Volume 1: Principles, Background, and Application

Simplified Signs

A Manual Sign-Communication System for Special Populations

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5. Childhood Autism and Sign Communication

When we began the Simplified Sign System project, our primary focus was on improving the communicative success of children with autism. Many of these individuals had serious difficulties understanding and producing speech. For these children, training in an augmentative and alternative communication strategy, such as manual signs, was a possible intervention approach. Unfortunately, the motor problems experienced by many persons with autism, coupled with the formational complexities of many of the signs of full and genuine sign languages, such as American Sign Language (ASL), have limited the success of sign intervention programs to some extent. To address these difficulties, we explicitly set out to develop a system composed of signs that were easier to form.

Because persons with autism may also have problems acquiring and remembering signs from genuine sign languages, we included signs that we felt would be more readily learned. In particular, we strove to ensure that the signs in the Simplified Sign System visually resembled the concepts they represented as much as possible. This iconic aspect of many of the signs should make them easier for individuals with autism to learn and remember by providing a visual "clue" to the meanings of the signs. The more transparent nature of the signs should also make them easier for family members, caregivers, teachers, peers, and other persons in the wider community to understand.

It is important to note that participation in an intervention program that utilizes an augmentative and/or alternative communication system, such as the Simplified Sign System, does not weaken or prevent the development of spoken language skills. Rather, sign-communication training and teaching may actually facilitate the development of

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these skills, with some sign-learning children making considerable progress learning to speak. Finally, it is also important to point out that children with autism are a diverse group, and the Simplified Sign System is not to be thought of as the best or only approach for every child with communication difficulties. There are a variety of non-oral communication approaches or methods that may be utilized as either alternatives to speech or as supplementary or augmentative communication techniques.

Childhood Autism

It has been over seventy years since Leo Kanner (1894–1981) first described the syndrome of childhood autism in 1943.[1] He portrayed children with autism as self-absorbed with severe social, communication, and behavioral problems. More specifically, he described them as failing to interact socially, frequently displaying stereotyped gestures or mannerisms, often preoccupied with maintaining sameness or uniformity in their environment, and as having marked impairments in their use of language to communicate. In the years that followed, children who met Kanner's initial clinical description of the principal characteristics of autism have frequently been seen as having classic autism.

At about the same time that Kanner, located in Baltimore, MD, was developing his views about the nature of autism, Hans Asperger (1906–1980), a Viennese clinician, was working with and describing a number of youngsters who shared many of the characteristics of the children seen by Kanner. For many years, it was believed that the two investigators had worked in parallel and been unaware of each other's efforts. That view has changed recently, as it has become apparent that there were important ties between the personnel present in the two clinics (Silberman, 2015). In his work, Asperger described children with autism who varied across a wide range of abilities but who manifested difficulties in social interaction and who frequently engaged in repetitive

1 Although Kanner was the first investigator to specify the characteristics of childhood autism, there is considerable evidence that certain persons, who today would likely be identified as on the autism spectrum, have been present in society over a long period of time (Donvan & Zucker, 2016).

actions and pursued narrow interests. Because Asperger highlighted the performance of some of the more intellectually gifted children he worked with in his accounts, many children with autism with higher IQs and relatively good formal language skills were described in the scientific literature as having Asperger syndrome.[2]

Over time, the more inclusive view of autism advanced by Asperger, with its wide range of ability levels, has come to be the generally accepted version of the syndrome (Frith, 2008; Silberman, 2015). This diversity of abilities is captured by the term autism spectrum disorder (or ASD). Individuals with ASD are identified by several core features or diagnostic criteria (American Psychiatric Association, 2013; Frith, 2008): difficulties in engaging in reciprocal social interactions and social communication (including atypicalities in nonverbal communication, the production of few communicative gestures, and problems understanding facial expressions); repetitive actions, behaviors, or narrow interests (such as stereotyped movements, resistance to change, and object fixations); the presence of these symptoms in early childhood; and these symptoms are not attributable to an intellectual disability or a global developmental delay. There frequently is also a delay in spoken language development that is evident in both receptive (understanding) and expressive (productive) language in infants who are subsequently diagnosed with ASD (Lazenby et al., 2016). The wide range of abilities among persons on the autism spectrum can be seen in that some individuals are highly gifted intellectually while others have an intellectual disability.

Although much has been written about childhood autism over the last seven decades, the origin and neurophysiological basis of the disorder remain unclear. Kanner originally believed that parents, through their curtailed and frigid patterns of interaction with their children, likely caused the disorder; he was subsequently to abandon this view. Most contemporary investigators view the underlying issue in autism as some form of organic or neurochemical brain dysfunction that has not yet been specifically determined.[3] Although there have been numerous

2 It should be noted that in the recent edition of the *Diagnostic and Statistical Manual of Mental Disorders*, or DSM-5, that Asperger syndrome is no longer identified as a separate diagnosis (American Psychiatric Association, 2013).

3 Some evidence of brain dysfunctions related to atypicalities associated with autism is beginning to emerge. Post mortem examination of portions of the cortex from children with ASD has shown patches of disturbances in the cortical architecture

reports in recent decades of anatomical abnormalities located in the brains of individuals with ASD, it should be noted that many of these findings subsequently failed to be replicated in a larger sample (Haar et al., 2016). Moreover, multiple genetic and environmental risk factors likely contribute to the atypicalities associated with autism (Wozniak et al., 2017).

There is now considerable evidence of a substantial genetic component in childhood autism (Acosta & Pearl, 2006; Autism Genome Project Consortium, 2007; Bailey et al., 1995; Gamsiz et al., 2015; Muhle, Trentacoste, & Rapin, 2004; Rosenberg et al., 2009; Rutter & Thapar, 2014; Sutcliffe, 2008; Yuen et al., 2017). The evidence of a genetic component in childhood autism is particularly striking in studies involving monozygotic (identical) and dizygotic (fraternal) twins. If one monozygotic twin is diagnosed with autism, then the co-twin also is quite likely to be diagnosed. The concordance rates for autism among dizygotic twin pairs, in contrast, are much lower. There is also growing evidence, albeit indirect, that exposure to toxic chemicals early in development may contribute to childhood autism (Landrigan, 2010). In addition, the findings from a recent twin study suggest that shared environmental factors, including those present in the womb, likely play an important role in autism (Hallmayer et al., 2011). Two such factors reported as being associated with increased risk of ASD were maternal antidepressant use during pregnancy (Boukhris et al., 2016) and maternal exposure to fever during the second trimester of a pregnancy (Hornig et al., 2017).

The initial investigations that established a genetic role in the etiology of autism focused on families in which more than one member had been identified with ASD and emphasized classic Mendelian inheritance patterns. Over the past decade, however, a very different viewpoint has emerged as to the genetic origins of a large number of cases of autism. This new viewpoint is that ASD often arises from spontaneous (or *de novo*) mutations (Gamsiz et al., 2015; Iossifov et al., 2014; Sebat

of most of these individuals (Stoner et al., 2014). These patches of disorganized cortex, furthermore, were found in regions that mediated functions often impaired in persons with ASD. A reduced volume of the arcuate fasciculus also has been reported for persons with autism. The arcuate fasciculus is the major white matter tract that connects important language-processing regions in the brain. The reduction in arcuate fasciculus volume, moreover, also was significantly related to autism symptom severity (Moseley et al., 2016).

et al., 2007; Yuen et al., 2017). Such de novo mutations reportedly occurred more frequently in families where there was only a single child identified with autism as opposed to families where two or more children were affected. These mutations, moreover, frequently turned out to be complex genetically and to have taken place as the parents' eggs or sperm cells were developing. Additional research showed that whereas these spontaneous mutations individually were quite rare, collectively they appeared to account for a substantial number of cases of childhood autism (Hall, 2015; Iossifov et al., 2014; Yuen et al., 2017). In coming years, it will be important to continue to pinpoint more precisely the many genes associated with autism; if this is accomplished, then it will enable clinicians to prioritize those infants most in need of early diagnostic assessments and interventions (Yuen et al., 2017). The wide variety of individual de novo mutations involved might also help explain the great heterogeneity seen in the behavior of persons with autism. Finally, the finding that many such mutations occurred during egg and sperm cell development, rather than earlier in the development process, might help account for the reported increased rates of ASD in children with older parents.

Even though the precise cause of autism has remained elusive, the number of children diagnosed with it has increased steadily over the years (Hertz-Picciotto & Delwiche, 2009). Originally believed to be quite rare and to occur in only one or two children per 10,000, by the mid-1990s the incidence of autism spectrum disorder (ASD, that is, childhood autism and other closely related syndromes) was estimated at 1 in about every 500 children (Bristol et al., 1996). Recently, the incidence of children with ASD in the U.S. has been reported as being much higher: 1 in every 91 children in one study (Kogan et al., 2009) and 1 in about every 59 children in another (Centers for Disease Control and Prevention, 2018). Furthermore, the prevalence of autism spectrum disorder among elementary-school-aged children in a South Korean community has been found to be even higher, 2.64%, or 1 in about every 38 children (Kim et al., 2011). Finally, an estimate of the number of individuals with ASD worldwide was made recently at 67 million, with approximately 600,000 of these persons living in France (Bonnet-Brilhault, 2017). These large numbers helped lead France to recognize autism as a national public health priority.

One explanation advanced for the rapid increase in the prevalence of autism was that of diagnostic substitution; that is, many children who previously had been classified as having an intellectual disability were subsequently being classified with autism (Croen et al., 2002). Whether the apparent increase is the product of greater awareness of the characteristics of childhood autism (and thus more accurate diagnoses), the inclusion of milder forms of autism because of expanded diagnostic criteria (Gernsbacher, Dawson, & Goldsmith, 2005), greater availability of services spurring more families to come forward for assistance, diagnostic substitution, or the result of an actual increase in the number of individuals born with or developing autism has been a topic of considerable debate in recent years.

Childhood autism affects individuals of all races, ethnicities, and social backgrounds. Autism is much more common in boys, who are about four to five times more likely to be affected than girls (Centers for Disease Control and Prevention, 2018; Fombonne, 2005; Lajonchere & the AGRE Consortium, 2010).[4] Why autism occurs much more frequently in boys than girls remains unexplained. Childhood autism begins at birth or in early childhood and is highly likely to persist throughout adulthood. Some of these individuals require lifelong care from their parents, siblings, other caregivers, or state agencies.

While some individuals with ASD may demonstrate average or above-average intelligence, many do not. Earlier accounts of children with autism indicated that about three-quarters of this population earned scores in the intellectually disabled range on most intelligence tests (American Psychiatric Association, 1994; Fombonne, 2005). This proportion, it should be noted, may be too high as some of the characteristics of children with ASD may have interfered with the assessment of their intelligence (Edelson, 2006). Moreover, as the syndrome of childhood autism has become better known and more widely applied, the proportion of children with ASD being identified as intellectually disabled has decreased substantially (Baird et al., 2000; Kielinen, Linna, & Moilanen, 2000; Volkmar et al., 2014). More specifically, 31% of children with ASD have been identified as having intellectual disability (IQ of 70 or lower) and another 25% as scoring in

4 In the Centers for Disease Control study, the prevalence rate for boys was 1 in 37 and for girls was 1 in 151.

the borderline range on tests of intellectual ability (IQ scores of 71–85) (Centers for Disease Control and Prevention, 2018).

The view that a large proportion of children with ASD are cognitively impaired also has been challenged. In one study, thirty-eight children with autism were assessed using the Raven Progressive Matrices (Raven, Raven, & Court, 1998), a test of high-level analytical reasoning and problem solving. The children's scores were at the 56th percentile, indicating an average level of performance (Dawson et al., 2007). In contrast, these same children scored on average 30 percentile points lower on the Wechsler scales of intelligence (Wechsler, 1974, 1991), which rely heavily on verbal comprehension. Evidently, many individuals with ASD have average or above-average reasoning skills when they are tested in a particular nonverbal domain.

A recurring complicating factor both in the diagnosis and treatment of childhood autism is that of *comorbidity*. In other words, a substantial number of children with ASD have one or more additional medical conditions at the same time (Autism Speaks, 2017; Fombonne, 1999; Volkmar et al., 2014). Included among the many associated medical conditions are fragile X syndrome, epilepsy, disrupted sleep, depression, cerebral palsy, Down syndrome, and hearing and visual impairments. Like children with Down syndrome, children with ASD have a significantly increased rate of middle ear infections and otitis media-related complications in comparison with typically developing children (Adams et al., 2016), as well as a higher incidence of hearing impairment (Demopoulos & Lewine, 2016).[5] These difficulties in hearing may, in turn, adversely affect their spoken language development. In addition, it has been observed that many children with ASD also meet the diagnostic criteria for attention-deficit hyperactivity disorder (ADHD) (Autism Speaks, 2017). Indeed, the observation that individuals with ASD and ADHD share a large number of behavioral and neurophysiological features has led some investigators to suggest that the two disorders may exist along a continuum and have a common etiology (Kern et al., 2015). Aside from making the determination of an optimal intervention program for children with autism a more challenging endeavor, the

5 The prevalence of autism in deaf individuals is estimated at 1 in 59 (Szymanski et al., 2012), a number that matches the overall prevalence of autism in the general population (Centers for Disease Control and Prevention, 2018).

presence of these associated medical conditions likely has also resulted in an overdiagnosis of autism more generally.

A problem frequently encountered by teachers and caregivers of children with autism is their production of maladaptive or challenging behaviors. Such behaviors might include self-injury, the destruction of property, tantrums, stereotypies (frequently repeated behaviors, such as finger flicking), or aggression (Goldstein, 2002). For example, some infants diagnosed with autism may begin to rock or bang their heads against their cribs. One early approach to these behaviors was to try to eliminate them, sometimes through the use of painful physical punishment (Lovaas, Schaeffer, & Simmons, 1965). A different perspective on the nature of these challenging behaviors emerged when it was hypothesized that some of these behaviors were serving a communicative function (Carr & Durand, 1985; Wetherby, 1986). If this were in fact the case, then the administration of punishment (or aversives) would be curtailing the children's efforts to communicate. This change in perspective led investigators to focus more on determining the underlying purposes or functions of the challenging behaviors and then on teaching useful communication skills; this approach has led to a reduction in many maladaptive or challenging behaviors (Carr & Durand, 1985; Horner & Budd, 1985; Mira Pastor & Grau, 2017; Schwartz et al., 2009; Wacker et al., 1990). Some of the children's challenging behaviors may also be indicative of problems in emotional regulation. Again, rather than trying to eliminate these behaviors, a more productive approach may be to strive to understand the reasons for or causes of those behaviors and then address these causes (Prizant with Fields-Meyer, 2015).

Communication Interventions and Outcomes

Since the early 1960s, there have been two major innovations in language or communication therapy programs for children with autism. The first innovation, the use of behavior modification speech training, often proved successful in fostering spoken language skills in children already exhibiting some speech or oral language ability. The second innovation, the use of augmentative and alternative communication systems, such as sign communication, often provided non-speaking children with the ability to communicate for the first time.

Studies by Ivar Lovaas and his associates have been a major source of information about the use and effectiveness of behavior modification (or operant) speech training for children with autism. Operant conditioning of behavior may be defined as changes in a person's or "animal's 'voluntary' responses after they have been followed, on prior occasions, by the presentation or withdrawal of reward or punishment" (Cohen, 1969, p. 5). Operant conditioning thus seeks to change behavior by either administering or removing a rewarding (or punishing) consequence for the behavior. Through the careful application of rewards for behaviors that the investigators wished the children would produce more frequently and, in some instances, the use of punishment for behaviors the investigators wished to decrease in frequency, many children with autism made noticeable progress in their spoken language and social skills (Lovaas, 1977, 1987; Lovaas et al., 1973; but see Ospina et al., 2008, for qualifications of these claims).

In the approach pioneered by Lovaas, complex behaviors were broken down into smaller, discrete actions that were learned through repetition and the application of rewards. Individual participants needed to be very carefully and systematically taught almost every skill they acquired. This applied behavioral analysis approach typically consisted of intensive one-on-one daily training and teaching sessions in a highly structured environment.[6] In the years since the Lovaas approach was first reported, there have been a number of other behavioral-based programs developed, with some designed for use in school and in home settings. Many children in these programs made dramatic improvements in their spoken language skills and social behavior; others made only

6 It is important to acknowledge that applied behavioral analysis (ABA) has been heavily criticized for the use of negative reinforcement (punishment) and its emphasis on control (Gruson-Wood, 2016). In recent years, a number of therapists who embraced the ABA approach have opted to use more child-directed behavioral methods in a more natural setting rather than the highly structured approach developed by Lovaas. This newer approach, known as pivotal response treatment, has been associated with more rapid improvements in communication in children with ASD (Mohammadzaheri et al., 2014). It should also be noted that there are varying degrees of implementation within the ABA approach, with some adaptations stressing positive reinforcement over punishment of undesired behaviors (Kates-McElrath & Axelrod, 2006).

minimal gains. It should be noted, however, that even minimal gains through behavioral or operant programs often contrasted with findings of virtually no improvement whatsoever in more traditional therapy programs (e.g., play therapy, psychodynamic therapy). Moreover, recent assessments of the efficacy of the behavioral approaches have underlined the effectiveness of intensive early behavioral intervention with children with ASD (Eldevik et al., 2009; Reed, 2016).

In this operant or behavioral approach, the ability to imitate verbally plays a major role in speech training. By analyzing the records of the children who participated in his studies, Lovaas was able to determine that those who were mute (that is, not producing recognizable speech) at the time that they began to participate were those who were least likely to benefit from operant speech-training programs. Those children who were already echoing or repeating elements of others' speech, though generally in a nonmeaningful way (that is, they were echolalic), typically made progress in the operant speech-training or verbal imitation program. This echoing or repeating of others' speech by some children with autism may indicate that they are able to retain utterances in short-term memory, an early step in the course of language development (Roberts, 2014). Lovaas (1977, p. 118) noted this difference in his program's effectiveness between the two groups of children:

> It was striking to observe how clearly, richly, and "effortlessly" the echolalic child imitated the adults' speech. They "spoke" a lot and "played" with speech. The imitative behavior of the previously mute children, on the other hand, stayed closely dependent on the experimental reinforcers, frequently deteriorated and "drifted" away from criterion, and sounded stilted. In general, our language program was not as successful for the mutes as for the echolalics. If the child was already echolalic, even though he did not know the meaning of his vocal expressions or how to arrange them in sentences, then it seemed easy for us to rearrange behavior (syntax) and bring it under appropriate stimulus control (semantics).

Although Lovaas' operant speech-training program has proven to be a highly beneficial intervention approach for many children with autism, it evidently was not nearly as successful with non-speaking children.

The second important innovation in language interventions for children with ASD has been the use of augmentative and alternative communication systems, primarily with non-speaking or minimally verbal individuals. Such children also tended to score very low on IQ tests, even on those tests designed for nonverbal children. Those children who had very little or no useful speech historically constituted the largest single subgroup of autism, comprising between one-third and one-half of the children diagnosed with autism (Frankel, Leary, & Kilman, 1987; Lord & Paul, 1997; Mesibov, Adams, & Klinger, 1997; Peeters & Gillberg, 1999).

The proportion of children without any functional expressive speech, however, has decreased considerably in recent years. This has occurred in part because of the inclusion of more children with higher cognitive skills and less severe behavioral problems within the diagnostic category autism spectrum disorder, and because of the benefits in language processing achieved by those children who participate in very early intervention programs (Lord, Risi, & Pickles, 2004; Wetherby, 2006). Recent estimates are that about 20–30% of those children diagnosed with ASD do not acquire useful spoken language (Kim & Lord, 2014; Tager-Flusberg & Kasari, 2013; Wodka, Mathy, & Kalb, 2013). In the past, the prognosis for children who do not acquire useful spoken language has been very bleak (Eisenberg, 1956). For many such children, the outcome has been lifelong institutionalization (Lotter, 1974). In contrast, those individuals with ASD who acquire useful speech by age five or six typically have better long-term outcomes (Howlin et al., 2004; Lord & Bailey, 2002; Szatmari et al., 2003). Still, despite the many advances in language intervention programs in recent decades, the long-term outcome for nearly half of all individuals with autism is considered to be poor or very poor (Steinhausen, Mohr Jensen, & Lauritsen, 2016).

For decades, investigators in the field of autism typically have accepted the view that autism was a lifelong condition. In general, the stability of a diagnosis of ASD in toddlers has been shown to be quite high when the same children were reassessed about two or more years later (Brian et al., 2016; Chawarska et al., 2009). Considerable improvements might be made in certain behaviors, but some aspects of autism seemed to continue throughout the affected individual's life. Occasionally, there were claims of children with autism spectrum disorder showing full "recovery," but those reports often were greeted with skepticism. Perhaps those children had been initially misdiagnosed as "autistic."

In recent years, the view that autism was a lifelong condition has changed somewhat. One of the first scholars to articulate the view that autism might be effectively treated in some cases was Lovaas (1987). He reported that some of the children he studied who received intensive intervention (40+ hours per week) made enough progress that they were able to attend and pass first grade in a mainstream classroom. In fact, some children with ASD can show sufficient improvements in their language, face recognition, communication, socialization, and social-interaction skills that they are able to function within normal limits and no longer meet the diagnosis of autism (Fein et al., 2013). These individuals, however, typically had milder symptoms of autism at initial assessment early in their development (Moulton et al., 2016).

The results of a second study (Dawson et al., 2012) also underlined the importance of intensive early intervention in improving a wide range of behaviors in children with autism. In addition, this study showed for the first time that brain activity (i.e., EEG) within normal limits was a possible outcome for children with ASD after such intervention. The results of these two studies raise considerable hope for the future development and education of children with autism. At the same time, caution needs to be exercised before considering children "recovered." Although some children initially diagnosed with ASD evidently can improve sufficiently after early intervention that they no longer meet the criteria for ASD, it should be recognized that most such youngsters will continue to need support. Furthermore, in a longitudinal follow-up of a group of children who purportedly had "recovered" from autism, a number of these children once again met the criteria for ASD at the time of their later assessment (Olsson et al., 2015). Finally, it remains to be seen just which forms of intervention are the most effective for which children with autism.

Sign-Communication Training and Teaching

Teaching non-speaking children with autism to communicate through signs has been one of the principal non-oral communication intervention approaches. Since the early 1970s there has been considerable growth both in interest about signing and in research on children's sign learning (Kiernan & Reid, 1984). As a result of their manual sign training, many children who had failed to make progress acquiring spoken language skills learned to convey their basic needs for the first time through signs. Altogether, the results of more than thirty studies involving non-speaking children with ASD have underscored the potential effectiveness of teaching signs to this population (Bonvillian, Nelson, & Rhyne, 1981; Goldstein, 2002; Lal, 2010; Layton, 1987; Valentino & Shillingsburg, 2011; Wendt, 2009). In these studies, the children's teachers or caregivers typically took individual signs from existing sign languages or sign-communication systems and paired them with spoken words in their interactions with their children. The gains that the children made in sign-communication skills often were retained for long periods (e.g., Webster et al., 2016); in contrast, rather poor word retention generally was evident in vocal language interventions (Gaines et al., 1988). In addition, after first learning to communicate through signs, some of the children in the different studies went on to acquire spoken language skills.

One of the first attempts to teach manual sign communication to non-speaking children with autism took place at Benhaven, starting in 1971 (Lettick, 1972, 1979). At that time, Benhaven, located in New Haven, Connecticut, was a school for autistic and brain-damaged children ranging in age from six to twenty-one years. Many of the Benhaven students had failed to make progress in programs at other schools or agencies. With the arrival of a deaf student with autism, the school embarked on sign language lessons for the entire staff and a program of sign and speech input for all the students who did not appear capable of acquiring useful speech. The outcomes of this simultaneous sign and spoken language training were positive for all the students, although progress varied widely. At one end were those children whose sign learning consisted solely of understanding the meaning of a few signs. At the other end were children who learned to respond to questions in signed sentences and who engaged in signed conversations. Furthermore, it was observed that the use of signs did not appear to stifle the emergence of communication skills in other modes (e.g., speech).

Another early effort to teach manual signs to a hearing but non-speaking individual with autism took place in Palo Alto, California in 1972 (Bonvillian & Nelson, 1976). Researchers began to work with a nine-year-old non-speaking boy with autism and an IQ score below 40 who experienced great difficulty in his ability to communicate with others. Because this boy was mute, he learned signs as an alternative form of communication in lieu of spoken language. In teaching him signs, investigators would first demonstrate the sign, and then mold his hands into the shape of the sign. After working with the child for only six months, the investigators had taught him fifty-six different signs. After several years, he had acquired a lexicon of over four hundred signs and was able to combine five or six signs into short sentences. By learning to sign, this boy was able to overcome the barrier that was holding him back from interacting with others and understanding the world around him (Bonvillian & Nelson, 1976).

Investigations of manual sign acquisition by non-speaking or minimally verbal youngsters with autism continued in the decades following these pioneering studies. Many of these studies used a key word signing approach in which the teachers or therapists spoke in sentences or phrases while signing the principal or key words in their utterances. In one such key word intervention (Tan et al., 2014), the three young participants acquired a core vocabulary of signs and generalized their sign usage across activities. These children's sign learning, moreover, was associated with increased production of both spoken words and natural (non-sign) gestures.

Many of the studies of sign-communication training and teaching in non-speaking, albeit hearing, children with ASD also reported improvement in their adaptive behaviors (Lal, 2010). In many cases, these improvements were not the outcome of direct training, but were associated with the children's enhanced communication skills through signing. Frequently observed improvements included increased attention span, declines in the incidence of tantrums and stereotypic behaviors, improved bladder control and fewer soiling incidents, increased willingness to participate in group activities, and better self-help skills. As can be easily imagined, these improvements often had a positive effect on the children's caregivers as well.

A number of possible explanations have been advanced to account for the success some individuals with autism have shown in learning to sign after experiencing repeated failure in acquiring speech skills. One explanation is that spoken language may be difficult for some persons with autism because they process sound atypically. Most preschool children with ASD prefer non-speech signals to speech input, whereas the opposite pattern is present in typically developing youngsters (Kuhl et al., 2005). In infants subsequently identified with ASD, the presence of speech has been shown to disturb their visual scanning of facial features (Shic, Macari, & Chawarska, 2014). Abnormal processing of vocal stimuli, but not for non-vocal sounds, also has been reported for adults and children with autism (Gervais et al., 2004; Sperdin & Schaer, 2016). In general, auditory-processing problems are quite common in individuals with ASD (Baranek, 2002; Condon, 1975; Greenspan & Weider, 1997). Temple Grandin, an accomplished scholar and highly articulate individual with ASD, has observed that some persons with autism are hypersensitive to certain sounds, often finding them painful. She also has reported that many individuals with autism, herself included, find the processing of complex sounds, such as those in spoken language, particularly difficult or problematic (Grandin, 1995; Grandin & Panek, 2013). For many individuals with ASD, their visual and kinesthetic processing abilities may be more advanced and intact than their speech-processing abilities (Mirenda, 2014; Mitchell & Ropar, 2004).

A second explanation for the successful use of signs is that the manual mode may be more conducive to direct instruction than speech. That is, teachers and caregivers not only can hold their hands in the same position for a long time in order to facilitate the child's copying of a sign, but they also can directly mold the child's hand(s) into the correct sign formation.[7] A similar degree of control is not possible for spoken language. A third reason for this success in signing over vocal skills training may be that a number of signs clearly resemble the objects, actions, or properties for which they stand. This iconic or pantomimic aspect of signs may make them easier for many children to learn and to

7 This latter option should be used with caution and respect for the bodily autonomy of persons with disabilities; permission should first be obtained before physical contact is made. This contact should also be as gentle as possible and should last no longer than is necessary. Such molding of the hands and movement of another person's hand(s) and/or arm(s) should be faded as sign production skills improve. Furthermore, some persons with ASD have extreme sensitivities to touch that may prevent the successful use of a molding approach to sign formation (Herman, Shield, & Morgan, 2019).

remember (Doherty, 1985; Konstantareas et al., 1978). In contrast, most spoken words do not clearly resemble the objects, actions, or properties they represent.

Fourth, it has been suggested that by teaching children with autism to sign, caregivers may have indirectly been teaching them to control their stereotypic gestures and mannerisms (Bram, Meier, & Sutherland, 1977).[8] Because the production of these repetitive gestures may interfere with cognitive processing, lowering their frequency might enhance the children's ability to learn. Another explanation for the reduced incidence of motor stereotypies in autistic children learning to sign is that acquiring sign-communication skills may reduce these children's anxiety levels. Finally, because learning to speak may be associated with frustration and failure in many children, a switch from a focus on speech to an emphasis on signs may avoid these negative feelings.

Although signing programs overall have a quite positive record as a form of communication intervention for non-speaking children with ASD, there are limitations that should be acknowledged. Even though the finding that sign interventions often are effective is based on the outcomes of many studies, only a small proportion of these studies involved ten or more participants. Indeed, a number of these studies involved only a single participant. Furthermore, detailed assessments of the background characteristics of many of these participants frequently were lacking, as were baseline and intervention outcome data (Schwartz & Nye, 2006). This is a serious problem because the range of outcomes in sign learning varied quite widely across individual participants. Without this background information, it is difficult to determine who would be a prime candidate for sign-communication intervention and who might benefit more from other approaches.

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8 This idea that the learning and use of manual signs is associated with reduced levels of motor stereotypies or repetitive behaviors (e.g., twirling, finger flicking) in children with autism has received support from a study of deaf children. In this study, deaf parents of deaf children with autism reported that their children did not produce the motor stereotypies typically seen in children with autism (Szymanski & Brice, 2008; see also Szymanski et al., 2012). Although the deaf children's signing may have enabled them to effectively control their motor movements, other explanations cannot be excluded; for example, the children's deafness may have prevented them from hearing aversive sounds that might have prompted their stereotypies.

Another important limitation of the studies of sign teaching in children with ASD is that relatively few involved very young children (Anderson, 2001). There appear to be two principal reasons for this. First, parents and teachers frequently wished to focus language training solely on spoken language; signing was an alternative to be explored if progress was not seen with speech. Only in recent years has there been recognition that language development in one mode fosters communication skills in another (Dunst et al., 2011; Millar, 2009; Millar et al., 2006; Rowe & Goldin-Meadow, 2009b).

A second reason that few young children with ASD participated in sign interventions is that the diagnosis of the disorder often was made at a later age. Today, children with ASD often are diagnosed at two to four years of age, and the average age of diagnosis is steadily decreasing. Although clear progress is being made at identifying children with ASD at younger and younger ages, diagnostic evaluations before the age of two years remain challenging (Zwaigenbaum et al., 2009). There is now evidence of high stability in diagnoses of ASD in children as early as eighteen months of age, but this appears to be the case for those children with more severe impairments; those children with more advanced language and adaptive skills often were not identified until three years of age (Zwaigenbaum et al., 2016).

Studies of very young children subsequently diagnosed with ASD have shown that certain behaviors (e.g., little response to name, lack of joint attention, poor eye control, lack of communicative gestures, and social touch aversion) may successfully distinguish these children from typically developing infants (Baranek, 1999; Chawarska et al., 2014; Osterling & Dawson, 1994; Veness et al., 2014; Watson et al., 2013; Werner et al., 2000). In the future, it may be possible to make accurate diagnoses relatively early in development in light of the above findings and of findings of movement atypicalities (Baranek, 1999; Bodison & Mostofsky, 2014; Teitelbaum et al., 1998) and of brain overgrowth (or accelerated head growth) during the first year of life in children subsequently identified with autism (Courchesne, Carper, & Akshoomoff, 2003; Dawson et al., 2007). Eventually, it may be possible to make accurate diagnoses relatively early in infancy. In fact, a recent examination (Hazlett et al., 2017) of cortical surface area expansion in infants from six to twelve months predicted subsequent diagnosis of autism in young children with familial high risk of ASD.

An accurate and early diagnosis of ASD is likely to be an important factor for intervention programs as there typically is greater neural plasticity or flexibility early in development (Knudsen, 2004; Knudsen et al., 2006; Nelson, 2000). That is, younger children often are more receptive to environmental interventions (such as signing) and thus have more potential for greater long-term progress than older children or adolescents. Moreover, there is evidence that even infants and toddlers with serious developmental disabilities, including ASD, can make progress in learning to communicate effectively through the use of manual signs, gestures, and other non-oral approaches (Branson & Demchak, 2009). Studies of deaf children with ASD who first learn a sign language also provide unique insights into the early application of sign intervention techniques (Herman et al., 2019; Shield, 2014; Shield, Cooley, & Meier, 2017; Shield & Meier, 2012, 2018; Shield, Meier, & Tager-Flusberg, 2015; Shield et al., 2016, 2017; Sparaci, Lasorsa, & Capirci, 2019). If very young children evidently can benefit from early intervention programs, then the question arises as to why so few young children participate in such programs. At the same time, it should be recognized that although the human brain is particularly adept at acquiring information early in life, there is considerable evidence to support the view that the brain is also a flexible structure that "can adapt and modify with age and with the acquisition of new motor and cognitive skills" (Denes, 2016, p. xiv). In fact, participants with ASD who demonstrated impressive skill gains after intensive early intervention showed recruitment of numerous additional regions of the brain to compensate for their atypical neural processing mechanisms (Eigsti et al., 2016).

Dispelling Myths

A concern frequently voiced by parents when therapists have suggested that their child with autism be introduced to sign language (or other forms of augmentative and alternative communication) is that he or she will never acquire spoken language (Cress & Marvin, 2003). For these parents, the prospect of using signs to communicate is tantamount to an admission that their child will not acquire speech and that the best outcome they can hope for is that he or she will learn a small vocabulary of signs or gestures. Their dream that their son or daughter will become a fully functioning and integrated member of a society that relies on spoken language is threatened.

In many instances, sign-communication training and teaching is initiated only after a child has failed to acquire functional language in a speech-training program. As Alpert (1980, p. 401) observed, “This is unfortunate, for not only does the child remain without a means of communicating during the entire training period, but as the child gets older, the probability that he will acquire functional communication skills may be reduced.” Although there are many reported instances of children with ASD acquiring spoken language skills after a severe language delay (Wodka et al., 2013), the frequency at which such late onset of speech occurs declines sharply with increasing age after the age of six (Pickett et al., 2009). This approach of not introducing signs to a young, non-speaking child would make sense if there were compelling research findings that showed that implementing a sign system impaired the acquisition of speech skills. To the contrary, there is considerable evidence that using signs with speech may facilitate comprehension and production of spoken language in both mute and echolalic children with autism (Barrera et al., 1980; Barrera & Sulzer-Azaroff, 1983; Carr, Pridal, & Dores, 1984; Dunst et al., 2011; Millar, 2009; Remington & Clarke, 1983; Valentino & Shillingsburg, 2011; see also Carbone et al., 2010).

Although training involving the use of signs together with speech has been associated with many children’s acquisition of language skills in both modalities, there has been wide variation in the degree of success achieved. Often, children with ASD first acquired a sign vocabulary and began combining signs before making a transition to spoken words (Layton & Watson, 1995). In many instances, those children who acquired both speech and sign skills had at least a minimal level of verbal imitative ability prior to training. A number of non-speaking children with ASD, however, made little or no progress in their verbal production ability despite substantial simultaneous speech and sign training. Such children who remain minimally verbal despite acquiring a sign lexicon in a simultaneous training program may make progress in vocal language production only when they are specifically rewarded for vocal production (Scarbro-McLaury, 2004).

It is not clear how the notion spread that learning to sign inhibits the acquisition of spoken language. Certainly, hearing children of Deaf parents typically master both the spoken language of the hearing population and the sign language used by their Deaf parents. Furthermore, hearing babies exposed to signs and speech often are more advanced in their spoken language acquisition than babies exposed only to speech (Goodwyn & Acredolo, 1998). The notion that signing inhibits speech probably came from educators of deaf students who wished to emphasize an oral-only (sign language prohibited) educational approach. These educators felt that deaf students who were allowed to communicate using signs and the manual alphabet would not be motivated to learn to speak. However, there is no evidence supporting this position, and indeed, if anything, the opposite appears closer to the truth: successful communication in one language modality is related to successful communication in another. According to multiple studies, "gestures and words constitute a single communication system with shared roots in development, underlying the multimodal nature of human communication" (Sparaci et al., 2019, p. 41; see also Goldin-Meadow, 1998; Kendon, 2014; Levinson & Holler, 2014; Vigliocco, Perniss, & Vinson, 2014). Moreover, one of the best predictors of the acquisition of expressive and receptive spoken language skills in young children with ASD is their use of communicative gestures (Luyster et al., 2008; Manwaring et al., 2017; Rowe & Goldin-Meadow, 2009a).

Although many parents of non-speaking children with ASD are reluctant to have them begin programs of sign-communication training and teaching because they feel they will have abandoned any chance of their children learning to speak, the results of a range of studies suggest that such concerns are not well-grounded. Of the thirty children with autism who were taught to sign in Creedon's pioneering study (1973; see Offir, 1976), seven also acquired considerable facility in spoken English and another 40% attained some speech skills. Success in learning both signs and speech also was reported by Fouts (Fouts, 1997; Fulwiler & Fouts, 1976). Fouts surmised that certain children with autism experience difficulty connecting information from the auditory channel to information from the visual channel. He felt that the result of this problem in cross-modal transfer was that "sound was confusing at best and terrifying at worst" (1997, p. 187). The two boys with whom he worked first learned to communicate in signs, then produced short sign phrases, next they uttered single words, and finally generated spoken phrases.

In reflecting on these children's dramatic progress in their ability to communicate, Fouts (1997) advanced the view that the key to their success was that both signs and speech involve precise and sequential motor movements. With signs, it is the fine motor movements of the hands; with speech, it is the fine motor movements of the tongue. That is, both speaking and signing involve planning, coordinating, and producing a sequence of fine motor movements. In the brain, the areas that control the movements of the tongue (and other areas involved in articulation) and the hands are closely interconnected. There is also a functional connection between the hand area of the motor cortex and the language-related areas of the motor cortex (Meister et al., 2003). Improved functioning in the motor areas related to sign production appeared to have had a side effect of benefiting the motor areas related to speech production. Another factor that may underlie the difficulties that persons with ASD experience in connecting information from the auditory channel to the visual channel is that they may process information from each channel at different rates. This difference in temporal processing rates across channels may make the perceptual integration of auditory and visual information much more problematic (Stevenson et al., 2016; see also So et al., 2015).

Additional support for the view that signing or the production of hand gestures may facilitate or bootstrap spoken language production in some individuals has come from studies of a phenomenon known as synesthesia, or blending of the senses. In instances of sensory blending, there may be cross activation of neighboring brain regions. Ramachandran and Hubbard (2003, p. 59) wrote that "a kind of spillover of signals occurs between two nearby motor areas: those that control the sequence of muscle movements required for hand gestures and those for the mouth… As Charles Darwin pointed out, when we cut paper with scissors, our jaws may clench and unclench unconsciously as if to echo the hand movements." If cross activation or spillover is occurring in the brain regions responsible for sign production and spoken language production, then this may account for the increased vocalization and speech of some sign-learning children with ASD.

Another approach to fostering communication in non-speaking children with autism combined a speech-imitation program with signing (Schaeffer et al., 1977; Schaeffer, Musil, & Kollinzas, 1980). In separate daily language sessions, three boys learned to imitate speech through a behavior modification program in one session and learned to sign spontaneously in the other. All three boys initially learned to sign spontaneously. After their sign-communication skills were firmly established, the investigators elected to have them combine their sign production with their spoken word production. That is, the boys were taught to utter the English word equivalents of the signs they were making. After four to five months of the boys communicating simultaneously in both signs and speech, the investigators gradually faded the boys' production of signs. The outcome was that all three boys eventually produced spontaneous speech (see also Valentino et al., 2011).

The results of the above studies should make it clear that teaching sign language to a child with ASD should not be equated with abandoning hope for the development of spoken language skills. In fact, the development of sign-communication skills may facilitate the subsequent development of spoken language skills. Although the results of the above studies and those of other investigations provide encouragement to many parents who dream of one day hearing their children's voices, it should be recognized that many non-speaking children with autism who are taught to sign do not acquire facility in speech. Rather, in most instances, gains in speech communication are relatively modest (Millar et al., 2006).

Teaching Generalization and Spontaneous Communication Skills

Many early attempts to foster language development in children with autism reported the successful teaching of a substantial vocabulary of words or signs. These communication intervention programs typically emphasized the children's production of the correct words or signs in response to discrete stimuli such as real objects, pictures, or teachers' prompts. A serious limitation to this approach is that children with ASD frequently experience difficulty in generalizing newly acquired words or signs to new instances of a concept or to new settings. As a result, they often would use their words or signs only in the structured learning environment in which they were taught and only for the items specifically trained. This outcome is problematic because the goal of most communication programs is for the learner to use words or signs to express needs and wants and to make requests in a variety of settings to a number of different persons. These children also were frequently passive, with their language or communication characterized by a lack of spontaneity (Carr, 1982; Carr & Kologinsky, 1983; Duffy & Healy, 2011; Schaeffer, 1978).

Examination of the children's language-learning environments showed that they often had been taught words or signs by a single instructor in a single setting using a single training format. In light of this narrow training environment and the children's difficulties in generalizing and in initiating communication, it should not come as a surprise to learn that their language production was quite limited or restricted. The children frequently failed to initiate communication, to generalize newly acquired vocabulary to new instances of items, or to use their vocabulary in different settings (Openden et al., 2009). Fortunately, procedures have been developed to increase communicative spontaneity and language generalization (Hundert, 1981; Reichle & Sigafoos, 1991; Schreibman, Stahmer, & Suhrheinrich, 2009).

One of the ways to facilitate children's spontaneous use of signs has been to have teachers identify natural opportunities to teach signs throughout the day. For example, signs for foods might be taught to children at mealtimes. Teachers also have been urged to capitalize on the children's desires and interests within the context of ongoing activities (McGee, Krantz, Mason, & McClannahan, 1983; Rogers, 2006). In particular, teachers should be alert to attempts by children to communicate and to use these incidental opportunities to teach new signs and to establish the usefulness of signs already learned. Indeed, this more naturalistic teaching strategy (or milieu therapy) typically results in greater progress in language development and more generalization of newly learned skills by children with autism (Delprato, 2001; Mancil, 2009). These incidental teaching practices, often essential in fostering the communication skills of children with ASD, typically prove quite helpful with children with other communication disabilities as well.[9]

How might one facilitate generalization of the different signs taught? That is, how might one promote the use of signs to different instances or examples of a particular concept, with different people, and in different settings? One important step would be to incorporate procedures or strategies designed to promote generalization in the plans for the language training and teaching prior to the actual commencement of language lessons (Openden et al., 2009). A number of strategies that might be helpful in promoting generalization include: teaching in a variety of settings, varying communication partners (e.g., language therapist, parents and siblings, babysitter) and locations, teaching during the day's naturally occurring routines, and varying the conditions of instruction and the materials used (Dodd & Gorey, 2014; Rombouts et al., 2019; Schreibman et al., 2009; Stokes & Baer, 1977). Because some children with autism become upset if their environments change, one may wish to implement the above recommendations gradually, rather than all at once. If a teacher varies the exemplars used and embeds instruction across the day and in a variety of settings, then generalization is much more likely to result.

Motor and Imitation Abilities

Before participating in a sign-communication program, a number of children with autism had spent long periods in speech-oriented language therapy programs without making noticeable progress. Although nearly all of the children who participated in sign programs made some progress, the range of individual outcomes was quite wide (Bonvillian & Blackburn, 1991; Konstantareas, 1985; Layton, 1987). Some children acquired hundreds of signs and learned to combine them into phrases to express a wide range of meanings. At the other end of the spectrum were those youngsters who made only very limited gains despite years

9 For more information on these practices, see the "Recommendations for Enhancing the Sign-Learning Environment" section in Chapter 4, as well as the following subsections in Chapter 9: "Use Environmental Cues or Contextual Information" and "Ensure a Positive Signing Environment" (under the "Guidelines for Using the Simplified Sign System" section).

of training and acquired only a receptive sign vocabulary or learned to produce just a few signs.

These wide individual differences in sign-learning success led investigators to try to determine what factors were associated with successful sign acquisition by children with autism. In general, those children who earned higher scores on intelligence tests and who had better social skills, receptive language abilities, and fine motor skills tended to make the greatest progress (Bonvillian & Blackburn, 1991; Gaines et al., 1988). In addition, the size of the children's vocabularies was positively related to how long they had participated. It should be noted, however, that most participants showed only a gradual increase in vocabulary size over time.

Of those factors found to be positively associated with sign learning, it was the children's scores on tests of fine motor skills that initially puzzled investigators. One reason for this confusion was that children with autism historically were depicted as having intact fine motor abilities (Kanner, 1943). This view that children with ASD had typical or near-normal motor abilities continued for some time. In 1988, Mirenda and Schuler referred to "The combination of severe social-cognitive limitations and relatively well-developed motor skills that is so typical of the autistic syndrome" (p. 25). This assumption that children with autism have near-normal motor abilities now appears to be fundamentally incorrect (Bo et al., 2016; Bodison & Mostofsky, 2014; Paquet et al., 2016).

Not only do children with autism frequently have deficits in fine motor skills, but they often have serious gross motor skill deficits as well (Chukoskie, Townsend, & Westerfield, 2013; Slavoff, 1998; see also LeBarton & Iverson, 2016a). Evidently underlying the many motor impairments or deficits reported for children with ASD are related patterns of atypical hemispheric lateralization of their motor circuits (Floris et al., 2016). These motor development difficulties may include such basic motor control processes as gait, balance and coordination, and posture (Gidley Larson & Mostofsky, 2006). The motor deficits of children with autism, furthermore, are developmentally stable; that is, motor performance typically continues to be substantially impaired with children's increasing age (Biscaldi et al., 2014). These deficits in motor skills that emerge early in the development of young children with ASD also apparently contribute to their problems in subsequent acquisition of executive functioning abilities (e.g., working memory, planning) (St. John et al., 2016). In light of these findings, motor impairments are now seen as occurring quite often among individuals with autism (Mirenda, 2008), and apparently constitute an integral part of the syndrome. Moreover, the motor atypicalities or impairments present early in the development of most children subsequently diagnosed with ASD may serve as behavioral markers of the syndrome and thus facilitate early diagnosis (May et al., 2016; Trevarthen & Delafield-Butt, 2013).

A likely reason why motor functioning difficulties in children with autism were not systematically probed until relatively recently is that motor disturbances may not be as striking or seem as important as other areas of developmental difficulty. When a child fails to acquire useful speech, does not respond emotionally to others in a typical way, and lags far behind his or her peers cognitively, then these difficulties or disturbances are both quite conspicuous and major sources of concern. Furthermore, when a child lags behind motorically after attaining the basic motor milestones of sitting, standing, and walking, such a deficiency may not be especially evident or seem of great importance. Today, however, motor disturbances and deficits in motor planning and sequencing are seen as vital aspects in the functioning of both younger and older children with ASD (Adams, 1998; Bodison & Mostofsky, 2014; Focaroli et al., 2016; Gidley Larson & Mostofsky, 2006; Herman et al., 2019; Hughes, 1996; Ming, Brimacombe, & Wagner, 2007; Mostofsky et al., 2006; Paquet et al., 2016; Vanvuchelen, Roeyers, & De Weerdt, 2007) and in deaf children with ASD (Bhat et al., 2016; Shield et al., 2017). The difficulties many children with autism experience combining actions into motor or action sequences may rest, in part, on their tendency to subdivide such sequences into smaller pieces. If children with ASD do not process motor or gestural sequences as whole units, they may have difficulty understanding the intentions of others' actions (Cattaneo et al., 2007; see also Angeleri et al., 2016).

In retrospect, it seems quite logical that children's scores on tests of fine motor skills would be positively related to their success in learning a visual-motor or sign-communication system. In fact, discussions with teachers of sign-learning children underscored the teachers' concerns about their students' motor problems in general and how these problems might impair their sign production (Bonvillian & Blackburn, 1991).

These teachers' concerns led directly to an investigation of the relationship between the sign production of children with autism and their motor functioning (Seal & Bonvillian, 1997). In this study, fourteen non-speaking students with autism were videotaped while they were signing with their teachers. These tapes subsequently were transcribed into the sign notation system developed by William C. Stokoe (1960; Stokoe et al., 1965). All of the students made errors in their sign formation, with the error rates varying widely among the participants. Those who acquired the most signs typically had low error rates, whereas those who learned relatively few signs had much higher error rates in sign formation.

The movement parameter of signs proved to be an area of particular difficulty in the sign production of these students (Seal & Bonvillian, 1997). Not only did the students have difficulty with various sign movements, but they often deleted movements from multi-movement signs and added extraneous movements to others. Eleven of these children subsequently were given an apraxia test battery to assess their purposeful motor actions or movements. The high incidence of errors by the students on the apraxia battery was consistent with a diagnosis of apraxia or dyspraxia.[10] Furthermore, the rate at which these students made errors in producing the movement parameter of signs was highly related to their scores on the apraxia battery. There was not, however, a strong relationship between the students' apraxia scores and their percentages of location or handshape errors.

These findings were interpreted as indicating that movement functioning played an important role in the signing of children with autism. Additional support for this interpretation of a frequently occurring apraxia component in children with ASD comes from the finding of a significant relationship between the apraxia scores of

10 Apraxia is a neuromotor disorder that precludes or limits an individual's planned, voluntary, and purposeful motor movements in the absence of muscle weakness or paralysis (Wertz, LaPointe, & Rosenbek, 1984). A loss of the ability to execute movements is usually referred to as *apraxia*, whereas a less profound impairment often is referred to as *dyspraxia*. While the term *apraxia* typically is used in the literature for adult-onset impairments, *developmental dyspraxia* frequently is used for impairments present from infancy or early childhood onward.

children with autism and their sign language production (Soorya, 2003). Because a large proportion of children identified with autism also have apraxia, it might be prudent to evaluate all children with autism and speech difficulties for apraxia (Bhat et al., 2016; Shield et al., 2017; Tierney et al., 2015). An elevated incidence of dyspraxia also has been reported to occur in adults with ASD (Cassidy et al., 2016).

Motor impairments in children with autism also were the focus of a study by Page and Boucher (1998). These investigators found that nearly 80% of the thirty-three children they examined exhibited marked impairments in various areas of motor functioning. The children's motor problems included oromotor skills (tongue and lip movements, chewing), manual skills (object manipulation, forming correct handshapes, sequencing handshapes), and gross motor skills (running, hopping). Although deficits were evident in all three skill areas, the most prevalent areas of difficulty were oromotor and manual skills. In light of their findings, the investigators suggested that oral and manual dyspraxia probably played an important role in the impaired speech and signing of many children with ASD. These concerns about the relationship of oral- and manual-motor difficulties to language proficiency appear to be well-founded. A more recent study demonstrated that the oral- and manual-motor skills of very young children with autism significantly predicted their level of speech fluency in middle childhood and adolescence (Gernsbacher et al., 2008).

One possible explanation for findings of dyspraxia in children with ASD is that their gestural and oromotor impairments might just reflect more general or basic motor impairments. Research results, however, suggest that findings of dyspraxia in these children cannot be fully accounted for by their basic motor skill deficits (Dziuk et al., 2007; see also Dowell, Mahone, & Mostofsky, 2009). Other factors, such as understanding others' intentions and the ability to sequence actions and keep them in memory, may be quite important as well (see also Angeleri et al., 2016 and Cassidy et al., 2016).

Not only do children with autism often show impairments in their gestural production, but they typically display nonverbal communication that is quite different from that of other children as well. Children with autism are much less likely than other young children to point, show objects, to use conventional gestures such as shaking or nodding one's head, or to gaze at another person to communicate, which may result in problems interpreting other people's facial expressions (Denmark et al., 2014; LeBarton & Iverson, 2016b; Mastrogiuseppe et al., 2015; Shield et al., 2015; So et al., 2015; Sparaci et al., 2019; Stone et al., 1997). When young children with ASD do use deictic gestures, they tend to extend an open palm toward an object (a "give" gesture) rather than using the extended index finger in a pointing gesture (Özçalişkan et al., 2017). Children with ASD also are less likely to integrate their gesture production with their spoken language than typically developing children (So et al., 2015). Some of these children's atypicalities in nonverbal or gestural communication, it should be noted, may rest on their impaired motor skills.

Another motor production factor involved in the speech and signing of children with autism is their sequencing of movements. In spoken language, the brain and oral musculature are involved in the rapid production of speech sounds over time. Sequential motor production is also an important dimension in the formation of signs from genuine sign languages such as American Sign Language (ASL). In ASL, many signs have more than one movement. Slavoff (1998) examined the gestural imitation and gestural sequencing of thirteen children with autism. Seven of the children communicated primarily through speech, six through signs. The vocabulary sizes of these children, regardless of language modality, were highly related to their scores on tests of gestural imitation and sequencing. That is, the better a child performed on the tests of gestural imitation and sequencing, the larger the size of his or her vocabulary. This finding of a substantial relationship between gestural imitation and sequencing scores and vocabulary size might be used as a predictor of which children with ASD would be good candidates for participation in a sign-communication program. Furthermore, the children's ability to imitate a gestural sequence declined sharply from one-movement gestures to three-movement gestures. These findings underscore an important movement component in the children's signing and speech, and probably an important imitation or memory component as well.[11] Moreover, not only do children with ASD imitate

11 Although it is not clear how best to account for this decline in performance, it is possible that those children who experienced considerable difficulty imitating multi-movement gestures may have had particular difficulty forming representations of more than a single action at a time. It is also possible that representations in their working memories may have decayed more quickly than normal.

actions less than typically developing children, they often successfully imitate only the final action of a sequence (Gonsiorowski, Williamson, & Robins, 2016). Another implication of these findings is that signs that involve more than a single movement are likely to prove difficult for some children with autism to remember and to produce.[12]

The finding that the gestural or motor imitation abilities of children with ASD were related to measures of vocabulary, language development, and language use (Slavoff, 1998; see also Ingersoll & Lalonde, 2010; Ingersoll & Meyer, 2011; Özçalişkan et al., 2017; Stone & Yoder, 2001; and Toth et al., 2006) in turn raises questions about how best to teach manual signs to youngsters with autism. That is, if a child with ASD has particular difficulty imitating another person's actions or gestures, then a sign-teaching approach that began by relying heavily on the modeling of a sign by the teacher likely would not be very effective. One approach would be to focus on enhancing the child's imitation skills prior to teaching signs. A promising procedure in this domain would be to have a communication therapist initially follow the child's lead by nearly simultaneously imitating all of the child's gestures, vocalizations, and actions on objects. If this approach is successful in gaining the child's attention, then the therapist would start interspersing bids for the child to copy or imitate the therapist's actions (Ingersoll & Schreibman, 2006).

Or, for a child who fails to imitate, it may be necessary to rely primarily on molding his hands into the correct sign handshape and then physically guiding his hands through the correct sign movement. This approach of molding and guiding the signer's hands may need to be employed often as deficits in imitation are quite widespread among children with ASD (Hepburn & Stone, 2006; Jiménez et al., 2015; Rogers & Bennetto, 2000; Rogers, Bennetto, McEvoy, & Pennington, 1996; Rogers & Williams, 2006; Smith & Bryson, 1998; Vanvuchelen et al., 2007, 2011; Williams, Whiten, & Singh, 2004). Moreover, deficits in gestural imitation are especially pronounced in non-speaking or minimally verbal children with autism (Heimann et al., 2016; Shield et al., 2017). Indeed, children

12 Studies concerning the motor difficulties of persons with ASD influenced the selection and development of signs in our Simplified Sign System. That is, we deliberately modified signs so that most had only a single movement and we excluded more complex handshapes. The fact that our signs resemble the concepts they stand for also should make them easier to learn and to remember.

with autism appear to rely more on proprioceptive feedback (sense of relative position of one's limbs) than on visual feedback to guide their motor learning (Bodison & Mostofsky, 2014).

The deficits in visual imitation seen in children with autism may be the product of a dysfunctional observation matching system (Bernier et al., 2007), motor-planning difficulties (Hughes, 1996; Lloyd, MacDonald, & Lord, 2011; Smith & Bryson, 1994), or problems in forming internal models or representations of actions (Haswell et al., 2009). In contrast to the motor deficits of children with ASD, which typically remain stable with increasing age, these children's difficulties in imitation skills tend to improve with age (Biscaldi et al., 2014). As a consequence, it may be possible for teachers to rely more on modeling and imitation in their students' learning of signs as the students get older.

A recent series of studies focusing on the signing of deaf children with ASD (Shield, 2010, 2014; Shield & Meier, 2012) has revealed that hand or palm orientation is another sign formational parameter that can be problematic. Some of the individuals in these studies occasionally reversed the palm orientation of the signs they made. This sign formational error, however, was interpreted as probably being a reflection of the children's difficulties in visual perspective-taking (Shield, 2010; Shield & Meier, 2012), rather than being the product of underlying motor impairments. Later, however, the authors surmised that persons with autism may approach imitation of gestures and signs in a manner different from typically developing individuals (Herman et al., 2019; Shield & Meier, 2018). Some deaf children with ASD also demonstrated sign echolalia or repetition of others' signs (Shield, 2014; Shield, Cooley, & Meier, 2017). This finding would indicate that echolalia in ASD is not modality dependent, as it evidently occurs both in sign and speech modes (see also Jure, Rapin, & Tuchman, 1991).

Although numerous studies in recent decades have underlined the many problems that children with ASD experience in their imitation of gestures (Vivanti & Hamilton, 2014), it is likely that these children will experience fewer difficulties imitating Simplified Signs than they do imitating gestures more generally. We say this because most of the signs in the Simplified Sign System are meaningful gestures. That is, the signs typically represent meaningful actions or the shapes of objects and thus are meaningful behaviors for most persons. In the past, investigators have reported that children with autism imitate meaningful gestures more accurately than gestures without clear meanings (Rogers et al., 1996; Smith & Bryson, 2007; Vanvuchelen et al., 2007).

Finally, the difficulties that children with ASD experience in the formation of words and signs and in their sequencing may be related to damage to or abnormalities of the cerebellum. The cerebellum is the hindbrain structure especially involved in muscular or motor control, the maintenance of equilibrium, learning, coordination, and the precise timing and sequencing of complex motor movements (Cheron, Márquez-Ruiz, & Dan, 2016). Because the cerebellum's developmental phase is a lengthy one, it is especially vulnerable to impairments associated with a number of different disorders (Becker & Stoodley, 2013). Cerebellar abnormalities often are evident in individuals with autism (Allen, 2005, 2006; Bauman & Kemper, 2005; Becker & Stoodley, 2013; Kemper & Bauman, 1998; Palmen et al., 2004). These abnormalities may negatively affect the musculature and sequencing involved in the production of spoken words and phrases and the motor movements and sequencing involved in the production of signs, fingerspelling, and multi-sign utterances. If, as some believe (Grush, 2004), the cerebellum plays a central role in the mimicking and the prediction of the outcome of motor actions, then it is easy to see why abnormalities in the cerebellum would adversely affect the learning and production of spoken words and manual signs. Furthermore, investigators have advanced the view that the cerebellum is involved in a variety of cognitive and linguistic functions (Becker & Stoodley, 2013; Leiner, Leiner, & Dow, 1989, 1993), including certain high-level linguistic processes (De Smet et al., 2007). It has also been hypothesized that the cerebellum may play an important role in the development of social cognition and emotion through its extensive connections in different areas of the cortex (Crippa et al., 2016).

Other Non-Oral Approaches

The serious motor and memory difficulties observed in some children with ASD may inhibit their acquisition of signs from the Simplified Sign System we have developed. Fortunately, there are a number of different augmentative and alternative communication systems that can be used in intervention programs for those individuals who fail to acquire speech and who experience great difficulty in learning to sign (Beukelman & Mirenda, 2005, 2013; Romski et al., 2015; von Tetzchner & Martinsen, 2000). These various systems are primarily visually-based communication systems and rest on the observation that many children with autism have better visual-processing skills than auditory-vocal processing skills. These approaches often make use of gestures, pictures, real objects, electronic devices, and computerized voice synthesizers or speech-generating devices.

The approaches that rely on pictures, real objects, and speech-generating devices to facilitate communication are known as aided communication. Approaches that do not include equipment, such as manual signs, speech, or gestures, are known as unaided communication. Among the advantages of the aided communication approaches are that they typically make only limited demands on the user's memory skills (especially if the symbols involved are iconic or representative), require only rather basic motor abilities, and often are understood by other persons in the user's environment (Wendt, 2009). Among the disadvantages of the aided systems are that they require that the equipment involved be carried by the user or communication partner to any change in location and that communicative exchanges often take longer than they do with unaided approaches.

Although it is beyond the scope of the present book to describe these systems in detail, we will provide brief overviews of a handful of these approaches for interested teachers and caregivers. At the same time, we should note that an important limitation of some of these systems is that the research evidence on which they are based often consists largely of descriptive accounts involving relatively few children.

One approach to facilitating communication is to have a non-speaking and non-signing child use real objects (or tangible symbols) to make requests or to convey information (Bondy & Frost, 2002; Rowland & Schweigert, 1990, 2000; Stillman & Battle, 1984; van Dijk, 1966). For example, a child might learn to bring his mother a paper cup if he is thirsty. Alternatively, another child might give his teacher a small ball if he wanted to play. In comparison with signs and speech, this approach involves little memory, imitation, or symbolic skills by the child and virtually no new learning by the caregiver. The motor demands on the child are also relatively minimal. Yet, it should be recognized that this approach has limited portability and that the desired objects may not be available when they are needed. It may also prove difficult to portray more abstract notions using real objects (Vanderheiden & Lloyd, 1986). The limitation in portability caused by having the child carry a collection of real objects with him wherever he goes may be overcome in part by switching to smaller versions of the objects. At the same time, it should not be assumed that young children will recognize that the much smaller version of the object will represent the full-sized object (DeLoache, Miller, & Rosengren, 1997). Communication, moreover, would still be restricted to the number of items one could easily carry in a bag and by the time involved in finding the desired item. The time needed to find the desired item from among a collection of objects also may make demands on the child's memory.

In comparison with real objects, photographs are more easily carried to different locations; thus, they do not have the same portability constraints. They also can be used to represent specific people, places, and activities (Bondy & Frost, 2002). Photographs, however, appear to require somewhat more symbolic sophistication by the child than the use of real objects because photographs transform a three-dimensional object into a two-dimensional representation. The ability to understand and interpret photographs usually unfolds over the first several years of life in typically developing children (DeLoache, Pierroutsakos, & Uttal, 2003). Teachers and caregivers working with a non-speaking child thus will need to ensure that the child understands that the photographs represent real objects and actions. Furthermore, these teachers and caregivers often will need to take photographs or clip pictures from magazines in order to establish the needed inventory of objects and activities. In the past, it might have taken considerable time to assemble a suitable and rich inventory of photos and pictures, but with the spread of computer technology (e.g., laptops, tablets), software, online resources, and the subsequent proliferation of smartphones with cameras and associated apps, this task is much less daunting today. Often, physical pictures are attached to a board or put into a communication book for a particular child, but it is also possible to put digital photos that serve the same function into a digital album on a child's portable computer and/or smartphone for use in public. Regardless of the specific form of the collection of photographs or pictures, such collections will need to be expanded periodically as the child's interests and desires change over time. If the collection of photographs or pictures gets large, then this communication approach likely will make demands on the child's memory and visual-tracking skills. Nonetheless, the use of picture boards or books has met with some success in fostering communication in children with autism (Mirenda & Santogrossi, 1985; Reichle, York, & Sigafoos, 1991).

One of the most popular picture systems is the Picture Exchange Communication System (PECS). PECS differs from other picture communication systems in that the developers, Andy Bondy and Lori Frost, devised a specific intervention protocol and that the system requires that a participating child interact with a communication partner (Bondy & Frost, 2009b). PECS was introduced as a communication system for children with autism who neither imitated vocally nor motorically, nor were they successful in pointing to pictures to communicate their needs or desires (Bondy & Frost, 1994, 2002). In this system, the first step is to determine what item or activity a particular child desires. A picture of this item (or activity) is then placed on a card. An adult, typically the teacher or caregiver, then holds the desired item in one hand while simultaneously extending the other hand to the child with the card representing the item. A second person, the physical prompter, typically sits near the child and guides the child's hand in first picking up the card and then releasing it back into the hand of the first adult. The item is then given to the child. Over time, the action of the physical prompter is faded or eliminated as the child learns to pick up and deliver the desired card to the first adult in exchange for receiving the desired item. The number of pictures is then expanded to include a wider array of items, activities, or persons.

An important aspect of the PECS approach is that it involves interaction with another person: the card recipient. Thus, the child not only is learning to use pictures to represent items or activities, but also is learning to initiate communication with a partner. Over time, children taught PECS typically show increases both in their frequency of communication and in the size of their PECS vocabulary (Flippin, Reszka, & Watson, 2010; Ganz et al., 2012; Ganz & Simpson, 2004; Gordon et al., 2011; Magiati & Howlin, 2003; Preston & Carter, 2009; Schwartz, Garfinkle, & Bauer, 1998), as well as in their spoken language skills (Bondy & Frost, 2009b). For some children with autism, the transition from PECS to spoken language skills will remain elusive; for these youngsters, the fostering of communication skills in another visual modality may be helpful (Bondy & Frost, 2009a).

There are a number of advantages to using PECS in comparison with other communication intervention approaches for non-speaking or minimally verbal children with autism. One advantage is ease of implementation. Time and effort do not need to be spent developing prerequisite skills, such as eye contact, verbal imitation, or gestural production in the participating children (Flippin et al., 2010; Preston & Carter, 2009). Also, teachers and therapists can acquire the skills needed to use PECS with children after only a relatively brief training period. In contrast, teachers and therapists who choose to use manual signs often need considerable training before they are sufficiently proficient signers to work effectively with children with ASD. Another advantage to using PECS is that progress in attaining functional communication skills by participating children often is quite quick. Finally, individuals not directly involved in PECS training frequently can recognize what participating children are requesting from looking at the pictures the children are holding, whereas outsiders may not understand the signs or vocal utterances that children produce. In light of these advantages, PECS has become a widely used intervention approach for many non-speaking children with ASD.

Although the results of a number of studies show that PECS can be readily learned by many young children with ASD who have little or no spoken language skills, some concerns remain about its effectiveness in certain domains. Anecdotal reports suggest that PECS may foster spoken language skills in some children. More systematic reviews, however, lead to the conclusion that it is unclear as to whether experience using PECS is associated with improvements in spoken language skills (Preston & Carter, 2009), and if there are benefits in speech, they appear to be small in magnitude (Flippin et al., 2010). Other concerns that investigators might wish to address include the efficacy of PECS in reducing challenging behaviors, whether PECS skills are maintained over time and generalized to new situations, and if PECS can fulfill more diverse communicative functions other than merely requesting items such as engaging in social interactions, commenting on current events, telling jokes or stories, or conveying other types of information (Bonvillian, 2019).

Line drawings are another option that may be effectively employed (Bloomberg, Karlan, & Lloyd, 1990; Hamilton & Snell, 1993). Line drawings have been used not only to depict persons, places, objects, and activities, but also to communicate properties or descriptors, feelings, and social etiquette messages such as please or thank-you (Bondy & Frost, 2002). In addition to creating one's own line drawings, there are a number of commercially available packages containing thousands of such symbols.

One of the earliest non-speech approaches to teaching children with autism to communicate involved the use of wooden or plastic symbols (McLean & McLean, 1974; Premack & Premack, 1974). In this approach, the symbols do not resemble their referents; they are equivalent to words or concepts in a spoken language. Using many of the same procedures first utilized by Premack (1971) to establish various language skills in a chimpanzee, McLean and McLean reported improved communication skills in children with autism. Two of their three non-speaking participants learned to use the symbols to describe a limited number of events or social interactions. It should be noted that these two children acquired a lexicon of manual signs as well.

Printed words or letters also may be responded to as visual symbols by children with ASD. Some success in developing communication skills has been reported in several studies that focused on learning printed or written words (LaVigna, 1977; Marshall & Hegrenes, 1972; Miller, 1969). These investigators began by training participants to recognize individual words and then teaching them to arrange the words in phrases. Training outcomes, though, varied widely across participants. A slightly different approach was used by Ratusnik and Ratusnik (1974) with a non-speaking ten-year-old with autism. This child initially was taught to spell individual words with plastic letters; he then learned to combine these words into phrases. At the study's conclusion, he occasionally combined words spontaneously into sentences. The use of words and letters to communicate may help some persons with autism to acquire literacy skills. However, in view of the fact that the meanings of written or printed words are not transparent, this might make them more difficult for children with autism to learn than the items used in most other approaches (Mirenda & Locke, 1989).

Improvements in technology also have benefited children with limited spoken language abilities. A number of these individuals have learned to use speech-generating devices or voice output communication aids (VOCAs) (Bornman & Alant, 1999; Schlosser, Sigafoos, & Koul, 2009; Sigafoos & Drasgow, 2001). These are portable electronic devices that produce digitized or synthetic speech output (Mirenda, 2003); these devices may help a child to interact effectively with people unfamiliar with the child's sign, symbol, or picture communication system. Unfortunately, a significant drawback to a number of these devices is that their output is limited to prestored messages (Schlosser et al., 2009), with the consequence that their use in new situations is considerably constrained. New messages may take considerable time to compose; children and adults who used speech-generating devices and their parents noted that some potential communication partners did not have the patience to wait long enough for a new message to be conveyed (Batorowicz et al., 2014). Furthermore, the batteries on many commercial speech-generating devices often become drained and need recharging, such devices frequently break down and may require weeks to repair, they may be more difficult to use in outdoor settings, particularly in bad weather or where electrical outlets for recharging are unavailable, or it may be hard to hear the voice output in public or noisy settings (Batorowicz et al., 2014; Iacono et al., 2013).

A more recently introduced software application for electronic devices, known as Proloquo2Go™ (Sennott & Bowker, 2009), shows much promise as an effective system of communication for many minimally verbal children with ASD. This application runs on a range of touchscreen devices. The screens on these devices display different pictures from which a user may choose. The user scrolls through and selects the item desired. The large storage capacities of these devices mean that users do not need to carry around large communication books or collections of pictures to ensure effective communication in diverse settings. Moreover, the public use of electronic devices (such as smartphones and tablets) by people of all ages is so common that children with autism using Proloquo2Go™ probably will not stand out as much, but rather fit in better with their peers and be more widely accepted (see Dada et al., 2016). The widespread availability and use of these portable electronic devices may also result in the children with ASD receiving more input and interaction throughout the day from their communication partners (Sennott, Light, & McNaughton, 2016).

Another important aspect of Proloquo2Go™ is that it offers a voice output system. That is, a user manually enters a desired phrase into the system, and the device then reads it aloud. This option should enable individuals unfamiliar with this communication application to respond appropriately to the user's requests. Because of the relative newness of this system, detailed evaluations of its effectiveness are limited in number. Among the early findings are reports that children with autism spectrum disorder are able to learn to make multistep requests (Alzrayer, Banda, & Koul, 2017) and to label aspects of their environments (Lorah & Parnell, 2017). These outcomes and others suggest that the speech-generating applications on smartphones and tablet-like devices are effective communicative approaches for many children with ASD, and that the results compare favorably with the use of manual signs or PECS (Kagohara et al., 2013). Overall, the Proloquo2Go™ application looks like it will be a very worthwhile addition to the array of communication approaches used by non-speaking individuals.

Comparison Studies

Although the past several decades have witnessed the emergence of a wide range of non-oral approaches designed to facilitate communication in children with ASD, there have been few systematic, large scale, long-term comparisons of the relative efficacy of these various sign, symbol, speech-generating, and picture communication systems with such children (Mirenda, 2003). This relative dearth of research comparing the effectiveness of different approaches has made it difficult for teachers, caregivers, and clinicians to make informed decisions or recommendations as to the optimal intervention strategy for particular children. This situation appears to be changing, however, as various investigators have conducted systematic comparisons in recent years (Couper et al., 2014; Gevarter et al., 2013; Mirenda, 2014; van der Meer et al., 2011; Wendt, 2009). One important difficulty with conducting such assessments is that children with autism constitute a very diverse group (Schaaf & Zoghbi, 2011) with widely differing abilities; this diversity makes it unlikely that a single intervention approach will be the optimal method for all children (Gevarter et al., 2013; Landa, 2007). A second difficulty is that the abilities and communication needs of individuals with ASD change from childhood to adulthood (Howlin et al., 2004). These changes, in turn, may need to be addressed by modifying or switching the intervention approach used.

In four carefully conducted comparison studies that examined the use of manual signs and PECS, the results did not clearly favor one approach over the other. In the first study (Anderson, 2001), six children, ranging in age from two to four years, were taught sign language or PECS in alternating sessions. As a group, the children showed a faster rate of acquisition and greater item generalization with PECS than sign language. In contrast, these same children demonstrated greater eye contact, higher levels of initiation of interaction and communication, and more frequent vocalization at post-treatment in sign training. Examining the performance of the participants individually, Anderson observed that three children behaviorally preferred PECS and that the other three behaviorally preferred sign language. Additional examination suggested that the children who preferred signs tended to be chronologically older, showed more advanced play behavior, and had higher fine- and gross-motor age equivalents than the children who preferred PECS. In interpreting her findings, Anderson observed that a certain level of cognitive and motor ability might need to be attained before sign language training is worthwhile. She speculated that very young children with autism might be effectively taught to communicate first with PECS and then later transitioned to signs.

In the second comparison study (Tincani, 2004), two elementary-school-aged children were trained on both manual signs and PECS. One child was more successful using signs; the other was more successful using PECS. Both participants vocalized more frequently during sign training. The finding that the children in both the Anderson (2001) and Tincani (2004) studies vocalized more frequently during sign training may be seen as additional evidence that acquiring manual signs not only does not inhibit vocal language development, but probably facilitates it. Furthermore, the finding that certain manual actions are positively related to the occurrence of vocal actions would be consistent with the emerging view that "systems of movement for mouth and for hand cannot be separated from one another, and that they are intimately linked in the production of language" (Iverson & Thelen, 1999, p. 35).

In the third study (Nollet, 2008), the three participants also were trained to communicate using manual signs and PECS. The two older children in this study acquired the two communicative methods at about the same rate, but when given the opportunity, they signed more frequently than they picture exchanged. The youngest participant, in contrast, learned picture-exchange skills more rapidly, and used this method more often. In addition, the incidence of problem behaviors (e. g., whining, tantrums) declined for all three participants over the course of the study, while vocal production increased for two.

In the fourth comparison study (Moodie-Ramdeen, 2008), three children were randomly assigned to PECS training whereas three others were taught American Sign Language signs. Although all six participants showed improvements in communication over the course of the study, progress was at a faster rate for those participants who received PECS training than those given sign instruction. More specifically, one child in PECS and one in manual sign training made quite substantial improvements whereas the other four children showed only minor improvements. The researcher, Moodie-Ramdeen, observed that young children with autism might well benefit from multiple forms of communication training. Moreover, the highly variable outcomes across these four studies suggest that the characteristics of the individual children often are critical in determining training program efficacy, not the particular system.

In more recent comparison studies, investigators have examined the acquisition and use of manual signs, PECS, and speech-generating devices (with Proloquo2Go™ application) to communicate in children with ASD (Achmadi et al., 2014; Couper et al., 2014; McLay et al., 2015). Across the studies, the children typically learned all three communication systems to the acquisition criterion. In general, though, the children tended to reach criterion more rapidly and to maintain performance better with the speech-generating devices and PECS. An explanation advanced for this pattern was that these two systems relied more on the children's recognition memory processes, whereas signs depended more on the children's recall skills. Furthermore, when assessments were conducted on the children's preferences, most of the children selected the speech-generating devices. The findings of these studies bode well for the continued and increased use of such speech-generating devices with minimally verbal children with ASD in the future.

Overall, more research needs to be conducted before one can make truly definitive statements about which individuals with ASD are more likely to benefit from which non-oral approaches. In particular, comparison studies need to examine which communicative system works best with which children over the long run. A determined effort also needs to be made to determine which training and teaching approaches are likely to optimize participants' progress in acquiring useful communication skills. Another factor that should be considered in selecting an intervention approach is the preference of the individual user for a particular system. Individual children with ASD (or other developmental disabilities) often show preferences for different communicative intervention approaches (van der Meer et al., 2011) and these preferences may change with increasing age. In addition, the teaching of signs that more closely resemble the concepts that they represent (that is, signs that are highly iconic or pantomimic, such as Simplified Signs) may positively influence the sign-learning abilities of a wide range of individuals with ASD. This potential enhancement of sign-learning abilities may, in turn, necessitate another round of comparison studies across the different intervention options.

Finally, it should be noted that when augmentative and alternative communication systems are used in an intervention program for children with autism, there is no evidence that the use of such systems will impede or hinder these children's speech production. Rather, systematic examination of the outcomes of numerous studies in which these systems were used indicate that children often showed gains in their speech production (Romski et al., 2015; Schlosser & Wendt, 2008). These gains, however, frequently were relatively modest ones.

Evaluative Comments

A large number of studies have reported that sign language training is an effective intervention strategy for teaching receptive and expressive language skills to non-speaking children with ASD. Indeed, in his review of communication intervention programs for children with autism, Goldstein (2002, p. 373) observed, "In particular, interventions incorporating sign language… have been used successfully to expand the communication repertoire of children with autism." At the same time, it should be acknowledged that relatively little is known about the interrelationships among participants' characteristics, types of instruction, the utilization of multiple intervention strategies, and sign-communication program outcomes.

Overall, there are both distinct disadvantages and advantages associated with using manual signs as opposed to other non-oral communication systems or approaches with children with autism (Wendt, 2009). Some individuals may have severe motor problems or impairments that may impede their sign learning (Bonvillian, 2002; Maurer & Damasio, 1982). In addition, although signs may be produced more slowly than speech, they are not as permanent or long lasting in the duration of their presentation as pictures or real objects. Some children may need a longer presentation time than is comfortable when signing. A third limitation of signing is that a learner needs sufficient memory skills to be able to recall and produce the signs that have been taught. Pictures and real objects require that the learner only recognize the needed concept or item from a display or collection.

Fourth, teachers and caregivers need to invest the time necessary to learn to communicate effectively through signs. Although the time commitment involved in keeping pace with the signing of most children with ASD is relatively small, it is not negligible; teachers and caregivers must make the commitment to use signs with the child throughout the day to maximize its effectiveness. Fifth, as the practice of adapting or modifying signs to make them easier to produce continues to grow, teachers and caregivers will need to learn the specific exceptions used with individual children. Finally, despite the increased popularity of signing in the general public over the past few decades, most members of society do not sign. This means that the usefulness of children's signing with persons outside of their homes, schools, and care centers will be considerably limited.

Although there are some disadvantages to using signs with non-speaking children with ASD, there are several distinct advantages as well. With signing, one does not need to carry around supplies or invest in expensive equipment. Additionally, conversations in sign, as opposed to other augmentative and alternative communication approaches, can be relatively fast-paced and spontaneous. The learner does not need to turn pages, find a picture or an object, or turn on equipment in order to communicate. A third advantage is that successful signing involves interaction with another person and, in particular, appears to foster increased eye contact. Finally, there is some evidence that the planning, coordinating, and sequencing of motor movements used in forming a sign are closely related neurobiologically to the specific oral-motor movements involved in uttering a spoken word. This close neurological association may help explain why some children learning to sign spontaneously start to vocalize.

If a decision is made to implement a signing program (or other augmentative and alternative communication interventions) for a child with ASD, the available evidence indicates that the earlier in the child's life that the program is begun, then the greater his or her acquisition of communication skills likely will be in the long run. With the diagnosis of childhood autism often being made in a child's second year, we see no compelling reason not to introduce signs as soon after the diagnosis as conveniently possible. This early introduction of signs contrasts markedly with the all too frequent approach of waiting to see whether a child with ASD will acquire useful speech and then teaching signs only after it appears that he or she will not speak. Implementing a sign-communication program early in development is likely to have lasting benefits.

If a sign-communication program is introduced, then progress in spoken language development is more likely to occur if speech accompanies the signed input. In most cases, the sign and speech input may be simultaneous. For those children with ASD who find spoken language input aversive, however, then a different strategy may need to be employed. One possibility would be to teach signing skills in a separate session from that of speech training. Once these children have learned to communicate spontaneously through signs, it may be possible to pair signs with speech to facilitate spontaneous spoken language usage and development.

Because of the motor and cognitive impairments present in many children with ASD, different signs may be learned and remembered more easily than others. In general, those signs that are easy to form, high in iconicity, and of interest or use to the children are acquired more readily. We selected or developed Simplified Signs to meet these criteria; therefore, they should constitute a good lexicon for individuals with autism. The Simplified Sign System also is a solid choice for others who experience cognitive, memory, and/or motor disturbances, such as persons with cerebral palsy, an intellectual disability, or aphasia. The language disorders of this last group of individuals often result from a severe head injury, brain tumor, brain infection, or stroke. In other words, after such an event, a person may have difficulty understanding speech (receptive aphasia) or producing recognizable speech (expressive aphasia). Our next chapter focuses on sign-communication training and teaching in persons who have aphasia.