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AAC and Natural Speech in Individuals with Developmental Disabilities

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Clinicians working with children who have significantly compromised speech production capabilities and subsequent reduced intelligibility are often faced with the question, What will happen to natural speech if an augmentative and alternative communication (AAC) system is implemented? Typically, the extent of the individual's speech production challenges influences the level of concern regarding the impact of AAC intervention on natural speech.

For individuals who experience such severe impairments that they are unable to voluntarily produce sound or can only produce gross undifferentiated vocalizations, the decision to implement AAC intervention to enhance communication effectiveness is usually eagerly endorsed by parents and professionals. The opportunity to allow the individual to communicate with others in order to participate in family life, express his or her wants and needs, further develop language, and develop social relationships usually overwhelms concerns about the impact of AAC on speech development. Due to the severity of the speech impairment, most stakeholders realize that the development of functional speech is likely to be a therapy-intensive process that may not be successful. Typically for such individuals, AAC interventions and natural speech interventions continue simultaneously, at least until it becomes clear that natural speech is not progressing, at which time the focus of communication intervention shifts primarily to AAC.

Others with significant communication impairments are able to speak such that they can be partially understood by very familiar partners. For these individuals, the decision to initiate AAC intervention is somewhat more complex than for those with more severe impairments. For individuals who demonstrate the potential to speak, even though their speech may not be functional to meet all communication needs, concerns that implementation of AAC may result in an arrest in speech development or a reduction in desire to use natural speech are often expressed. However, if AAC intervention is withheld until the course of natural speech development is clear, these children may be forced to learn, participate, and develop their social roles with a communication system that is minimally effective or that requires a caregiver to serve as an interpreter for other family members, peers, teachers, relatives, and so forth.

Finally, some individuals are able to use their disordered speech to meet many of their communication needs with familiar people (i.e., family members) in familiar contexts (i.e., home); however, the ability to meet their communication needs is inconsistent with less familiar communication partners (i.e., peers) and in less predictable contexts (i.e., community settings, school). For these individuals, the decision to initiate AAC intervention is often difficult, with parents and professionals, again, concerned about the impact of AAC on natural speech.

In summary, caregivers of individuals with moderately-severe and severe communication disorders face several options regarding AAC intervention:

1. Allow the individual's communication to remain compromised in all or most situations while waiting for his or her speech to develop through maturation and/or aggressive speech intervention.
2. Provide AAC intervention to enhance communication concurrently with speech intervention.
3. Provide AAC intervention to enhance communication while simultaneously providing less intensive speech intervention or discontinuing speech intervention.

To date, there is little direct empirical evidence that addresses the effect of AAC on natural speech. Consequently, AAC practitioners are unable to provide accurate and satisfactory information to families and other professionals regarding this important concern. In the absence of definitive information, clinicians may be tempted to turn to informal or anecdotal reports such as those provided by Silverman (1995).

Following a review of the literature pertaining to AAC and motivation to use natural speech, Silverman stated,

> Teaching a severely communicatively impaired person to use augmentative communication does not appear to reduce his or her motivation for speech communication–a conclusion supported by more than 100 published and unpublished reports. (1995, p. 34)

Based on this same review of the literature, Silverman claims that using AAC "seems to facilitate speech (i.e., increase verbal output)" in at least 40% of individuals who use AAC (p. 34). On the surface, this information is good news for advocates of AAC; however, it is important to note that Silverman's conclusions were not drawn entirely from published research-based evidence but rather from summary results from a number of sources, some of which were anecdotal and unpublished. In addition, Silverman's review encompassed individuals with aphasia, apraxia, dysarthria, autism, and mental retardation–populations with very different underlying problems.

In an attempt to determine the effect of AAC on natural speech production in individuals with developmental disabilities, Millar, Light, and Schlosser (2000) completed a formal meta-analysis of published literature in which documentation of speech production during and/or following AAC intervention was reported. Ultimately, this meta-analysis included 50 studies that were published between 1975 and 1998. Critical to note is that none of the available research examined the effects of AAC on speech directly. Rather, information about speech was reported secondarily to other research questions. Meta-analysis results showed that across all studies, the majority of individuals demonstrated limited increases or no change in speech use following intervention involving AAC. Again, this would appear to be relatively good news to advocates of AAC; however, quantitative measures associated with speech production including segmental analysis, speech intelligibility, and communication effectiveness when natural speech was employed are unknown. Simply measuring the number of productions or verbal communicative attempts, as was the case in many of the studies examined in Millar and colleagues' meta-analysis, provides a gross estimate of speech use but does not address any changes in quality or accuracy of productions. These are important variables to consider when assessing the impact of AAC on natural speech.

Clearly, the question of how AAC affects natural speech is complex, and the answer is not well understood. In part, this may be because the question is too broad to answer without addressing several, more circumscribed, constituent questions. This chapter provides a conceptual framework for considering the relationship between AAC and natural speech through examination of five components, shown schematically in Figure 2.1, that pertain to natural speech and AAC. These components are

1. Speech production characteristics: What do we know about the underlying speech production problems experienced by targeted populations of individuals with developmental disabilities?
2. Speech intelligibility: Does use of AAC make natural speech more understandable to communication partners?
3. Use of speech: How does AAC affect modes of communication employed?
4. Communication effectiveness: How does AAC affect the individual's ability to communicate effectively?
5. Integrating multiple modes of communication: In what ways can speech and AAC be used together to enhance communication?

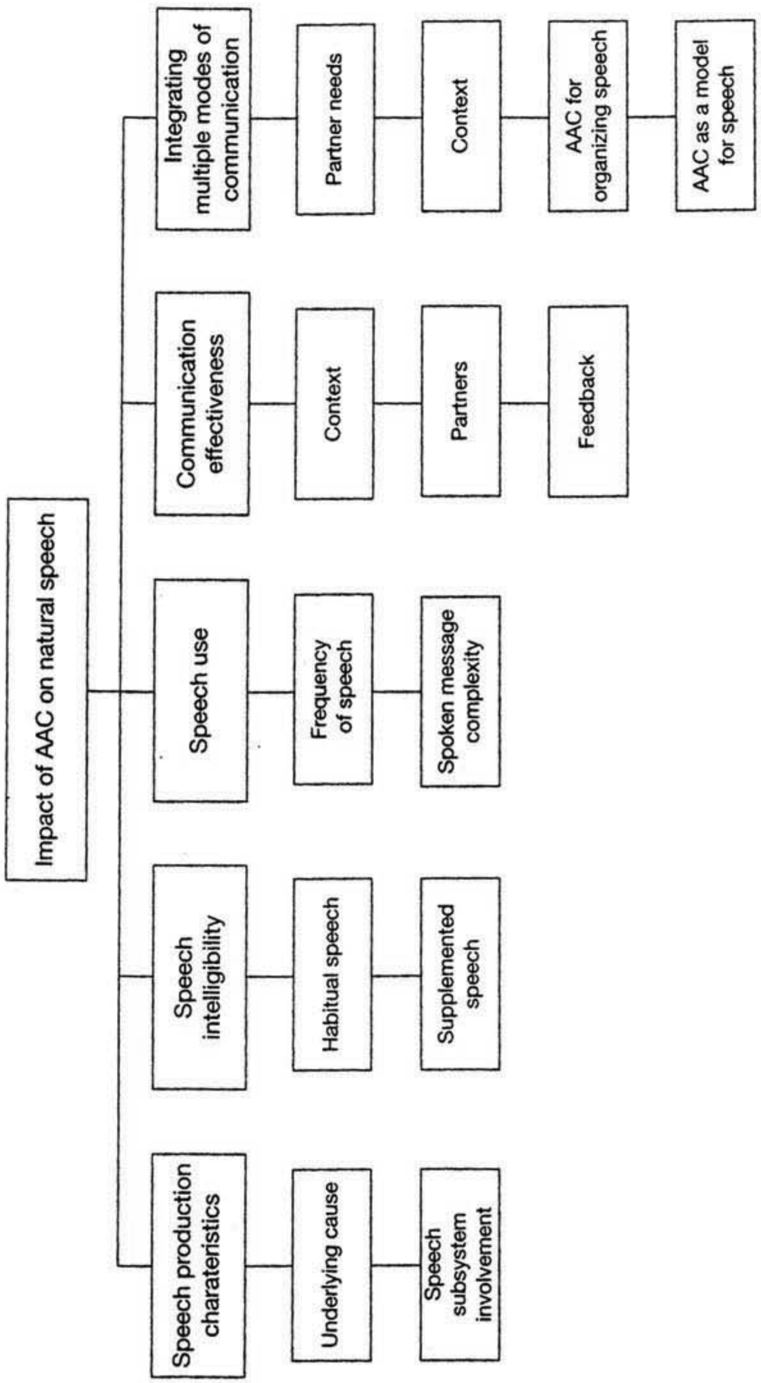

Figure 2.1. Conceptual framework for considering the effects of AAC on natural speech.

This chapter describes what is known about the effects of AAC on natural speech according to each of the five components outlined above and identifies directions for future research. Finally, a case example illustrating consideration of each component is provided.

SPEECH PRODUCTION CHARACTERISTICS

To understand the impact of AAC on speech, it is important to examine specific speech characteristics and their underlying bases, both of which can have important implications for intervention and long-term outcomes. This is particularly true with respect to expectations for changes in speech that might occur with growth and development or with intervention. Three common, yet very different, populations of individuals with developmental disabilities who are frequent candidates for AAC will be addressed in this section. These are individuals with cerebral palsy, Down syndrome, and developmental apraxia of speech (DAS).

Cerebral Palsy

Cerebral palsy is a nonprogressive, neurologically based motor impairment syndrome that is diagnosed in early childhood (Pellegrino & Dormans, 1998). Prevalence estimates of dysarthria associated with cerebral palsy vary between 31% (Wolfe, 1950) and 88% (Achilles, 1955). Speech characteristics observed in those with cerebral palsy are extremely heterogeneous in nature and depend, to a great extent, on underlying pathology–specific muscles and muscle groups that are affected and the physiologic involvement of each. Accordingly, generalizations across individuals, levels of severity, and physiological types are somewhat difficult to draw. Research, although sparse, suggests that speech problems experienced by people with cerebral palsy can affect all speech subsystems–respiration, phonation, resonation, and articulation. Specific effects on each subsystem follow.

In general, respiration is considered the driving force behind the production of speech. It provides the energy source for the phonatory system, which in turn provides the sound source that is filtered by the articulatory and resonatory systems, resulting in the sounds and words of a language (Kent & Read, 1992). Research suggests there are several respiratory problems that may occur in individuals with cerebral palsy, including:

- Respiratory patterns appear to be less flexible than those observed in typically developing children (Hardy, 1964).
- Use of a rapid inhalation and prolonged exhalation pattern of speech breathing employed by speakers without disabilities may be difficult (McDonald, 1987).

- Antagonistic movements of the diaphragm–abdomen and thorax may be more common, resulting in less efficient and reduced inhalatory volume (McDonald, 1987).
- Maintaining consistent subglottal air pressure for speech may be difficult, thus resulting in loudness variation (McDonald, 1987).

Phonatory problems associated with cerebral palsy have received less attention in the research literature; however, McDonald (1987) made the following generalizations:

- Coordinating initiation of phonation with expiration may be difficult.
- Adduction of the vocal folds may be too forceful and regulation of vocal fold tension may be difficult.
- Prevocalizations often result from difficulty with timing the onset of phonation.

Velopharyngeal function in individuals with cerebral palsy has also received little research attention; however, Kent and Netsell (1978) found that individuals with athetoid cerebral palsy tend to have difficulty achieving consistent velopharyngeal closure.

Of all speech subsystems, articulation appears to have received the most attention. Research has demonstrated several different articulatory characteristics of individuals with cerebral palsy. Collective observations across studies are as follows:

- Sounds involving the anterior portion of the tongue tend to be frequently misarticulated (McDonald, 1987; Platt, Andrews, Young, & Quinn, 1980).
- Individuals tend to exhibit a large range of mandibular movements (Kent & Netsell, 1978), including hyperextension (McDonald, 1987).
- Stops, nasals, glides, velars, and bilabials tend to be articulated correctly (Platt, Andrews, Young, & Quinn, 1980).
- Voiceless sounds tend to be misarticulated more frequently than voiced cognates (McDonald, 1987).
- Errors tend to occur more frequently in the word-final than word-initial position (Platt, Andrews, & Howie, 1980; Platt, Andrews, Young, & Quinn, 1980).
- Abnormalities in the timing and range of tongue movements tend to occur (Kent & Netsell, 1978).
- Articulatory transition times tend to be prolonged (Kent & Netsell, 1978).
- Individuals with spasticity and athetosis evidence differing error patterns (Platt, Andrews, & Howie, 1980; Platt, Andrews, Young, & Quinn, 1980).
- Fricatives and affricates are often misarticulated (Platt, Andrews, Young, & Quinn, 1980).

- Vowel productions are often inaccurate (Platt, Andrews, Young, & Quinn, 1980).
- Coarticulation may be problematic (McDonald, 1987).

The constellation, severity, and functional manifestation of subsystem deficits are highly variable among individuals with cerebral palsy. Problems with any one or all of the speech subsystems can result in functional limitations, typically measured by intelligibility and rate of speech (Yorkston, Beukelman, Strand, & Bell, 1999). The relationship among speech subsystems is complex, and problems with a greater number of subsystems do not necessarily constitute greater functional limitations. Some individuals may experience problems primarily with the articulatory system and consequently have profound functional limitations, whereas others may have problems with all of the subsystems and have only mild functional limitations.

Perhaps the most important point regarding speech production in individuals who have cerebral palsy is that the underlying cause is neuromuscular in nature. Consequently, although these individuals may experience some changes in speech with growth, development, and aging, for the most part, problems are static, and gross functional changes without the use of compensatory AAC strategies are not likely.

Down Syndrome

Individuals with Down syndrome present with a unique set of speech production differences relative to those associated with cerebral palsy. Research suggests that 95% of parents of children with Down syndrome sometimes or frequently have difficulty understanding their children's communication attempts (Kumin, 1994). Speech problems appear to be associated with anatomical and neurological differences along with mental retardation. Specific problems include

- Central nervous system structures may differ in size relative to age-matched peers (Florez, 1992; Scott, Becker & Petit, 1983) and consequently may be associated with reduced accuracy, timing, and sequencing of speech movements (Leddy, 1999).
- Larger tongue size in relation to the oral cavity (Arden, Harker, & Kemp, 1972) may affect tongue placement for articulation. Attempts to correct this anatomical difference have included tongue resections, which seem to result in little if any improvement in speech intelligibility (Parsons, Iacono, & Rozner, 1987).
- Abnormal development of the facial bones, including smaller skull (Frostad, Cleall, & Melosky, 1971; Kisling, 1966; Roche, Roche, & Lewis, 1972; Sanger, 1975), may result in a smaller oral cavity.

- Midfacial muscles tend to be poorly differentiated and may result in limited elevation of the upper lip and corners of the mouth for facial expression (Leddy, 1999).
- Hypotonia may make it more difficult for individuals with Down syndrome to control both fine and gross motor movements (Yorkston et al., 1999). Because speech production involves the coordination of many muscles within the four subsystems (i.e., respiration, phonation, resonation, articulation), hypotonia may play a role in decreased speech intelligibility in individuals with Down syndrome.

In addition, problems with articulatory, phonatory, and resonatory subsystems are also characteristic of individuals with Down syndrome (Leddy, 1999). Articulatory problems, in particular, appear to be associated with anatomical and neurological differences outlined previously, as well as a wide range of cognitive abilities. Articulatory characteristics that affect some, but not all, individuals with Down syndrome are as follows:

- Articulation and phonological processing disorder patterns are similar to those of younger children without Down syndrome and include initial cluster reduction, stopping, and final consonant deletion (Bleile & Schwartz, 1984; Iacono, 1998).
- Range and frequency of speech errors seems to be greater for children with Down syndrome than for typically developing children (Parsons & Iacono, 1992)
- Dysarthria or verbal apraxia may influence overall intelligibility (Yorkston et al., 1999) and can compound the effects of an existing phonological processing disorder.
- Tongue thrust patterns may influence both mastication and articulation (Kumin, 1994).

Problems with the phonatory system are most commonly manifest as a hoarse vocal quality (Leddy, 1999). Leddy suggested that anatomical differences, endocrine dysfunction, and an abnormal vocal fold structure may contribute to this percept in the speech of individuals with Down syndrome. Resonatory problems seen in individuals with Down syndrome include hyponasality or hypernasality. Hyponasality may be due to enlarged adenoids or allergies, and hypernasality is often due to flaccid muscle tone (Leddy, 1999).

Finally, fluency disruptions occur in approximately 45%–53% of individuals with Down syndrome (Devenny & Silverman, 1990; Preus, 1990), with dysfluencies tending to be more common among those who have better expressive language skills (Kumin, 1994). Given the wide range of structural and neurological differences, it is not surprising that some researchers believe individuals with Down syndrome have fluency disruptions due to motor-based difficulties, whereas others believe that dysfluencies are linguistically based.

Similar to interventions with individuals with cerebral palsy, AAC interventions do not necessarily have a direct effect on speech production in individuals with Down syndrome. For those with Down syndrome who evidence phonological disorders, particularly children, traditional speech intervention should not be completely abandoned, as there is ample evidence that this type of remediation is effective for other children with phonological disorders (Gierut, 1998); however, generalization of phonological treatment efficacy to individuals with Down syndrome remains largely speculative, and progress is likely to be slow because of cognitive limitations, with changes in speech production that result in functional improvements in spoken communication taking months or even years for some individuals. Consequently, it is important that AAC be implemented for those with reduced intelligibility to enhance functional communication.

Developmental Apraxia of Speech

Developmental apraxia of speech (DAS) is a disorder that is poorly understood and highly controversial in the field of communication disorders (Marion, Sussman, & Marquardt, 1993). "Most definitions of DAS . . . focus on the inability or difficulty with the ability to perform purposeful voluntary movements for speech in the absence of paralysis or weakness of the speech musculature" (Caruso & Strand, 1999, p. 14); however, researchers disagree as to what causes the disorder, with perspectives including motor-level impairment, linguistic deficits, and auditory processing deficits (Strand & Skinner, 1999).

Unlike individuals with cerebral palsy and Down syndrome, those with DAS may seem to be developing typically with the exception of speech production abilities. Although there do not appear to be any anatomical differences, children with DAS may exhibit what some describe as "soft neurological signs," which are characterized by an overall clumsiness or awkwardness, and/or mild sensory aversions to tasks such as brushing their teeth or washing their faces.

Because children with DAS have an outward appearance of being typically developing, their parents and caregivers may resist the implementation of AAC systems and strategies that would make them visibly different to the world around them. Clinical observations suggest that children with DAS sometimes devise their own elaborate signs or gestures to help them communicate. These compensatory strategies may also contribute to parents' resistance to implement AAC. Parents may feel that their child is already using other means to communicate and additional "formal" strategies are not necessary.

The specific speech production characteristics of children with DAS vary among individuals; however, children with DAS generally tend to have particular difficulty with articulation and prosody, which appear to be caused by motor planning deficits. These problems may lead to significantly reduced intelligibility and difficulty with functional communication. Specifically, articulation skills of children with DAS may be characterized by some or all of the following:

- Both consonant and vowel phonemic repertoires are limited (Chappell, 1973; Davis, Jakielski, & Marquardt, 1998; Edwards, 1973).
- Errors are predominantly characterized by omissions, cluster simplification, and assimilation (Davis et al., 1998; Rosenbek & Wertz, 1972; Smartt, LaLance, Gray, & Hibbert, 1976).
- Vowel errors are numerous, and patterns are sometimes different from children with functional articulation disorders (Crary, 1984; Davis et al., 1998; Rosenbek & Wertz, 1972; Smartt et al., 1976; Yoss & Darley, 1974).
- Articulation errors are not consistent (Davis et al., 1998).
- Children with DAS often rely predominantly on simple syllable shapes, and errors increase on longer units of speech output (Davis et al., 1998).
- Reduced diadochokinetic rates, articulatory groping, and impaired volitional oral movements are present (Chappell, 1984; Davis et al., 1998; Rosenbek, Hansen, Baughman, & Lemme, 1974).
- Imitating words and phrases is difficult (Davis et al., 1998).

Prosodic disturbances in children with DAS may include monotony, rate that is too rapid, or rate that is too slow (Davis et al., 1998). Research by Shriberg, Aram, and Kwiatkowski (1997) suggests that inappropriate stress patterns may be a diagnostic marker for DAS. In addition, dysfunctions in speech production may be related to perceptual problems (Shriberg et al., 1997) such as impaired temporal perception of the durational aspects of sounds (Robin, Hall, & Jordan, 1986).

The effect of AAC intervention on speech production in children with DAS is completely unknown and speculation is particularly difficult because of the motor planning problems characteristic of this population. Research with this population is critical to determine the influence of AAC on speech production. In addition, efficacy research examining the effects of traditional speech-oriented therapy on speech production is also necessary because there is little published empirical evidence.

SPEECH INTELLIGIBILITY

Speech intelligibility is often defined as the degree to which a message produced by a speaker is recovered by a listener (Kent, Weismer, Kent, & Rosenbek, 1989; Yorkston & Beukelman, 1980; Yorkston, Strand, & Kennedy, 1996). Although the integrity of speech subsystems plays an important role in intelligibility, a direct one-to-one relationship does not exist because a number of other variables, in addition to the integrity of the speech subsystems, contribute to speech intelligibility (Yorkston et al., 1999). These include the listener's ability to apply his or her inherent top–down knowledge of the language and shared context between speaker and listener (Hustad, Beukelman, & Yorkston, 1998).

The ability of parents and other highly familiar caregivers to understand young children, often in spite of compromised intelligibility, illustrates the importance of context and predictability to intelligibility. Parents have shared knowledge regarding such things as the child's experiences, preferences, communication partners, and the general routine of each day. This shared knowledge enables parents to develop expectations for the content of the child's message and, in essence, compensates for the child's reduced intelligibility, enabling an understanding of the intent of the child's message.

In his model of mutuality, Lindblom (1990) discussed the role of two sources of information, signal-dependent and signal-independent information, that contribute to mutual understanding between speaker and listener. Signal-dependent information consists of the speech signal itself, which for many individuals with cerebral palsy, Down syndrome, and DAS is compromised. Lindblom conceptualized signal-dependent information on a continuum ranging from poor to rich, depending on the quality of the acoustic signal produced by the speaker. Signal-independent information consists of knowledge that the listener possesses. Examples include knowledge of the language (i.e., semantics, syntax, morphology, phonology, pragmatics), world knowledge, knowledge of the speaker and the contexts of his or her life, and shared knowledge between speaker and listener (Hustad et al., 1998; Hustad, Jones, & Dailey, in press). Signal-independent information, like signal-dependent information, is also conceptualized on a continuum ranging from poor to rich. According to Lindblom, signal-dependent and signal-independent sources of information are inversely related. If signal-dependent information is compromised (as is the case with individuals who have reduced intelligibility), richer signal-independent information is necessary to compensate so that speaker and listener can achieve mutual understanding. Conversely, when signal-dependent information is rich, little signal-independent information is necessary for speaker and listener to reach mutual understanding because the speech signal is sufficient to carry the communication load.

As children grow older, the signal-independent knowledge specific to the child and all of the contexts of his or her life that communication partners possess may change. Partners may no longer know all of the contexts and situations in a child's life. In addition, as language development proceeds, children may begin to talk about topics and events that are removed in space and time and for which partners do not have shared knowledge or experience. One

AAC intervention that shows promise for increasing intelligibility through enhancement of signal-independent knowledge possessed by listeners is known as speech supplementation (Hustad & Beukelman, 2001; Hustad et al., in press). AAC strategies that can be used to supplement speech include alphabet cues in which the speaker points to the first letter of each word while simultaneously saying the word, topic cues in which the speaker indicates the topic or main idea of a forthcoming message prior to producing it, and combined cues in which both topic and alphabet cues are employed together. A small preliminary body of research suggests that when individuals with reduced intelligibility use these supplemental AAC strategies together with natural speech, intelligibility can be significantly improved, even for those with severe impairments (Beliveau, Hodge, & Hagler, 1995; Beukelman & Yorkston, 1977; Crow & Enderby, 1989; Hustad & Beukelman, 2001; Hustad et al., in press). Although speech supplementation strategies are intended to increase intelligibility by enhancing signal-independent listener knowledge, a byproduct of alphabet supplementation seems to be that speakers reduce their rate of speech and increase word segmentation, thereby modifying production characteristics of speech and making it more intelligible (Beukelman & Yorkston, 1977; Crow & Enderby, 1989; Hustad et al., in press). Consequently, this type of AAC strategy would seem to have a positive effect on both signal-dependent and signal-independent factors. (See Hustad, Morehouse, & Gutmann, 2001, and Hustad & Beukelman, 2000, for detailed discussion of speech supplementation strategies and their implementation.)

Research on the efficacy of speech supplementation strategies has primarily addressed adults with cerebral palsy and other acquired dysarthrias (Beliveau, Hodge, & Hagler, 1995; Beukelman & Yorkston, 1977; Hunter, Pring, & Martin, 1991; Hustad & Beukelman, 2000, 2001; Hustad et al., in press), although preliminary case descriptions suggest that speech supplementation strategies hold promise for children with DAS (Hustad et al., 2001). Additional research is necessary to validate the effectiveness of these strategies with other populations of individuals who have developmental disabilities, including those with Down syndrome.

USE OF SPEECH

One of the obstacles in addressing the impact of AAC on the use of speech is the lack of a consistent operational definition of *speech use.* In the sparse existing literature, this term has been used interchangeably to address the frequency of productions and the complexity of spoken messages. Frequency of productions refers to the number of vocalizations produced and is assessed by counting the number of utterances in a given period of time. Complexity, however, refers to the length and the form of the utterance (consonant–vowel versus consonant–vowel–consonant productions; word-level utterances versus sentence-level utterances).

In general, research examining frequency of speech productions has suggested that availability of AAC does not preclude the use of natural speech and other unaided modes of communication. For example, following implementation of AAC systems and strategies with individuals with mental retardation, Calculator and Dollaghan (1982) found that other, unspecified, modes of communication were used more frequently than AAC systems and strategies for initiating and responding. Similarly, Light, Collier, and Parnes (1985) found that children with severe physical disabilities who used AAC employed vocalizations more frequently than any other communication mode. Further, Beck (1988) reported increases in the frequency of word-level speech productions for children with various developmental disabilities following AAC intervention.

In a study examining the effects of AAC on communication interactions of children with suspected DAS, Cumley (1997) found that AAC did not decrease the frequency of speech use; however, there seemed to be a decrease in the quantity of gestures employed by children who were deemed "high-frequency" users of AAC. Cumley interpreted this as a positive finding because the communication boards employed in this study involved symbols that were more readily understood by a variety of communication partners than gestures.

Less research has focused on changes in the complexity of spoken messages following AAC intervention. However, in a case study, Romski, Sevcik, and Pate (1988) found that complexity of spoken utterances increased from exclusively monosyllabic productions to some bisyllabic productions following intervention emphasizing use of graphic symbols in communicative contexts.

Existing research seems to support the notion that implementation of AAC systems and strategies with individuals who have developmental disabilities does not hinder the use of speech as a mode of communication. Additional research is necessary to further explore the impact of AAC on use of speech. In particular, research should systematically examine individuals with different underlying etiologies, speech impairments of varying severity, different types of AAC systems, and different intervention approaches to further understand the effects of AAC on use of speech.

COMMUNICATION EFFECTIVENESS

Communication effectiveness is a construct that has recently begun to receive increasing attention (Hustad, 2001; Hustad et al., 1998; Yorkston et al., 1999). In general, communication effectiveness refers to the success with which a speaker is perceived to interact, or exchange information, in various communication situations compared with speakers without disabilities of similar age, background, and experience (Hustad et al., 1998). Communication effectiveness is largely a subjective social construct that is measured on the basis of speaker and partner perceptions of success in various communication situations. Yorkston and colleagues (1999) provided an instrument for assessing communication effectiveness in which speakers and partners independently rate success in specific communication contexts using Likert-type rating scales. This type of instrument is useful for systematically determining situations in which the speaker experiences less success, indicating the need for different communication strategies to enhance effectiveness. In addition, the instrument developed by Yorkston and colleagues is useful for determining whether discrepant perceptions between speakers and their communication partners exist. Clinical experience suggests that some individuals may have unrealistic beliefs regarding their own communication effectiveness in different situations and this, in turn, may influence the AAC strategies those individuals choose to employ. For example, those who believe themselves to be effective communicators using speech alone may refuse to use AAC strategies such as alphabet or topic supplementation because they do not see the need. Many of these speakers seem to lack insight into their speech intelligibility challenges and their own behaviors that may propagate reduced communication effectiveness. To some extent, this may be influenced by feedback provided by communication partners.

Skills that seem to be vitally important to effective communication in individuals who use speech that is reduced in intelligibility include the abilities to monitor partners for comprehension, ask partners for feedback, and accept feedback from partners. Conversely, it is critical that communication partners provide honest feedback to speakers with reduced intelligibility, indicating when messages were not fully understood. All too often, listeners of individuals who use speech as a mode of communication are unwilling or uncomfortable indicating that they did not understand the message. As a result, many listeners nod their heads in agreement with the speaker, suggesting that they understand. The consequences of this inaccurate feedback may have far-reaching effects for individuals with speech intelligibility challenges. First, they may fail to develop insight into their intelligibility problems. Second, they may realize that partners did not understand them and come to believe that what they say is not important. Third, they may not learn to look for indicators of comprehension in their communication partners. A quotation from one adult with cerebral palsy illustrates her experiences:

> I know how I feel. I don't like people to say "yeah, yeah" when they really didn't know what I said. I know better than that and I don't like that. I always tell everybody, if you don't know what I said, please just ask me to stop and I will. I will tell you again and again.

It is important to realize that speakers, particularly those who are adolescents and adults, can effect change in their listeners' behavior. Communication, by its very nature, is dyadic. Returning to Lindblom's (1990) model of mutuality, communication or mutual understanding is achieved when the speaker produces a message and the listener processes that message using any and all information available to aid in doing so. When the listener does not have sufficient information to process the message, additional information can be provided by the speaker via AAC strategies. However, the speaker needs to know whether this information is necessary, which can be determined by asking for feedback if it is not provided. It would seem that this type of communication monitoring between speaker and listener should begin early in communication development and continue throughout the life span for individuals who have chronic speech intelligibility challenges. The sooner children learn to identify communication breakdown and acquire tools to repair it, the more effective communication will be.

INTEGRATING MULTIPLE MODES OF COMMUNICATION

The ultimate outcome of any communication intervention should be improvement of the individuals' ability to communicate effectively using any and all means available. For many, this means that both speech and AAC are primary modes of communication, depending on the communication partner and the context. For example, in some situations, exclusive use of AAC may be necessary; however, in other situations, the same person may rely exclusively on speech. Finally, in different situations, this same speaker may benefit from the use of speech supplementation strategies to enhance intelligibility as discussed previously. Often, the mode of communication employed is determined by the communication partner's skill in understanding the message, further illustrating the importance of honest feedback.

Other ways that AAC and speech can be used together include the use of AAC to organize speech. For example, individuals with cognitive disabilities may use low-technology AAC books or boards to structure the content of messages that are then spoken. Finally, AAC can also be used for speech training purposes, serving as a practice partner or a production model. In this type of application, individuals may activate messages stored in a voice output communication device and then repeat those messages using natural speech. The following case example describes a child who benefited from multimodal communication incorporating natural speech, speech supplementation strategies, voice output AAC, and AAC for speech training.

Case Example: Sandy

Sandy was a child with a diagnosis of DAS when she was referred for a speech, language, and AAC assessment at 5 years, 9 months of age. She was just completing kindergarten in a regular education setting and school personnel reported that she was having significant difficulty with communication due to speech intelligibility challenges. Sandy's speech and language intervention to this point had focused primarily on traditional speech-oriented objectives with a strong emphasis on motor planning drill-and-practice activities. Sandy's parents were hesitant to consider AAC options because they felt her speech production was not impaired enough to warrant this. There was also some concern that others weren't "trying hard enough" to understand her. School personnel believed that Sandy's parents did not have a realistic picture of their daughter's communication impairment and her communication needs.

To determine the adequacy of Sandy's speech, quantitative intelligibility measures were collected. This was accomplished through tape recording Sandy's production of a series of structured utterances that were appropriate for her age and language skills. Family members and school personnel were asked to estimate how much of Sandy's speech they thought they typically understood. In addition, they were asked to transcribe the speech sample, writing down each word that they were able to understand. Intelligibility was scored for each listener as the number of words identified correctly divided by the total number of words possible. Results for three family members (mother, father, and a grandparent) showed they estimated that they understood 80%–90% of Sandy's speech. However, transcription intelligibility scores indicated that when signal-dependent information was presented in isolation and family members did not have the full benefit of signal-independent context, quantitative scores ranged from 9% to 35%. For the six school personnel, estimates of intelligibility ranged from 20% to 30% and quantitative measures ranged from approximately 18% to 25%.

These data, displayed graphically in Figure 2.2, illustrate several important points. First, when parents have maximal access to signal-independent information, as they would in a real communication situation, they probably do, in fact, understand 80%–90% of Sandy's messages. Markedly lower estimates of intelligibility by other communication partners who did not have the same comprehensive signal-independent knowledge that her parents have suggest that this signal-independent information is very important for successful communication. Quantitative intelligibility measures of Sandy's speech across school personnel and family reveal that her speech alone is probably not functional when signal-independent information is constrained. In real communication situations, signal-independent information may be limited with unfamiliar communication partners, in situations where the topic or referent is unknown, and in situations where partners do not have shared knowl-

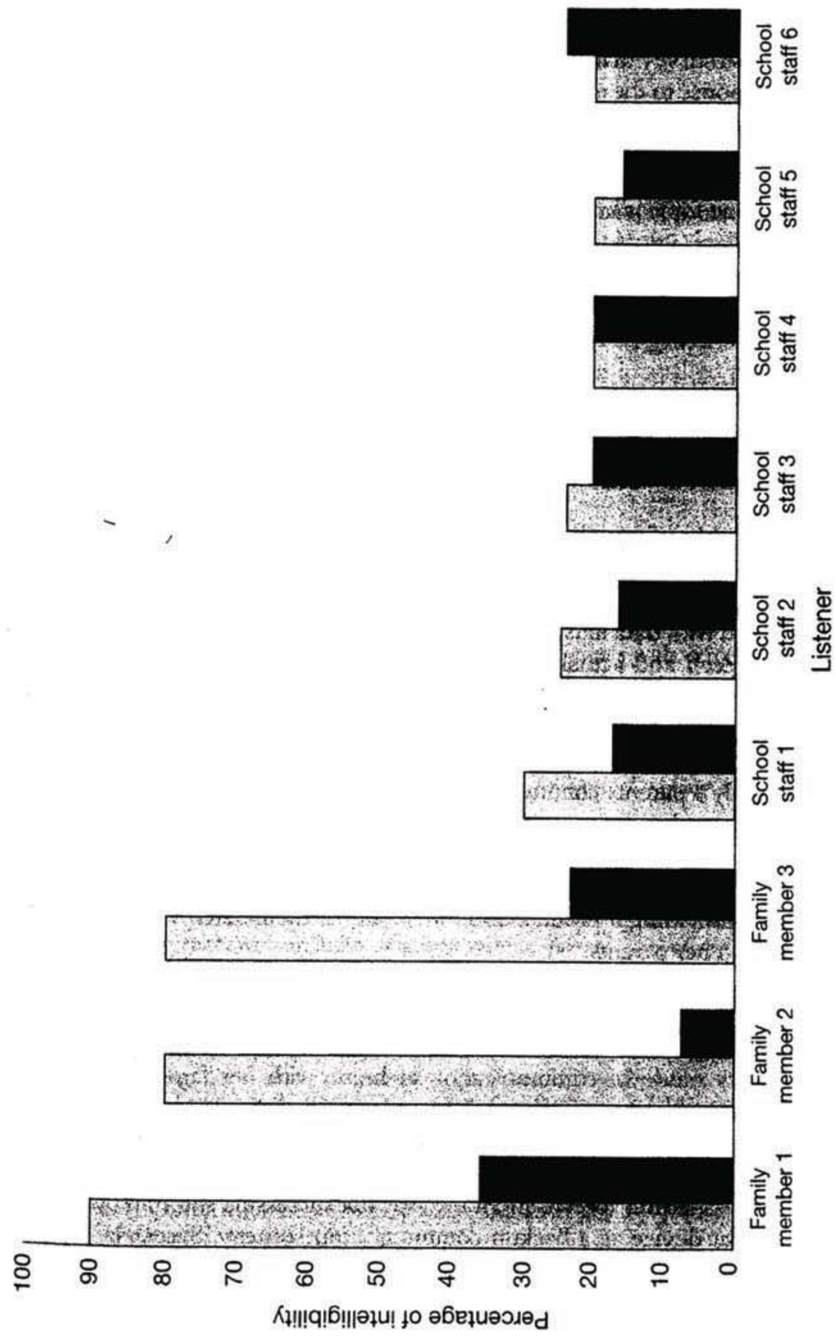

Figure 2.2. Estimated and measured intelligibility by individual speaker for Sandy. (Key: ☐ = estimate of intelligibility; ■ = percent of words identified correctly.)

edge or experience. This is corroborated by responses from a communication effectiveness survey that family and school personnel completed.

In response to the question *In what situations can you understand Sandy's speech best?* answers included the following:

- During routine activities in the classroom
- When the topic is known
- When she is working together with other children on a joint project

In response to the question *In what situations is it hardest to understand Sandy's speech?* answers included the following:

- When no referent is available
- When rate of speech is rapid
- When the general content or topic is unknown
- When there is other noise in the room

Given this information, it seemed very important to provide Sandy with AAC strategies for use when communication partners failed to understand her. Parent education was an important component of intervention for Sandy. When faced with data illustrating the discrepancy between their perception of Sandy's speech and actual performance in decoding her messages without benefit of context, Sandy's family began to see the need for AAC. In addition, comparing intelligibility data from school personnel with their own suggested that difficulty understanding Sandy was probably not associated with failure to try. Sandy's parents continued to advocate for traditional speech therapy; however, they also now agreed to intervention focusing on functional communication via AAC strategies. The suggestion that AAC strategies, in particular use of a voice output communication device, could be used to facilitate speech by providing a production model that Sandy imitated was especially appealing to her parents.

Sandy's intervention focused on use of multiple modes of communication including speech, supplemental AAC strategies, gestures, and voice output communication options. For example, Sandy continued to use speech as her primary mode of communication at home with her family; however, Sandy and her family learned to follow a hierarchy of AAC strategies including use of topic boards and a voice output AAC system for resolution of communication breakdown. At school, Sandy used topic boards in conjunction with her natural speech, and if this was not successful, she employed her voice output device as a backup communication strategy. Speech-language therapy continued to focus on improving speech production as a secondary objective, and use of AAC strategies to enhance functional communication became the primary objective.

SUMMARY

This chapter focused on the relationship between AAC and speech in individuals with developmental disabilities through discussion of five, more circumscribed, issues: underlying speech production variables, effects of AAC on speech intelligibility, effects of AAC on use of speech, communication effectiveness, and the integration of AAC and speech for multimodal communication. Research examining these issues has been somewhat sparse and additional investigation is necessary to fully understand the impact of AAC on each of these speech-related variables. Single-subject and group research designs would both be beneficial in addressing questions identified throughout this chapter so that the effects of AAC on natural speech can be characterized more clearly. Future research is urgently needed to advance understanding in the field and to improve outcomes for individuals with developmental disabilities who have significant speech impairments.

REFERENCES

Achilles, R. (1955). Communication anomalies of individuals with cerebral palsy: I. Analysis of communication processes in 151 cases of cerebral palsy. *Cerebral Palsy Review, 16,* 15–24.

Arden, G.M., Harker, P., & Kemp, F.H. (1972). Tongue size in Down syndrome. *Journal of Mental Deficiency Research, 16,* 160–166.

Beck, A. (1998). Improving natural speech. *Advance for Speech Language Pathologist and Audiologists, 9.*

Beliveau, C., Hodge, M., & Hagler, P. (1995). Effect of supplemental linguistic cues on the intelligibility of severely dysarthric speakers. *Augmentative and Alternative Communication, 11,* 176–186.

Beukelman, D., & Yorkston, K. (1977). A communication system for the severely dysarthric speaker with an intact language system. *Journal of Speech and Hearing Disorders, 42,* 265–270.

Bleile, K., & Schwartz, I. (1984). Three perspectives on the speech of children with Down's syndrome. *Journal of Communication Disorders, 17,* 87–94.

Calculator, S., & Dollaghan, C. (1982). The use of communication boards in a residential setting: An evaluation. *Journal of Speech and Hearing Disorders, 47,* 281–287.

Caruso, A.J., & Strand, E.A. (1999). Motor speech disorders in children: Definitions, background, and a theoretical framework. In A.J. Caruso & E.A. Strand (Eds.), *Clinical management of motor speech disorders in children* (pp. 1–28). New York: Thieme Medical Publishers.

Chappell, G. (1973). Childhood verbal apraxia and its treatment. *Journal of Speech and Hearing Disorders, 38,* 362–368.

Chappell, G. (1984). Developmental verbal dyspraxia: The expectant pattern. *Australian Journal of Human Communication Disorders, 12,* 15–25.

Crary, M.A. (1984). Phonological characteristics of developmental verbal apraxia. *Communication Disorders, 9,* 33–49.

Crow, E., & Enderby, P. (1989). The effects of an alphabet chart on the speaking rate and intelligibility of speakers with dysarthria. In K. Yorkston & D. Beukelman (Eds.), *Recent advances in clinical dysarthria* (pp. 100–108). San Diego: College Hill Press.
Cumley, G. (1997). *Introduction of an augmentative and alternative modality: Effects on the quality and quantity of communication interactions of children with severe phonological disorders.* Unpublished doctoral dissertation, University of Nebraska, Lincoln.
Davis, B.L., Jakielski, K.J., & Marquardt, T.M. (1998). Developmental apraxia of speech: Determiners of differential diagnosis. *Clinical Linguistics and Phonetics, 12,* 25–45.
Devenny, D.A., & Silverman, W.P. (1990). Speech dysfluency and manual specialization in Down's syndrome. *Journal of Mental Deficiency Research, 34,* 253–260.
Edwards, M. (1973). Developmental verbal dyspraxia. *British Journal of Disorders of Communication, 8,* 64–70.
Florez, J. (1992). Neurological abnormalities. In S.M. Pueschel & J.K. Pueschel (Eds.), *Biomedical concerns in persons with Down syndrome* (pp. 159–173). Baltimore: Paul H. Brookes Publishing Co.
Frostad, N.A., Cleall, J.F., & Melosky, L.C. (1971). Craniofacial complex in the trisomy 21 syndrome (Down's syndrome). *Archives of Oral Biology, 16,* 707–722.
Gierut, J.A. (1998). Treatment efficacy: Functional phonological disorders in children. *Journal of Speech, Language, and Hearing Research, 41,* S85–100.
Hardy, J. (1964). Lung function of athetoid and spastic quadriplegic children. *Developmental and Child Neurology, 6,* 378–377
Hunter, L., Pring, T., & Martin, S. (1991). The use of strategies to increase speech intelligibility in cerebral palsy: An experimental evaluation. *British Journal of Disorders of Communication, 26,* 163–174.
Hustad, K.C. (2001). Unfamiliar listeners' evaluation of speech supplementation strategies for improving the effectiveness of severely dysarthric speech. *Augmentative and Alternative Communication, 17,* 213–220.
Hustad, K.C., & Beukelman, D.R. (2000). Integrating AAC strategies with natural speech in adults. In D.R. Beukelman and J. Reichle (Series Eds.) & D.R. Beukelman, K.M. Yorkston, & J. Reichle (Vol. Eds.), *AAC Series: Augmentative and alternative communication for adults with acquired neurologic disorders* (pp. 83–106) Baltimore: Paul H. Brookes Publishing Co.
Hustad, K.C., & Beukelman, D.R. (2001). Effects of linguistic cues and stimulus cohesion on intelligibility of severely dysarthric speech. *Journal of Speech, Language, and Hearing Research, 44,* 407–510.
Hustad, K.C., Beukelman, D.R., & Yorkston, K.M. (1998). Functional outcome assessment in dysarthria. *Seminars in Speech and Language, 19*(3), 291–302.
Hustad, K.C., Jones, T., & Dailey, S. (in press). Implementing speech supplementation strategies: Effects on intelligibility and speech rate of individuals with chronic severe dysarthria. *Journal of Speech, Language, and Hearing Research.*
Hustad, K.C., Morehouse, T.B., & Gutmann, M. (2001). AAC strategies for enhancing the usefulness of natural speech in children with severe intelligibility challenges. In J. Reichle, D. Beukelman, & J. Light (Eds.), *Exemplary practices for beginning communicators: Implications for AAC.* Baltimore: Paul H. Brookes Publishing Co.
Iacono, T.A. (1998). Analysis of the phonological skills of children with Down syndrome from single word and connected speech samples. *International Journal of Disability, Development, and Education, 45*(1), 57–73.
Kent, R., & Netsell, R. (1978). Articulatory abnormalities in athetoid cerebral palsy. *Journal of Speech and Hearing Disorders, 43,* 353–373.
Kent, R.D., & Read, C. (1992). *The acoustic analysis of speech.* San Diego: Singular Press.

Kent, R., Weismer, G., Kent, J., & Rosenbek, J. (1989). Toward phonetic intelligibility testing in dysarthria. *Journal of Speech and Hearing Disorders, 54,* 482–499.
Kisling, E. (1966). *Cranial morphology in Down's syndrome: A comparative roentgenocephalometric study in adult males.* Copenhagen, Denmark: Munksgaard.
Kumin, L. (1994). *Communication skills in children with Down syndrome: A guide for parents.* Bethesda, MD: Woodbine House.
Leddy, M. (1999). The biological bases of speech in people with Down syndrome. In J.F. Miller, M. Leddy, & L.A. Leavitt (Eds.), *Improving the communication of people with Down syndrome* (pp. 61–80). Baltimore: Paul H. Brookes Publishing Co.
Light, J., Collier, B., & Parnes, P. (1985). Communicative interaction between young nonspeaking physically disabled children and their primary caregivers: Part III. Modes of communication. *Augmentative and Alternative Communication, 1,* 125–133.
Lindblom, B. (1990). On the communication process: Speaker–listener interaction and the development of speech. *Augmentative and Alternative Communication, 6,* 220–230.
Marion, M.J., Sussman, H.M., & Marquardt, T.P. (1993). The perception and production of rhyme in normal and developmentally apraxic children. *Journal of Communication Disorders, 26,* 129–160.
McDonald, E.T. (1987). Speech production problems. In E.T. McDonald (Ed.), *Treating cerebral palsy: For clinicians by clinicians* (pp. 171–190). Austin, TX: PRO-ED.
Millar, D., Light, J., & Schlosser, R. (2000). *The impact of AAC on natural speech development: A meta-analysis.* Presentation at the Ninth Biennial Conference of the International Society for Augmentative and Alternative Communication, Washington DC.
Parsons, C., & Iacono, T. (1992). Phonological abilities in individuals with Down syndrome. *Australian Journal of Human Communication Disorders, 20,* 31–46.
Parsons, C.L., Iacono, T.A., & Rozner, L. (1987). Effect of tongue reduction on articulation in children with Down syndrome. *American Journal of Mental Deficiency, 91,* 328–332.
Pellegrino, L., & Dormans, J. (1998). Definitions, etiology, and epidemiology of cerebral palsy. In J. Dormans & L. Pellegrino (Eds.), *Caring for children with cerebral palsy: A team approach* (pp. 3–30). Baltimore: Paul H. Brookes Publishing Co.
Platt, L.J., Andrews, G., & Howie, P.M. (1980). Dysarthria of adult cerebral palsy: II. Phonemic analysis of articulation errors. *Journal of Speech and Hearing Disorders, 23,* 41–55.
Platt, L.J., Andrews, G., Young, M., & Quinn, P.T. (1980). Dysarthria of adult cerebral palsy: I. Intelligibility and articulatory impairment. *Journal of Speech, Language, and Hearing Research, 22,* 28–40.
Preus, A. (1990). Treatment of mentally retarded stutterers. *Journal of Fluency Disorder, 15,* 223–233.
Robin, D.A, Hall, P.K., & Jordan, L.S. (1986, November). *Auditory processing deficits in developmental verbal apraxia.* Paper presented at the Annual Convention of the American Speech-Language-Hearing Association, Detroit, MI.
Roche, A.F., Roche, J.P., & Lewis, A.B. (1972). The cranial base in trisomy 21. *Journal of Mental Deficiency Research, 16,* 7–20.
Romski, M., Sevcik, R., & Pate, J. (1988). Establishment of symbolic communication in persons with severe retardation. *Journal of Speech and Hearing Disorders, 53,* 94–107.
Rosenbek, J., Hansen, R., Baughman, C., & Lemme, M. (1974). Treatment of developmental apraxia of speech: A case study. *Language, Speech and Hearing Services in Schools, 5,* 13–22.
Rosenbek, J.C., & Wertz, R.T. (1972). A review of fifty cases of developmental apraxia of speech. *Language, Speech and Hearing Services in Schools, 5,* 13–22.

Sanger, R.G. (1975). Facial and oral manifestations of Down's syndrome. In R. Koch & F.F. de la Cruz (Eds.), *Down's syndrome (Mongolism): Research, prevention and management* (pp. 32–46). New York: Brunner/Mazel.
Scott, B.S., Becker, L.E., & Petit, T.L. (1983). Neurobiology of Down's syndrome. *Progress in Neurobiology, 21,* 199–237.
Shriberg, L.D., Aram, D.M., & Kwiatkowski, J. (1997). Developmental apraxia of speech: I. Descriptive and theoretical perspectives. *Journal of Speech, Language and Hearing Research, 40,* 273–285.
Silverman, F.H. (1995). *Communication for the speechless* (3rd ed.). Needham Heights, MA: Allyn & Bacon.
Smartt, J., LaLance, L., Gray, J., & Hibbert, P. (1976). Developmental apraxia of speech: A Tennessee Speech and Hearing Association subcommittee report. *Journal of the Tennessee Speech and Hearing Association, 20,* 21–39.
Strand, E.A., & Skinner, A. (1999). Treatment of developmental apraxia of speech: Integral stimulation methods. In Caruso, A.J., & Strand, E.A. (Eds.), *Clinical management of motor speech disorders in children* (pp. 109–148). New York: Thieme Medical Publishers.
Wolfe, W. (1950). A comprehensive evaluation of fifty cases of cerebral palsy. *Journal of Speech and Hearing Disorders, 15,* 234–251.
Yorkston, K., & Beukelman, D. (1980). A clinician-judged technique for quantifying dysarthric speech based on single-word intelligibility. *Journal of Communication Disorders, 13,* 15–31.
Yorkston, K.M., Beukelman, D.R., Strand, E.A., & Bell, K.R. (1999). *Management of motor speech disorders in children and adults.* Austin, TX: PRO-ED.
Yorkston, K., Strand, E., & Kennedy, M. (1996). Comprehensibility of dysarthric speech: Implications for assessment and treatment planning. *American Journal of Speech-Language Pathology, 5,* 55–66.
Yoss, K.A., & Darley, F.L. (1974). Developmental apraxia of speech in children with defective articulation. *Journal of Speech and Hearing Research, 17,* 399–416.

3

Toward Linguistic Competence

Language Experiences and Knowledge of Children with Extremely Limited Speech

Susan Blockberger and Ann Sutton

Behind the eyes full of life
Thinking many thoughts
Thinking if just . . .
If just these thoughts could become words
(Dalhoff, 2000)

Light's (1989) influential definition of communicative competence for individuals who use augmentative and alternative communication (AAC) systems proposed that knowledge, judgment, and skills in four domains contribute to communicative competence in individuals who use AAC. One of these four key domains is the *linguistic domain,* which includes comprehension and expression of the spoken language or languages of the community as well as the conveying of language through the medium of the individual's AAC system(s). Although it is possible to communicate without linguistic competence, such communication is limited in both scope and precision of content and is likely to be ineffective with unfamiliar partners. To avoid these significant limitations, people who use AAC must develop knowledge, judgment, and skill in interpreting and producing the linguistic code or codes of their community, and they must also master how language is represented and produced by their AAC systems.

CHILDREN WITH EXTREMELY LIMITED SPEECH

This chapter explores the language experiences and developing linguistic knowledge of children who use AAC or may potentially use AAC, that is, chil-