things more on a thematic basis; “dog” would go preferentially with “bone,” rather than “cat,” because dogs chew bones [e.g., Smiley and Brown, 1979; Bauer and Mandler, 1989]. Yet many aided AAC symbol displays incorporate a taxonomic system, with pages displaying items like “snacks” (CHIPS, SODA, POPCORN) versus “animals” (DOG, CAT, HORSE). Although the research on this so-called thematic preference has been criticized [Waxman and Namy, 1997; Osborne and Calhoun, 1998; Blaye and Bonthoux, 2001], the fact remains that if younger children do rely predominantly on thematic organization, a taxonomically based display might not match their naturally occurring semantic organization strategies. Some research has attempted to examine the issue of semantic organization within the context of AAC [Fallon et al., 2003; Traylor, 2004], including with individuals with MR/DD [Wilkinson and Rosenquist, 2006]. These all represent initial efforts that offer potential methods for further research, however, and follow-up research is clearly warranted.

A final area for mapping AAC to the needs of chronologically or develop-

mentally young users of AAC is offered by the emergence of the concept of “natural scenes” as displays. Historically, aided symbols have been organized into grids, with each symbol occupying a separate space. Drager et al. [2003, 2004] and Light et al. [2004] have argued, however, that these abstracted approaches to symbol displays may not be consistent with the experiences of typical children during oral/aural language acquisition. Children learning speech hear words in a rich context; thus, the word “dog” is often initially heard as part of a predictable routine with rich contextual support—the actual dog, the parent pointing to or petting the dog, the feel of the soft dog, the sound of his panting, and so forth. Only after they have acquired truly symbolic understanding of the word can they use the word to refer to any dog, in any context, and even when there is perhaps no dog present. This “decontextualized” symbol use is the end product of the learning process. Light, Drager and their colleagues have argued that aided AAC symbols should be presented within a similarly rich contextual environment. Their initial studies show some promise for these contextually supportive scenes with young nondisabled children [Drager et al., 2003, 2004; Light et al., 2004], but extension of the research to individuals with MR/DD, whose functioning is at the preschool developmental level, is clearly necessary.

Human Factors and Systematic Approaches to Constructing Aided Displays

Another area of growing research concerns the analysis of the visual factors contributing to aided AAC. Given that the input and output modality of aided AAC is visual, study of visual-perceptual processing seems as critical to understanding its effectiveness as the study of auditory processing is to understanding aural/oral forms of communication. Yet although Pooch and Blackstone [1992, p. 288] noted 15 years ago that “it may be that symbol use (or lack thereof) could reflect characteristics of the symbol (size, color, shape, figure/ground), the board layout, instructional strategies, and many other factors,” there has been virtually no examination of the role of visual processing factors in construction of visual communication displays [cf. Wilkinson and Jagaroo, 2004]. Do the actual stimulus characteristics themselves, like shape, color, or placement on the

board, influence how readily they are seen, remembered, or used?

Wilkinson and Jagaroo [2004] have argued that these visual-perceptual factors may indeed play a role in determining outcomes that are components of aided AAC symbol use. In an initial study of one of the most powerful stimulus dimensions, color, Wilkinson et al. [2006] examined whether the color composition of an array influences the speed and accuracy of symbol location by typically developing children. Both dependent variables are relevant to aided AAC. The ability to accurately find a desired symbol has obvious implications for functional and effective communication. Reaction time, or latency to find that symbol, is also of great clinical interest because, as Beukelman and Mirenda [2005] point out, the rates of message production in augmented modes are often “only a fraction of those achieved by natural speakers” (p. 67). Wilkinson et al. [2006] found that indeed, as predicted from visual cognition, accuracy, and latency of symbol location were enhanced when at least some of the symbols differed in color. In pilot studies extending these findings with individuals with intellectual disability, the identical pattern emerged for individuals with autism, while the pattern was substantially more pronounced in participants with Down Syndrome [Wilkinson et al., in preparation]. These initial results, while simple in and of themselves, indicate that further research in the role of visual perception is warranted within the area of AAC.

SUMMARY

We have only scratched the surface of the many possible directions for research in AAC in this article. Valuable insight has emerged concerning multimodal communication, the role of speech in AAC, the application of AAC to young children, comprehension and production in AAC, and many others of the important issues facing professionals and researchers. The technological advances are changing the landscape of AAC by providing ever more powerful tools with capacity to store, organize, and combine thousands of symbols. Perhaps in 10 years another review will be able to examine how these existing issues play out in terms of the evidence base in AAC and the ways in which design characteristics of the systems, including their visual features, may be constructed to better match to the skills and needs of communicators with developmental and intellectual disabilities. ■

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