11

Technology and Communication Disorders

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Learning Objectives

After reading this chapter, students will be able to

- Define assistive technology
- Describe how technology is implemented within clinical practice
- Discuss how evidence-based decision making is employed when using technology
- List commonly used technology for expressive communication and assistive listening
- Discuss the issues related to the use of current technologies

INTRODUCTION

Technology is an integral part of today's society that helps make our daily lives a bit easier and more enjoyable. Each of us can probably think of a dozen ways that we use technology to improve our daily functioning from setting an alarm on our mobile phone to asking a smart-home device to order more laundry detergent. For people with disabilities, those with **complex communication needs (CCN),** and individuals with significant and chronic impairments in spoken and/or written communication, technology may be essential to support independence and promote quality of life.

The Technology-Related Assistance for Individuals with Disabilities Act (Tech Act) of 1988 (PL 100-407) defines assistive technology (AT) As any "item, piece of equipment, or system, whether acquired commercially, modified, or customized, that is commonly used to increase, maintain, or improve functional capabilities of individuals with disabilities." We can think of AT as any piece of technology whose primary

function is to promote independence of the user (Khasnabis, Mirza, & MacLachlan, 2015). For example, AT may be a computer with specialized software that speaks a message when the user activates a button, but it can also be a mobility aid, such as a motorized wheelchair. This chapter will focus on the former—technologies that promote communication skills.

Audiologists and speech-language pathologists (SLPs) frequently use AT as part of their clinical practice. This in part is due to the advancements in medical technologies that have contributed to increased survival rates and life span for people with disabilities resulting in a greater incidence of individuals who utilize AT (Light & McNaughton, 2012b). Audiologists are usually responsible for hearing assistive technology (HAT), including fitting of hearing aids (Bess, Dodd-Murphy, & Parker, 1998; Lesner, 2003), whereas SLPs typically provide technology to aid in expressive and receptive communication. Individuals who use AT represent a heterogenous group. SLPs may use AT with clients who have diverse communication needs and varying ages from young children (Campbell, Milbourne, Dugan, & Wilcox, 2006) and school-age students (Griffiths & Addison, 2017; Johnston, Beard, & Carpenter, 2007; Sadao & Robinson, 2010) to adults with developmental disabilities (Holyfield, Drager, Kremkow, & Light, 2017), such as autism spectrum disorder. Adults with acquired impairments, such as traumatic brain injury or stroke, may also benefit from AT (Brunner, Hemsley, Togher, & Palmer, 2017; de Joode, van Heugten, Verhey, & van Boxel, 2010; Russo et al., 2017).

AT can serve a variety of functions for individuals with communication disorders. For example, a young adult with Down syndrome might use an electronic device that when activated speaks a preprogrammed message. Individuals with hearing loss may use assistive listening devices to improve their ability to listen in a classroom setting. AT may also be used to support people with cognitive impairments, such as memory difficulties due to Alzheimer's disease, by setting a calendar reminder on their phone reminding them of a planned dinner with their child. Clinicians are charged with identifying if their clients may benefit from AT to support or enhance cognitive-linguistic functioning, and to select the appropriate AT to meet their individual needs. In order to do this, audiologists and SLPs need to conduct comprehensive assessments of the AT user's communicative strengths and areas of need. This is typically done in collaboration with other allied health professionals. Training family, educators, and other staff to implement and troubleshoot AT is also the responsibility of the SLP and audiologist. Continued education, monitoring, and adjustment of the AT are often required as users' needs change over time.

EVIDENCE-BASED DECISION MAKING FOR TECHNOLOGY

The American Speech-Language Hearing Association's (ASHA, n.d.-b) definition of evidence-based decision making suggests that SLPs and audiologists combine clinical expertise, scientific evidence, and client values when making a clinical decision. This holds true when assessing the appropriateness of AT as part of a client's treatment plan. Evidence-based decision making is still essential despite inherent challenges in AT practice due to the heterogeneity of AT users relative to age, type, and severity of disability and ever-changing forms of AT. Clinicians need to characterize the user, identify appropriate goals, review the literature for evidence of efficacy, and then

implement intervention (Hill, 2004). After implementation, clinicians must carefully collect data on the targeted behaviors to evaluate if the intervention was effective. A detailed discussion of evidence-based practice and evidence-based decision making can be found in Chapter 3.

One potential framework used to guide evidence-based decision making for AT selection is the participation model (Beukelman & Mirenda, 1988, 2013), which closely aligns with the World Health Organization (WHO) International Classification of Functioning, Disability, and Health (ICF) (WHO, 2001). The WHO-ICF defines disability and functioning as a set of complex interactions between health conditions and contextual factors. For example, a child with sensorineural hearing loss (health condition) may use a cochlear implant (a type of AT) that reduces the experience of physical impairment and allows the child to listen to directions from a teacher to understand how to complete an art activity with peers (context).

The participation framework compares how typically developing individuals and those with disabilities differ in their ability to engage in daily activities. The gaps identified in participation help guide AT selection and intervention goals. For example, an adult with aphasia may not be able to order his or her favorite breakfast at the diner due to word-finding difficulties, whereas this is a simple task for most adults. This example highlights the gaps in daily activity participation between a typical individual and one with a communication disorder. Although the participation model is primarily used for those with congenital disabilities, it could be extended to those with acquired impairments (ASHA, n.d.-a). The main procedures in the participation framework are to 1) identify the type of participation barriers based on the client's communicative needs and current engagement in activities, 2) the selection of appropriate assessment tools based on barriers identified, and 3) the choice of appropriate AT, if indicated, following assessment.

Student, Environments, Tasks, and Tools (SETT) is another common framework that follows the principles of the participation model and is commonly used within interprofessional settings to identify tools to improve participation of individuals who may benefit from AT (Zabala, 1995). Several questions and topic areas embedded in this acronym are used to guide the AT decision-making process. *Student* involves defining the activity limitation or participation restriction; this requires a careful observation to identify the student's current abilities and areas of need. *Environments* requires identification of the barriers that contribute to the activity limitation or participation restriction as well as the physical arrangement of the environment and expectations for participation. *Tasks* refers to the use of observations to gain insight into the typical activities in which the client is to participate, as well as information gathering regarding instruction methods. *Tools* refers to tools and strategies currently in use as well as identification of additional tools, instructional strategies, and service provision to support appropriate participation. SETT meetings involve an interprofessional team (e.g., SLP, audiologist, special educator, paraeducators, family members, private clinicians) engaging in collaboration to discuss each of these factors. Figure 11.1 outlines the SETT framework.

Both the participation and SETT frameworks are commonly used when making **augmentative and alternative communication (AAC)** decisions. AAC is one type of AT in which clients may use a tool such as a device or set of pictures to augment expressive communication or to take the place of spoken language altogether.

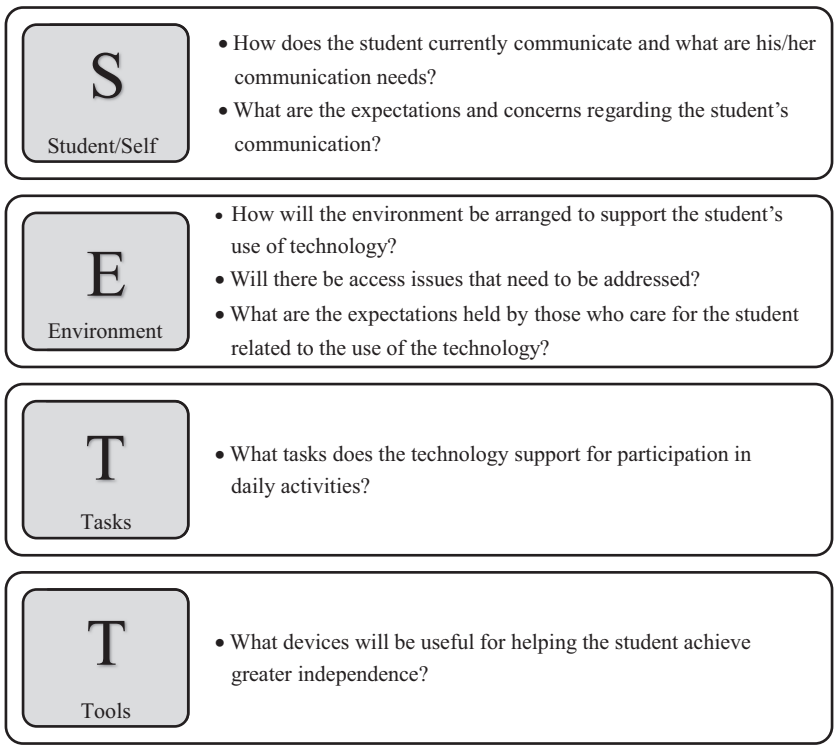

Figure 11.1. Outline of the SETT framework (From Zabala, J. [2005]. *SETT.* Retrieved from http://www.joyzabala.com; adapted by permission.)

INTERPROFESSIONAL COLLABORATION

Many people with CCN have motor or cognitive impairments in addition to impairments in communication. The nature and complexity of these individuals' needs necessitate collaboration with other professionals who play a role in their treatment plans. Successful AT implementation is dependent on capturing the perspective, values, skills, and ideas of all relevant stakeholders. For example, a girl with cerebral palsy may have significant motor impairments that affect both spoken output and mobility. She may not only require a motorized wheelchair but also may lack the fine motor skills to press buttons on a communication device. An interprofessional team-based approach provides a range of expertise for addressing all issues with which the client presents.

AT team composition may differ based on the client's needs and environments. For children in a school-based setting, the team may include special educators, SLPs, occupational therapists, and physical therapists. DeCoste, Reed, and Kaplan (2005) suggest that other team members may also be necessary depending on the client's needs and profile. These could include social workers, nurses, psychologists, respiratory therapists, and so forth.

The SLP may need to collaborate with the occupational therapist and physical therapist who can provide consultation regarding how the user interacts with the AT, particularly for those who have fine or gross motor impairments. *Access method* refers to how the user interfaces with the AT, such as touching their device as you might to enter a fingerprint on a tablet. However, interacting with AT tools is not limited to

manual means. Clients with cerebral palsy, for example, may require a large button or switch that they activate with their arms, legs, or head. As experts in body movement, occupational therapists and physical therapists play an essential role in assessment.

Consultation with team members will not be limited to professionals. The clinician will also collaborate with the client and family. Collaboration with families during AT assessment and treatment planning can diminish the likelihood of accidently missing pieces of important information and choosing AT without consideration of how it will be integrated with other devices the client may be using (Eddy, 2017) or with the family's living circumstances. A team-based approach for making AT decisions may also increase likelihood of device adoption so that the client will actively use it rather than putting it in the back of a drawer because it does not fit in with his or her lifestyle (Copley & Ziviani, 2004).

ASSESSMENT OF NEED FOR ASSISTIVE TECHNOLOGY

There are many standardized assessments to evaluate speech, language, and communication skills. These are outlined in Chapter 4 of this book. However, standardized assessments for evaluating a client's ability to utilize AT are much more limited. As previously discussed, the unique profile of AT users—including their diverse communication, motor, and cognitive skills—makes standardization very challenging. As a result, clinicians must use a variety of information sources and assessment tools to gather the data necessary to select appropriate AT. The purpose of an AT evaluation is to identify tools, teaching strategies, and supports that will help an individual participate in meaningful activities. A complete and comprehensive assessment that evaluates client strengths and needs will improve AT acceptance and integration (Copley & Ziviani, 2004). SLPs and audiologists should utilize a range of assessment methodologies for collecting information regarding the client's AT requirements (Beigel, 2000; Copley & Ziviani, 2007). The information learned should reflect the user's skills in a variety of environments and their performance with various tools, and it should include members of the client's support network (Johnston et al., 2007).

Speech and Language Evaluation

Most AT assessments include a comprehensive speech and language evaluation to identify the client's communicative strengths, challenges, and primary modality of communication (Johnston et al., 2007). As they would in any evaluation, SLPs should collect background information and a medical history. A review is likely to consist of education records including a client's individualized education program (IEP) for those of school age, as well as any available medical records. If previous AT assessments have been completed, these along with evaluations by interprofessional colleagues (e.g., occupational therapist, physical therapist) should be reviewed. Speaking with other professionals currently providing services to the client is also suggested because they can provide invaluable information that might not be easily ascertained through written records. Gathering background information will help SLPs make decisions about the tools used for the remaining parts of the AT assessment.

As outlined in the participation model, a direct observation of the client in natural settings, such as during classroom time, interacting with peers, or ordering coffee at a local café, is recommended. Observation should occur in settings where the AT is expected to be implemented as well as where the client spends a significant amount

of time. The clinician should observe the client's current communication skills and preferred methods of communication. Does the client prefer use of gesture or gaze over use of speech? How intelligible is the client in single words or sentences? Are any other forms of AT currently in use? When possible, clinicians should attempt to observe at various times of the day to determine whether environmental and biological factors (e.g., fatigue) affect performance.

Interviewing both the client and members of the his or her social network can provide additional information not easily obtained using direct observation. Parents, spouses, teachers, and other clinicians are commonly interviewed during the assessment process. Most clinicians can create their own interview questions that provide client-specific information, such as family and client concerns regarding implementation of AT, client expectations, and preferences about features of the device (e.g., colors, voice output).

A formal or informal assessment, often conducted by an interprofessional team, is necessary to evaluate the client's present level of functioning, and to assess the client's skillset in several domains beyond communication. For example, a child psychologist is helpful in understanding the various functions of any challenging behaviors present; understanding these behaviors can help the SLP support replacement of these behaviors with functional means of communication. As experts in hearing, speech, and language, audiologists and SLPs should identify all the aspects of the behavior that contribute to communication strengths and challenges.

Because many candidates for AT have CCN, audiologists and SLPs need to be creative when using appropriate assessment measures. Sometimes, standardized measures may be administered in a nonstandard way (e.g., adapted for gaze access). For users who have normal gross and fine motor skills, traditional standardized measures that require gestural response, such as pointing to named pictures, may be appropriate. More frequently, clinicians will employ criterion-referenced measures. Criterion-referenced tools compare an individual's performance against a predetermined standard rather than the performance of others (norm-referenced). See Table 11.1 for a list of criterion-referenced measures that may be used for individuals with CCN.

The information gained from the speech and language evaluation helps identify the relative strengths and challenges in receptive and/or expressive communication of the AT user and guides subsequent technology decisions.

ASSISTIVE TECHNOLOGY INTERVENTIONS

AT tools used by SLPs and audiologists address the listening and communication skills of those with communication disorders. These tools can range from simple books containing photographs that a client touches to request a preferred snack, all the way to complex electronic devices that output a spoken message when activated. There are also applications available for mobile technology like tablets and smartphones, which are designed to assist and augment communication. These tools are also discussed in the following section.

Hearing Assistive Technology

Audiologists are the clinicians responsible for quantifying the degree and type of hearing loss and determining candidacy for hearing related technology. HAT is appropriate for those individuals who are deaf or hard of hearing and may even benefit

Table 11.1. Criterion-referenced assessments for individuals with complex communication needs

Assessment	Developmental age range	Description
Communication Complexity Scale (Brady, Fleming, Thiemann-Bourque, Olswang, L., Dowden, Saunders, & Marquis, 2012)	0–1 year	Measures three levels of early communication (preintentional, intentional-nonsymbolic, beginning symbolic)
Every Move Counts (Korsten, Dunn, Foss, & Francke, 1993)	0–1 year	Motor movements are elicited, monitored, and recorded to assess means of AAC access
Communication Matrix (Rowland, 1996)	0–2 years	Assesses early pragmatic skills (basic communication functions)
Pragmatics Profile of Everyday Communication Skills in Children (Dewart & Summers, 1995)	0–10 years	Parent- or teacher-administered checklist of pragmatic behaviors
Test of Aided-Communication Symbol Performance (Bruno, 2010)	Child to adult	Helps identify the AAC features that might be most useful to the user (e.g., size of symbols used on the device, number of icon displayed, ability to sequence icons to create phrase)
Augmentative and Alternative Communication Profile: A Continuum of Learning (Kovach, 2009)	2 to adult	Identifies the functional skills useful for developing communicative competency using AAC; most appropriate for those with congenital communication disorders

Key: AAC, augmentative and alternative communication.

those with minimal hearing loss (American Academy of Audiology, 2013; Bess et al., 1998). The overarching goal of HAT is to improve the **signal-to-noise ratio (SNR)** of the user. Imagine being at a dinner party where a lot of people are laughing, plates are clanking, and music is playing while guests are trying to have a conversation with friends. Guests may subconsciously lean forward to hear better. With this movement, a person is attempting to improve the SNR to hear conversational partners better. The greater the SNR, the easier time a listener will have hearing a message (Good & Gilkey, 1996; Welzl-Muller & Sattler, 1984). HAT is particularly useful in noisy or echoic environments with poor SNRs, such as classrooms, conference rooms, or restaurants. These devices can be used in conjunction with amplification such as that provided by hearing aids and cochlear implants, although HAT can be used without amplification as well.

There are three main types of HAT systems that are widely used in both education and in public venues in order to improve access for individuals who are hard of hearing: 1) hearing loops, 2) infrared systems, and 3) frequency modulation (FM) systems. Table 11.2 describes the differences among these systems. There are three basic components to most HAT systems. These include a **microphone,** a **transmitter,** and a **receiver.** The microphone picks up signals from the sound source. The transmitter converts the sound energy to a usable form and then sends it (by means of **hard wired, frequency modulated,** or **infrared** transmission) to the receiver. Last, the receiver delivers the sound information to the user via headset or speaker. These devices can be easily set up in a classroom, church, or theater to improve the SNR.

There are many factors that affect the client's use of the HAT, such as motivation, family support, or educational staff support. For some populations, such as the elderly, HAT may be the preferred alternative to hearing aids (Pruitt, 1990). These devices can be used across multiple settings, such as the client's home or school. For example, there

Table 11.2. Description of the varying types of hearing assistive technology

Hearing assistive technology	Description	Benefits	Disadvantages
Hearing loop	Voice is captured via a microphone connected to a copper wire around a room, creating an electromagnetic field. The signal is received either by the user's hearing aid or through a special receiver and headset worn by the user.	Excellent sound quality Discreet and simple to use	Expensive installation Typically requires a permanent installation
Infrared	Voice is captured via a microphone and transmitted through infrared light, like a television remote control, to a receiver and headset worn by the user.	Good sound quality Inexpensive Ease of use, especially for those who wear hearing aids or who have cochlear implants	Poor operation in low light Need to be in direct line of site of transmitter
Frequency modulation (FM)	Voice is captured via a microphone and transmitted through FM signals to a receiver and headset worn by the user.	Good sound quality Inexpensive Ease of use, especially for those who wear hearing aids or who have cochlear implants	Interference from low-frequency radio bands Limited range

Source: Gelfand (2001); Hearing Loss Association of America (2018).

are infrared television amplifiers and flashing lights for doorbells. Newer AT, built into devices such as smartphones, may hold some promise as another form of HAT. Apple's iPhone has integrated accessibility features for those who are hard of hearing or deaf. These include integrated real-time text (RTT) and text telephone (TTY) features that allow the user to type and read telephone conversations. Most smartphones and tablets have settings that allow the user to be notified of new text messages, phone calls, or video conferencing via a series of vibrations or flashing lights.

When selecting the appropriate HAT, it is important to consider which will offer the optimal performance to the user while also considering the user's willingness to incorporate the AT into daily life. Clinicians consider a variety of factors such as types of volume control, power supply, telephone access, and ability to attach to an amplifier. For some, it might be easier to use a smartphone with a set of specially curated apps rather than use multiple devices such as a special landline telephone, vibrating pillow alarm, and flashing doorbell.

Technology for Communication: Augmentative and Alternative Communication

One type of AT commonly used by SLPs is known as augmentative and alternative communication. AAC may be as simple as a set of photographs that a client points to in order to communicate a thought or idea, or it may be as sophisticated as a dedicated computer that will output a spoken message when a button is activated. Individuals who are unable to develop intelligible spoken language or have lost speech or language due to a neurological event may particularly benefit from AAC.

AAC serves four communicative functions (Romski & Sevcik, 2005). First, it may be used to augment existing natural speech. For example, an adult with apraxia who experiences reduced intelligibility may use AAC to repair communication

breakdowns by typing out a word or sentence on a communication device. Second, AAC may be used as a primary mode for expressive communication to replace spoken language. If a child has limited ability to vocalize, then he or she may instead use an AAC device to produce words and sentences. Third, AAC may be used for receptive language input because people with CCN may benefit from learning language through visual icons or visual symbols. Finally, AAC may be used as a language intervention. Individuals who engage in challenging behaviors such as hitting, biting, or spitting may be attempting to communicate a message that can be conveyed through a more appropriate form of communication using an AAC tool.

Because there are no universal measures or battery of measures for AAC assessment, clinicians must use a variety of information sources and tools to gain the necessary data. Shane and Costello (1994) introduced feature matching, a systematic, person-centered process where an individual's strengths, abilities, and needs are assessed to identify features necessary in an AAC tool for functional use. The feature-matching process evaluates several domains that will help guide the AT selection process. These domains are represented in Figure 11.2 and described in detail in the next sections.

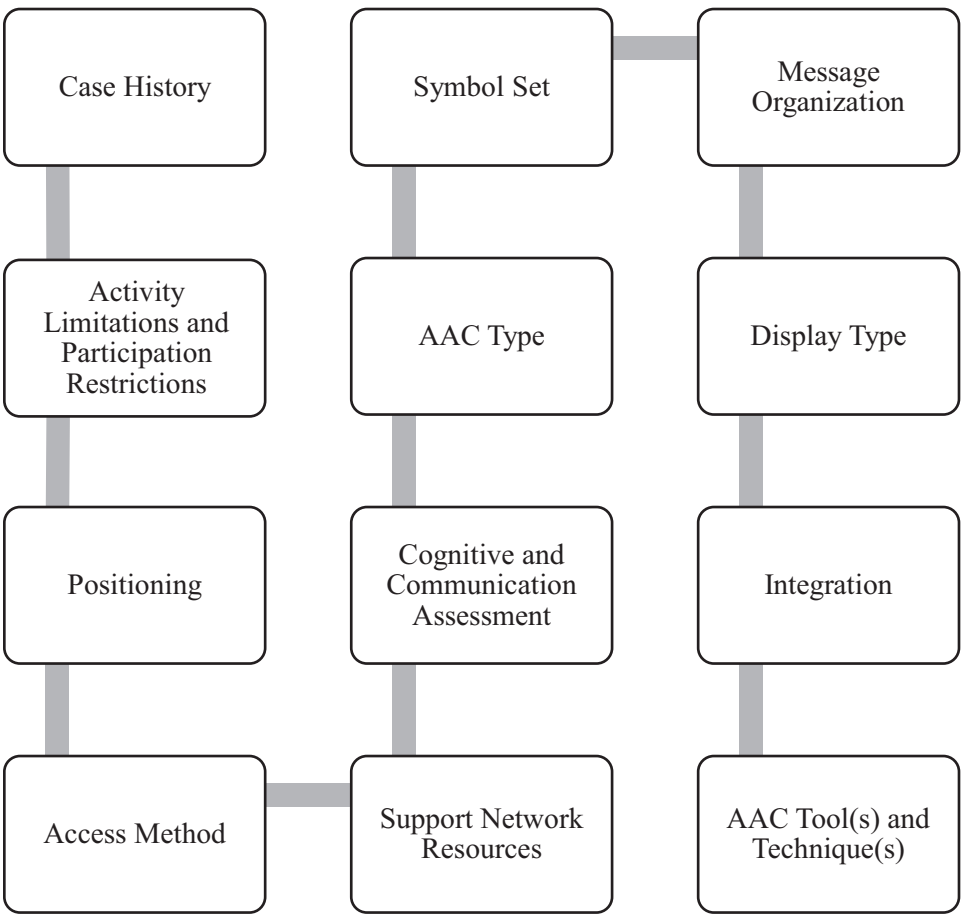

Figure 11.2. Domains assessed during feature matching. (*Key:* AAC, augmentative and alternative communication.)

Access Method In order to use AAC, an individual needs to be able to access the AT tool by, for example, pressing a button on an electronic device. Access methods will vary depending on the cognitive-linguistic and motor skills of the user. **Direct selection** occurs when the user manually selects a button using a body part such as a finger (Video Example 1; see Box 11.1) or a pointing device like a computer mouse. Many people are familiar with direct touch selection as it is used on most consumer electronic devices to select letters on a keyboard. However, even those with impaired fine or gross motor skills can select a button directly by using a joystick (similar to a computer mouse). If the user lacks the fine and gross motor skills to use a mouse or joystick, head-pointing may be used. A camera tracks the head movement of the user to control a mouse-like pointer. With advancements in AT, eye gaze can be used on some devices as a direct selection method (Video Example 2; see Box 11.1). In this case, a small infrared camera is used to track the client's eye movements to a specific location on the computer screen. Once the client's gaze is fixated for a predetermined amount of time, that button or image on the screen will be activated and the message will be played (Ball et al., 2010).

Clients with severe motor impairments may benefit from the use of **scanning** as a method of selection. Scanning requires the client to press a button to move across items until the target item is reached, and then to select the choice. Scanning may be done independently or facilitated by a partner. For example, if the client wants to activate the icon for the message "Let's read *The Very Hungry Caterpillar*" (Carle, 1994), he will pass all other messages until the indicator reaches the icon for his desired message. A facilitator, such as a family member or paraprofessional, can remove the unwanted choices. After reaching the desired item, the user must select via use of a predetermined behavior, such as an eye blink (Video Example 3; see Box 11.1). Independent scanning typically requires a high-tech communication device that features built-in software to support scanning. These tools present an item by highlighting or speaking a symbol representing a message, and the user may press a button to move until the desired message is reached. The user then selects by use of another button. Video Example 4 demonstrates a user activating a switch via head movement (Video Example 4; see Box 11.1 at the end of the chapter).

Augmentative and Alternative Communication Types AAC methods are divided into classes based on their technological complexity and capacity. Each AAC type can be used with any of the previously discussed access methods. AAC systems can be categorized as unaided or aided. Unaided forms of communication, also known as "no-tech," use only bodily functions to communicate. Examples of unaided AAC include facial expressions, gestures, gaze, and manual signing systems. Aided forms of communication require an external tool and include light-, mid-, and high-tech tools.

Light-tech, sometimes referred to as low-tech, includes tools that do not require a battery to operate. The Picture Exchange Communication System (PECS; Bondy & Frost, 2001) is an example of a light-tech communication strategy. A PECS user is taught to exchange a picture of a desired object with an adult for the item pictured (Video Example 5; see Box 11.1). As language develops with these tools, the number of messages required may expand to many pages, and some users find it cumbersome. Another challenge is that a communication partner must be attending because it does not provide voice output. Although light-tech tools do not utilize computerized equipment, many of these light-tech systems are being adapted for platforms such as tablets to increase their mobility and convenience.

Mid-tech AAC devices include speech-generating devices, and these vary in technological complexity, size, and number of messages that can be programmed. These devices, like high-tech devices, are also referred to as voice output communication aids (VOCAs). They can range from a large button that plays a single prerecorded word or phrase when pressed to more complex tools that allow the user to express multiple prerecorded messages. These devices typically require a facilitator to record voice messages into the tool, which the user then plays back by selecting the button. Voice output is the primary benefit of these tools. However, VOCAs are limited in the number of messages they can store. Often, these tools may be used for communication in specific activities or to express a limited set of messages across a variety of activities, or as an introduction to more generative forms of AAC.

High-tech devices are computerized speech-generating devices with built-in rechargeable batteries. They often feature a variety of high-quality synthesized voices generated by computer software, similar to text-to-speech function on a tablet that expresses text as words. As you can imagine, for those with the ability to use this type of system, it can allow for significant flexibility in the messages that may be generated. Figure 11.3 illustrates the different types of AAC devices, from light- to high-tech options. Selection of the type of AAC is based on the number and type of messages that a user needs to communicate, a user's motor and cognitive abilities, and stakeholder interviews.

Symbol Selection and Organization After selecting the complexity of the AAC device and access method, clinicians must choose a symbol set. A symbol refers to how a message is represented. Oral language is one type of symbol set that is used to represent ideas and messages. People without disabilities usually represent messages with spoken language, but messages can also be represented through gestures, signs, objects, photographs, icons, or writing. Symbol selection depends on the cognitive-linguistic skills of the client, as well as on careful assessment of the comprehension of each symbol set. For example, some symbols are more abstract (e.g., *democracy*) and harder to represent using a picture, whereas other symbols are more concrete (e.g., *ball*) and easier to represent.

Following symbol selection, messages must be organized on the user's device. Messages can be organized in many different ways such as by *activity* where symbols representing a group of messages required for a given activity are placed together. For example, symbols for ordering lunch at the local diner may be placed on a single page to allow for quick access and ease of communication for this activity. Alternatively, *taxonomic* organization groups symbols by categories. For example, the symbol banana would be found in the *fruits* folder, which would be found in the *foods* folder. Clients may prefer a *pragmatic* organization in which symbols and messages are organized based on their social functions. In this case, messages are separated into folders based on the pragmatic functions they serve, so all requests (e.g., *I want to go outside; I want to eat; more please!*) might be in one folder while discourse initiations (e.g., *How are you today?; I had a great day*) would be in another folder. Finally, a client may utilize a *semantic-syntactic* organization in which symbols are sorted based on parts of speech so that pronouns are grouped together, verbs as a separate grouping, and adjectives and other parts of language have their own groupings.

Display Type AAC devices offer different types of displays. One type is a static or **fixed display** in which the symbols on the tool do not change when selected

Light-Tech	Communication board (Choice board using Mayer-Johnson Symbols)	
	Pragmatically Organized Dynamic Display (PODD) (Porter & Cafiero, 2009)	
	Single message switch (BIGmack)	
Mid-Tech	Multiple message switch (CheapTalk 4 In-line with real objects)	
	Digitized speech-generating device with fixed display (GoTalk9+)	
High-Tech	Dynamic display with synthesized speech (Prentke Romich Company Accent 1000 with NuPoint)	
	Tablet with specialized application (Apple iPad with AlexiCom AAC application)	

Figure 11.3. Augmentative and alternative communication (AAC) devices from light-tech to high-tech.

(Beukelman & Mirenda, 2013). The calculator on your smart device is an example of a static display. The symbols (e.g., numbers on the keypad) do not change. A **dynamic display** is another type usually integrated into high-tech AAC devices. When a symbol is selected on a dynamic display, a new set of symbols appears. Opening your pictures on a smart device allows you to select one of many pictures, and after selecting you may notice that the buttons available to you change; this is an example of a dynamic display. Finally, a hybrid display includes both static and dynamic features. An example of this is available on a smartphone keyboard when texting. As you type, the keys on the keyboard remain static, but the word prediction function is dynamic and changes based on your keystrokes.

Integration Integration of the AAC tool with the user's other AT needs requires collaboration with the interprofessional team. For example, a client using a wheelchair may require the AAC tool to be mounted in a consistent location on it. When clinicians fail to consider integration, the user may be prevented from readily accessing the tool. Further, some high-tech AAC tools offer additional environmental controls, such as infrared commands (e.g., for controlling the television), wireless internet capability (e.g., used for unlocking the door to their house), or Bluetooth. Consultation with colleagues in occupational therapy is particularly useful when considering electronic aids to daily living.

There are many potential combinations of these tools, such as a light-tech, gaze-accessed, dynamic display with a pragmatic language organization using icons, or a high-tech, scanning-accessed, static display with an activity language organization using real photos. Clinicians must understand that they are not matching their client to a device or tool but instead must match the *tool to the client* based on the features each client requires and can use.

Mobile Technology for Communication

Many SLPs and audiologists are incorporating consumer electronics such as mobile technology, including tablets and smartphones, into their clinical practice (Fernandes, 2011). Mobile technology can enhance clinical practice and provide clients with a powerful and flexible means of communicating. Unlike previous AT, mobile technology is portable and easily accessible, and can be customized to the needs of the user (Furlong, Morris, Serry, & Erickson, 2018; Melhuish & Falloon, 2010). Given the widespread use of mobile technologies, some users may perceive these tools as more socially acceptable than a **dedicated communication device.** Additionally, the integrated nature of tablets with AAC apps means that the client can use the tablet for other functions such as text messaging, entertainment, and e-mail. As many as 90% of clients who use tablets with an AAC app report using the technology for purposes in addition to AAC communication (Niemeijer, Donnellan, & Robledo, 2012).

Mobile technology can be used as a high-tech communication device. For example, you can put an AAC app like Proloquo2Go (Video Example 6; www.assistiveware.com; see Box 11.1) on a tablet (e.g., iPad). The feature-matching framework should still be utilized when deciding on the use of a mobile device for AAC (Gosnell, Costello, & Shane, 2011; Light et al., 2019). If the feature-matching process supports the use of a tablet or other mobile technology, selection of an app that would be most beneficial should also be determined via feature matching (e.g., considering language organization, symbol set) as well. Gosnell and colleagues (2011) developed a set of questions

Table 11.3. Feature matching process for selection of augmentative and alternative communication applications

Clinical feature	Description
Purpose	What is the application's intended function?
Output	Does the application provide speech output? If so, what type?
Speech settings	Does the application allow for customized speech settings, including changes to volume, pitch, and rate?
Symbols	Does the application include icons or symbols?
	Can you import your own symbols?
Display	Does the application allow for customization of display features?
	Can you change the layout? Size of buttons, fonts, colors?
Feedback	Does the application provide visual or tactile feedback upon button activation?
Rate enhancement	Does the application provide rate enhancement features (e.g., word and grammar prediction) to increase the speed and accuracy of communication output?
Access	Does the application require the user to use direct selection?
	Are there other access options (e.g., switch access, scanning)?
Support	Does the application provide users with technical support if the need arises?
Miscellaneous	Does the application offer any other special features that might be useful?

Source: Gosnell, Costello, and Shane (2011). From Alliano, A., Herriger, K., Koutsoftas, A., and Bartolotta, T. (2012). A review of 21 iPad applications for augmentative and alternative communication purposes. *Perspectives on Augmentative and Alternative Communication, 21,* 60–71; adapted by permission.

that may be used to determine candidacy of mobile technology devices and applications for communication; these questions closely align with the feature matching process (see Table 11.3).

Besides utilizing mobile technology as an AAC tool, SLPs often use mobile technology as a therapeutic tool to teach speech or language. There may be unique benefits to using a tablet and app to teach a new communication skill to clients with communication disorders. Apps tend to be visually appealing and may capture and hold the client's attention more readily than traditional materials (Davis & Sweeney, 2015). For example, if you are teaching vocabulary using an app, the app may show the function of each vocabulary item when it is touched on the screen. There are many resources available to clinicians who are looking for information regarding choosing appropriate apps to teach speech and language skills. Sweeney (2010) suggests using the FIVES model to systematically choose an app for therapeutic use. Table 11.4 outlines the FIVES criteria.

Table 11.4. The FIVES criteria for evaluating apps for speech and language therapy

Category	Criteria
F	**F**airly priced for the features it provides and overall quality
I	**I**nteractive and engaging to maintain client's attention
V	**V**isual, functioning as a visual scaffold for learning speech and language skills
E	**E**ducationally relevant (for school-age individuals) and supports the client's academic curriculum
S	**S**pecifically targets speech and language skills or can be used to teach communication skills

Source: Sweeney, S. (2010). *The FIVES criteria: For evaluating and integrating simple technology resources in speech and language interventions.* Retrieved from http://www.scribd.com/doc/44503715/Fives-Booklet; adapted by permission.

CONTEMPORARY TOPICS IN ASSISTIVE TECHNOLOGY

Mobile technology revolutionized access to AT, and particularly access to AAC. Historically, the cost of dedicated speech-generating AAC devices, as much as $18,000 or more, could be prohibitive for clients. Commercialization has made AAC far more affordable and accessible to a larger audience, with some high-tech tools available free of charge. Unfortunately, most existing AAC apps have little research to support their use and may not be an appropriate fit for some users (McNaughton, 2013). This is particularly true because many smart technologies are designed for mass-market users with typical fine motor skills and the ability to touch and swipe. This will not be possible for all clients with CCN (Light & McNaughton, 2012a).

In addition to the ever-changing landscape of mobile technology, other technologies including novel access methods to AAC devices continue to be developed. Hybrid access systems that combine eye tracking and switch scanning (Fager, Jakobs, & Sorenson, 2018; Sahadat, Alreja, & Ghovanloo, 2018) hold particular promise for individuals whose access ability changes throughout a day as a result of fatigue, or who have difficulty making accurate selections on their own. For individuals with severe motor impairments who maintain some reliable movement of a limb, such as a pinky finger, but who are unable to reliably use common switch access technology, use of movement-sensing tools may provide enhanced reliability of access. Movement-sensing tools can determine if a movement is intentional or unintentional. If intentional, the AAC device will be activated (Fager, Fried-Oken, Jakobs, & Beukelman, 2019).

Brain–computer interfaces are additional technologies being tested to activate AAC devices and as communication tools on their own (Brumberg, Pitt, Mantie-Kozlowski, & Burnison, 2018). These tools utilize electrical activity at the scalp, a proxy for brain activity, which allows users to control computer cursors and access electronic aids to daily living (Wolpaw & Wolpaw, 2012). The Shuffle Speller (Peters et al., 2018) is an example of a brain–computer interface for communication that operates by collecting electrical activity at the scalp using electroencephalography (EEG) (Video Example 7; see Box 11.1). It presents letters divided among several boxes on a screen. The user fixates on a flashing light next to the box containing a target letter and competitor letters. Each light flashes at a different frequency that can be detected through EEG activity. Shuffle Speller continues to move the target and competitor letters to different boxes until it collects enough evidence to identify which letter was being selected. Eventually, the computer learns to predict which letters are most likely to come next in the sequence, allowing the user to improve the rate of communication with fewer selections.

Case Example

A 6-year-old girl with athetoid-type cerebral palsy arrives at a clinic. Her medical history is significant for asphyxia at birth secondary to the umbilical cord wrapped around her neck. She receives oral baclofen (muscle relaxer) to manage her increased tone. The client's mother reports her primary concern is that her daughter has difficulties being understood by unfamiliar communication partners, which limits her ability to develop relationships with peers. She attends elementary school and is in the special education program full time with collaborative speech-language services. Her school-based SLP is working on placement of bilabial speech sounds. During evaluation, the

clinician notes that the client presents with dysarthria and uses primarily single words to communicate her wants and needs, with only a few two-word combinations. Without context, the clinician also notes that she is approximately 25% intelligible to unfamiliar listeners. However, her mother and family report that they can understand 90%–95% of what she communicates in the home setting.

Given the client's presentation, consider the following questions:

1. What members of the interdisciplinary team might need to be involved in the AT assessment? How might the information you gain from these team members be used in your AAC evaluation?
2. You recognize that developing peer relationships is a complex process. At this time, you feel that you do not have enough information about how her communication is specifically influencing this. How could the participation model provide you with greater insight?
3. What forms of AT do you think this client may benefit from?
4. How might the client access the technology?

CONCLUSION

SLPs and audiologists are responsible for assessing and selecting AT devices that improve communicative functioning for their clients. The AT evaluation is interprofessional, especially for individuals with CCN, and includes other allied health professionals and stakeholders to ensure appropriate fit of the AT. In addition to being

Box 11.1. Video Examples

1. A preschool child with autism using a light-tech device, PECS, to communicate during a semistructured play activity: https://www.youtube.com/watch?v=WPRrMorSAkQ
2. An adult with a Broca's aphasia following a stroke using direct access to select messages on a dedicated device with dynamic display: https://www.youtube.com/watch?v=ZhIOl3wvKIM
3. A school-age child using gaze to select buttons on his speech generating AAC device. Note the infrared camera capturing eye movements at the bottom of the device: https://www.youtube.com/watch?v=mCeOMoQPn_8
4. An adult with amyotrophic lateral sclerosis (ALS) using a facilitator and scanning to select letters of the alphabet to spell words: https://www.youtube.com/watch?v=pLb6-Oi3uR0&list=PL5BD0CF9D639DB3AB&index=5
5. An adolescent with cerebral palsy using two BigMack switches and scanning to access her dedicated speech-generating device with dynamic display: https://www.youtube.com/watch?v=fAdEOXD9Tvk
6. A minimally verbal child uses a tablet with AAC app, Proloquo2Go, to engage in a storybook activity with his mother: https://www.youtube.com/watch?v=mlnKh4TFWKg
7. An adult wears an EEG cap while calibrating and using the Shuffle Speller, a brain–computer interface communication tool: https://www.youtube.com/watch?v=j9oyjRAjl-U

used with individuals with CCN, AT also benefits individuals with mild hearing loss, adults with acquired neurological conditions, and children with language disorders.

AAC, including both dedicated devices and mobile technology, are the most common types of AT employed by SLPs, while HAT are the most common types of AT employed by audiologists. Clinicians practicing AT must remain up-to-date regarding the newest technological innovations in AT and must match their clients with tools that support the necessary features. Evidence-based decision making and treatment planning are requirements in AT practice, just as they are other domains, in the SLP and audiologist's scope of practice.

Study Questions

1. Describe how SLPs and audiologists can use AT as part of their clinical practice.
2. Explain how evidence-based decision making is used to inform practice when choosing technology for a client.
3. Discuss the components of a comprehensive AT assessment.
4. Describe the groups of individuals who might benefit from assistive listening devices.
5. Compare and contrast the features of light-tech, mid-tech, and high-tech AAC devices.
6. Explain the four functions of AAC, as outlined by Romski and Sevcik (2005).
7. Describe issues related to the use of mobile technology in populations with communication disorders.

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