LANGUAGE AND COMMUNICATION DEVELOPMENT IN DOWN SYNDROME

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Although there is considerable variability, most individuals with Down syndrome have mental retardation and speech and language deficits, particularly in language production and syntax and poor speech intelligibility. This article describes research findings in the language and communication development of individuals with Down syndrome, first briefly describing the physical and cognitive phenotype of Down syndrome, and two communication related domains—hearing and oral motor skills. Next, we describe language development in Down syndrome, focusing on communication behaviors in the prelinguistic period, then the development of language in children and adolescents, and finally language development in adults and the aging period. We describe language development in individuals with Down syndrome across four domains: phonology, semantics, syntax, and pragmatics. We then suggest strategies for intervention and directions for research relating to individuals with Down syndrome. © 2007 Wiley-Liss, Inc.
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Down syndrome is the most common genetic cause of mental retardation. Although variable, language delays are also common in individuals with Down syndrome and follow a characteristic profile. This article describes research findings in the language and communication development of individuals with Down syndrome, first briefly describing the physical and cognitive phenotype of Down syndrome, then two communication related domains—hearing and oral motor skills. Next, we describe language development, focusing on the prelinguistic period, then the development of language in children and adolescents, and finally language in adults and the aging period. We describe language development in individuals with Down syndrome across four domains: phonology (or speech), semantics (or vocabulary), syntax (or grammar), and pragmatics (or use of language). Finally, we suggest strategies for intervention for individuals with Down syndrome.

BACKGROUND OF DOWN SYNDROME

Down syndrome occurs in ∼13.65 per 10,000 live births, affecting nearly 5,500 infants in the United States each year [Centers for Disease Control and Prevention, 2006]. Trisomy 21, in which there is an extra copy of chromosome 21, is the most common cause of Down syndrome, accounting for 98% of cases. Translocation is another cause of Down syndrome and occurs when part of chromosome 21 attaches to another chromosome. Mosaicism, the least common cause of Down syndrome, is the result of a nondisjunction of chromosome 21 that places an extra copy of the chromosome in some, but not all, cells. Many genes, currently estimated at 329, contribute to the expression of Down syndrome [Roizen and Patterson, 2003]. It is the extra genetic material of chromosome 21, rather than qualitative abnormalities in the genes, that is responsible for the developmental and physical characteristics associated with Down syndrome [Roizen and Patterson, 2003; Antonarakis and Epstein, 2006].

Physical characteristics commonly associated with Down syndrome include dysmorphic facial features, growth retardation, broad hands, congenital heart disease, anomalies of the gastrointestinal tract, epicanthal folds, and hyptonoia (low muscle tone). The degree of cognitive deficit varies widely from close to normal intelligence to severe retardation, with 80% of individuals showing moderate retardation [Pueschel, 1994; Roizen, 2002]. In individuals with Down syndrome, the brain is microcephalic, with the hippocampus, prefrontal cortex, and cerebellum having particularly low volume. Though few studies have directly explored related functional impairments, there is evidence of hippocampal dysfunction [Nadel, 2003]. Behavioral and psychiatric difficulties, such as attention deficit/hyperactivity disorder and depression, occur more often in Down syndrome than in the general population, but less frequently than in other types of intellectual disabilities [Roizen and Patterson, 2003; Antonarakis and Epstein, 2006]. Studies from the 1990s indicate that about 10–12% of individuals with Down syndrome also have a diagnosis of autism spectrum disorders (ASDs) [Ghaziuddin et al., 1992; Kent et al., 1999], although a recent review [Cohen et al., 2005]

indicates that there is not a consensus regarding the prevalence of comorbid Down syndrome and autism.

LANGUAGE-RELATED DOMAINS: OTITIS MEDIA/ HEARING AND ORAL MOTOR SKILLS

In this section, we describe two domains that are particularly important for language development in individuals with Down syndrome. First we describe hearing and otitis media and then oral motor structure and function.

Otitis Media and Hearing

Adequate hearing is important for language learning. Hearing loss occurs in about two-thirds of children with Down syndrome because of conductive or sensorineural hearing losses or both [Roizen, 2002]. Roizen et al. [1993] reported that for 47 children between 2 months and 3 1/2 years, 28% had hearing loss in one ear and 38% in both ears. The hearing loss was conductive in 19 ears, sensorineural in 16, and mixed in 14. The loss was mild in 33 ears, moderate in 13, and profound in 3.

In regard to otitis media, which causes conductive hearing loss, Shott et al. [2001] found that 96% of 48 preschool-aged children with Down syndrome had at least one ear infection, 83% required pneumatic tube placement, and of those requiring medical treatment, 81% had abnormal hearing prior to treatment. Causes of otitis media in individuals with Down syndrome include narrow auditory canals, cranial facial differences, and subtle immune deficiencies that lead to increased respiratory illnesses [Roizen, 2002]. Otitis media is of concern for children's language development because it is often accompanied by fluid in the middle ear, which can cause a mild to moderate fluctuating hearing loss [American Academy of Pediatrics, 2004; Roberts et al., 2004]. Although the relationship between a history of otitis media with effusion (OME) or middle ear fluid and later language is negligible to mild in degree in typically developing children [American Academy of Pediatrics, 2004; Roberts et al., 2004], children with Down syndrome (who are at risk for language learning difficulties) are thought to be more vulnerable to language difficulties because of OME-associated hearing loss [American Academy of Pediatrics, 2004; Roberts et al., 2004]. Two studies have reported

that hearing impairment (due to either conductive or sensorineural hearing loss) in individuals with Down syndrome is related concurrently to difficulties in comprehension of grammatical morphemes, number of different words produced, utterance length, and speech intelligibility [Chapman et al., 2000; Miolo et al., 2005]. Since there are no prospective studies on the linkage between a history of OME and later language and learning difficulties, longitudinal research is needed to determine whether a history of OME and associated hearing loss contributes to later language and learning difficulties in individuals with Down syndrome and to specify which aspects of language and learning are affected [American Academy of Pediatrics, 2004].

Oral Motor Skills

Structural and functional differences in oral structures in individuals with Down syndrome are thought to affect speech production [Stoel-Gammon, 1997; Miller and Leddy, 1998]. Although variable, oral structure differences in individuals with Down syndrome may include a small oral cavity, a narrow, high arched palate, irregular dentition, and a large tongue that protrudes forward. The facial musculature has been reported to have multiple anomalies such as missing, additional, or poorly differentiated muscles, hyperextendable joints, and nerve innervation differences [Miller and Leddy, 1998]. These muscular and innervation variances are thought to account, in part, for the reduced speed, limited range of motion, and difficulty with coordination of the speech articulators observed in individuals with Down syndrome and may impact speech intelligiblity. There are also reports of drooling, open mouth posture, large tongues, hypotonia, velopharyngeal insufficiency, and compromised respiratory support as well as apraxia (difficulty in execution of the motor programming of speech movements) and dysarthria (weakness or incoordination of the articulators that results in slow, weak, imprecise, or discoordinated speech) [Miller and Leddy, 1998; Dodd and Thompson, 2001]. Barnes et al. [2006] found that boys with Down syndrome showed atypical oral structure (of the lips, tongue, and velopharyngeal area), oral motor function not involving speech (for the lips), and speech function (of the lips, tongue, velopharynx, larynx, and coordinated speech) when compared with typically

developing boys. The boys with Down syndrome, unlike the typically developing boys, repeated multiple syllable words with lesser accuracy when compared with single syllable words, indicating a possible breakdown in articulatory accuracy as the number of syllables and segments in an utterance increases. Further research is needed to define the oral motor patterns in individuals with Down syndrome and how specific oral motor patterns are related to speech development.

LANGUAGE DEVELOPMENT

When acquiring any language, children must learn rules about sounds, grammar, meanings, and uses. These rules are reflected in four components of language: phonology, syntax, semantics, and pragmatics. Before learning a language, children communicate prelinguistically using gestures, vocalizations, and other behaviors. In this section, we first describe prelinguistic communication development in individuals with Down syndrome, then the development of speech and language in children and adolescents focusing on phonology, vocabulary, syntax, and pragmatic development, and finally language development in adults and the aging period.

Prelinguistic Development

The prelinguistic stage, which occurs from 12 to 18 months of age in typically developing children, is the period before children use language to communicate. During this period, individuals communicate through gestures, vocalizations, facial expressions, and other movements. This period can last several years, for individuals with Down syndrome, or as long as a lifetime for individuals with severe motor speech disorders. Most of the literature on prelinguistic development focuses on the use of either gestures or vocalizations.

Similar to typically developing children, children with Down syndrome use gestures in the early stages of communicative development. Some studies have found that gesture use is a strength in children with Down syndrome when compared to typically developing children. For example, children with Down syndrome aged 10 months to 4 years used more types of gestures, as measured by parent checklists [Singer-Harris et al., 1997; Caselli et al., 1998]. However, both the number of different gestures and the total number of gestures produced during mother–child interactions were similar for children with

Down syndrome and language matched typically developing children [Iverson et al., 2003]. Furthermore, the typically developing children produced more word–gesture combinations in which the word and gesture each contributed unique, rather than repetitious, information. The communicative functions of gestures used by children with Down syndrome may differ from those of typically developing children. For example, Mundy et al. [1995] found that children with Down syndrome showed lower rates of requesting, but not commenting, compared to typically developing language matched children. Greater use of gestures was related to better later language development for children with Down syndrome in two studies [Mundy et al., 1995; Yoder and Warren, 2004].

The development of vocalizations in infants with Down syndrome is generally similar to the development in typically developing infants [Dodd, 1972; Smith and Oller, 1981; Smith and Stoel-Gammon, 1983], although the onset of canonical babbling (i.e., adult-like consonant–vowel combinations) is delayed [Lynch et al., 1995]. For example, Dodd [1972] reported that 9–13-month-old infants with Down syndrome were similar to typically developing infants in their use of consonant vowel vocalizations. Similarly, Smith and Oller [1981] found that the mean age of onset of reduplicated babbling (i.e., repeated consonant–vowel combinations), as well as the consonants and vowels produced, was similar for 10 infants aged birth to 9 months with Down syndrome and 9 chronological age matched typically developing infants. However, Lynch et al. [1995] found that the average age of onset of canonical babbling was 2 months later for infants with Down syndrome than for typically developing infants. The babbling period for infants with Down syndrome continues into the second year of life and is longer than that of typically developing infants [Stoel-Gammon, 1997]. Further research is needed to examine the use of gestures and vocalizations by individuals with Down syndrome and the relationships of both gestures and vocalizations to later speech and language development.

Development of Language

In this section, we describe language development for individuals with Down syndrome during the emerging, developing, and more advanced language stages. During the emerging language stage, the typical child between 18 and 36 months begins to produce single words building up to a 50-word vocabulary and combines words into two-word utterances and simple sentences. Next, in the developing language stage from 3 to 5 years, children acquire basic vocabulary and sentence structures and learn to use more complex language. After 5 years of age, typical children develop more advanced language as they learn to meet the demands of the school curriculum and interact with peers and others in their environment. In this section, we focus on phonology, vocabulary, syntax, and pragmatic development in children and adolescents with Down syndrome across all of these language stages. For more details about the language stages in typically developing children and children with developmental disabilities, see Paul [2007] and in individuals with Down syndrome, see Chapman and Hesketh [2000] and Roberts, Chapman, Martin, and Moskowitz (in press).

Differences in speech sound development for children with Down syndrome begin to emerge with the transition to first words.

Phonology

Phonology refers to the formation of speech sounds, or phonemes, and how phonemes are joined together into words. Differences in speech sound development for children with Down syndrome begin to emerge with the transition to first words [Stray-Gunderson, 1986]. Speech errors are common among preschool and older children with Down syndrome, with delays characteristic of developmentally younger children, while consonant errors, as well as phonological processes (patterns of sound errors such as deletion of final consonants), are similar to the patterns in younger typically developing children at similar mental levels [Dodd, 1976; Rosin et al., 1988]. Although children with Down syndrome use phonological processes or sound patterns that are similar to those used by typically developing children, they eliminate these processes at a slower rate [Stoel-Gammon, 1980; Smith and Stoel-Gammon, 1983; Bleile and Schwartz, 1984]. In an early study, Dodd [1976] reported more phonological processes and more different types of phonological process patterns in school-aged children with Down syndrome when compared with typically developing preschoolers. More recently, Roberts et al. [2005] reported that preschool- and school-aged boys with Down syndrome were delayed in their speech development, and they produced more sounds in error and more phonological processes as well as some different error patterns than did the younger typically developing boys at the same mental age on a single word articulation test. The boys with Down syndrome generally reduced word shapes, by omitted syllables (e.g., bana for banana), reduced consonant clusters (e.g., bu for blue), and deleted consonants (e.g., spoo for spoon). Others have reported that inconsistent sound productions can occur [Dodd and Thompson, 2001].

Individuals with Down syndrome often have poor speech intelligibility, which can be a major barrier in daily activities. Typically developing children are often fully intelligible at 48 months of age, while producing intelligible speech is a lifelong challenge for those with Down syndrome [Shriberg and Widder, 1990]. The cause of poor speech intelligibility in Down syndrome is not clear and may be due to the sound error patterns, reduction of word shapes, apraxia, and/or dysarthria. Other factors such as deviations in phrasing, rate, placement of sentence stress, and perceived voice quality (low-pitch, hoarse, harsh voice) have also been reported among individuals with Down syndrome [Stoel-Gammon, 1997]. Further research is needed to describe the speech of individuals with Down syndrome, particularly in conversation. Research is needed to determine how phonological factors such as sound deletions, suprasegmental factors such as rate, oral motor factors such as tongue mobility, cognitive factors such as phonological working memory, and/or hearing loss due to OME are affecting speech intelligibility in individuals with Down syndrome.

Semantics

Semantics refers to the meanings of words and includes knowledge of vocabulary and concepts about objects and events. Despite considerable individual variability, the onset of the first spoken word is often delayed, and early expressive vocabulary growth is slow for children with Down syndrome [Caselli et al., 1998; Mervis and Robinson, 2000; Berglund et al., 2001]. For example, in a survey of 330 children with

Down syndrome between the ages of 1 and 5 years, Berglund et al. [2001] found that only 12% of 12–23-month-olds, 80% of 24–35-month-olds, and 90% of 36–47-month-olds produced one word. Typically developing children produce their first word by 10–15 months of age [Hoff, 2001]. Similar to the pattern of expressive vocabulary development in typically developing children, some children with Down syndrome experience a vocabulary spurt [Miller, 1999; Berglund et al., 2001], though this spurt appears to occur at more advanced mental ages for children with Down syndrome than for typically developing children [Miller, 1999].

Recent research findings regarding whether individuals with Down syndrome show expressive vocabulary deficits relative to nonverbal cognitive levels are inconsistent. Using standardized measures of expressive vocabulary, researchers have reported expressive vocabulary levels that were higher than nonverbal cognitive levels in adolescents and young adults with Down syndrome [Glenn and Cunningham, 2005], lower than nonverbal cognitive levels in children [Roberts et al., in press,b], and commensurate with nonverbal levels in children [Laws and Bishop, 2003]. However, when vocabulary production was assessed during language samples—perhaps a more challenging context than standardized tests—expressive vocabulary levels of preschoolers, elementary age children, and adolescents with Down syndrome were found to be delayed relative to nonverbal cognitive levels [Miller, 1988; Chapman et al., 1991, 1998].

Like expressive vocabulary, findings for receptive vocabulary have varied with the type of assessment administered. Receptive vocabulary levels of children [Miller, 1999] and adolescents [Chapman et al., 1991; Laws and Bishop, 2003] are usually consistent with overall developmental levels and less delayed than expressive vocabulary [Miller, 1999; Laws and Bishop, 2003], though Roberts et al. [in press,b] reported receptive vocabulary levels that were lower than developmental levels in children. In later adolescence and early adulthood, strengths in receptive vocabulary emerge, perhaps because of more life experiences. Recent studies have shown that for adolescents and young adults with Down syndrome, comprehension of experience- and event-based vocabulary exceeds both nonverbal cognitive levels [Glenn and Cunningham, 2005; Chapman, 2006] and comprehension levels of more conceptually difficult words

[Chapman, 2006]. Comprehension levels for conceptually difficult words have been reported to be lower than nonverbal cognitive levels in children with Down syndrome [Price et al., in press]. Similar receptive vocabulary profiles have been observed in individuals with other types of cognitive impairment [Facon et al., 2002; Chapman, 2006].

Typically developing children as young as 20 months engage in "fast mapping," in which they link a new vocabulary word with its meaning after only a few exposures to the new word [Hoff, 2001]. Adolescents with Down syndrome do not differ from children matched on nonverbal cognitive level [Chapman et al., 1990; Kay-Raining Bird et al., 2004] and syntax comprehension [Chapman et al., 2006] on simple fast mapping tasks, such as learning single words and words embedded in narratives. However, adolescents with Down syndrome demonstrated greater response times for novel words than

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syntax comprehension matches [Chapman et al., 2006]. Further investigation of fast mapping abilities, as well as other processes that underlie vocabulary acquisition, is needed, as is further examination of the effects of elicitation procedures on receptive and expressive vocabulary findings for individuals with Down syndrome.

Syntax

Syntax is the combination of words into phrases and sentences. It includes word inflections ("s" in "cars" to mark plurality), parts of speech (e.g., noun, adjective, verb), word order, and sentence constituents (e.g., noun phrase, verb phrase). Compared with vocabulary, syntax is a particular weakness for individuals with Down syndrome. Children with Down syndrome are generally delayed in transitioning from 1- to 2-word speech [Iverson et al., 2003]. After production of multiword speech has begun, children and adoles-

cents with Down syndrome produce shorter utterances, as measured by mean length of utterance (MLU), than younger typically developing nonverbal mental age matches [Miller, 1988; Rosin et al., 1988; Chapman et al., 1998] and mental age matches with mental retardation of unknown etiology [Rosin et al., 1988]. Although individuals with Down syndrome acquire grammatical morphemes in the same order as typically developing children [Berglund et al., 2001], they have difficulty with grammatical morpheme production when compared with TD children matched for MLU. This difficulty includes the use of grammatical function words (such as copula and auxiliary *be*, articles, and prepositions) and tense and nontense bound morphemes (such as past tense -ed and third person singular -s) [Chapman et al., 1998; Eadie et al., 2002]. Children with Down syndrome also produce fewer grammatical verbs (auxiliary and copula *do, be,* and *have*) and lexical verbs (main verbs that do not include *do, be,* or *have*) per utterance than do MLU-matched controls [Hesketh and Chapman, 1998]. Despite these morphosyntactic weaknesses, adolescents do not reach a "syntactic ceiling" or stop growing in their syntax [Fowler, 1990; Fowler et al., 1994] but continue to advance in utterance length and syntax complexity through at least 20 years of age [Chapman et al., 2002; Thordardottir et al., 2002]. Interestingly, syntax appears to be affected by sampling context, in that adolescents with Down syndrome demonstrate more advanced syntax skills in narratives than in conversation [Chapman et al., 1998].

Findings regarding comprehension of morphosyntax are mixed. Some studies indicate that the syntax comprehension skills of children, adolescents, and young adults with Down syndrome are commensurate with nonverbal cognitive skills [Miller, 1999], but others have found that receptive syntax levels are lower than nonverbal cognitive levels [Rosin et al., 1988; Chapman et al., 1991; Abbeduto et al., 2003; Laws and Bishop, 2003; Price et al., in press]. Yoder et al. [2006] recently found that children with Down syndrome with greater degrees of impairment in grammatical morpheme comprehension demonstrated smaller amplitude differences in event-related potentials when processing contrasting syllables, indicating that speech processing abilities are related to grammatical impairments in children with Down syndrome. Two longitudinal studies have shown that growth of morphosyntax comprehension slows,

or even declines, in the later adolescent and early adult years [Chapman et al., 2002; Laws and Gunn, 2004]. Future research should aim to clarify the relationship between receptive morphosyntax skills and nonverbal cognition, continue to explore underlying processes that may account for grammatical impairment, and compare the profile of morphosyntactic deficits in Down syndrome to those of other disabilities.

Pragmatics

Pragmatics refers to the use of language in social contexts for the purpose of communication. It includes the reason that someone talks (e.g., to request an object, to protest something), as well as the ability to take a turn in a conversation, to initiate or maintain a conversational topic, to modify speech for different listeners and situations such as to revise communication when clarification is requested, and to narrate events. In contrast to speech, vocabulary, and syntax skills, the pragmatic skills of children with Down syndrome appear to be a relative strength, although the findings in all areas of pragmatics are not consistent. In conversational interactions with their mothers, Coggins et al. [1983] reported that four children with Down syndrome expressed the same range of communication functions as typically developing children at similar language levels. Tannock [1988] also reported that 11 preschool-aged children with Down syndrome did not differ in the number of exchanges during mother–child interactions in which they stayed on topic when compared to children matched on mental age and communication level, yet the children with Down syndrome were less likely to introduce new topics. Beeghly et al. [1990] found that 17 boys and 11 girls with Down syndrome used fewer requests but did not differ in topic maintenance or in their use of answers, comments, and protests when compared to developmental age matched children. The children with Down syndrome, however, stayed on topic for more turns and responded more appropriately to adults than a group of language matched control children. More recently, Roberts and colleagues [in press,a] compared the conversational interactions with a trained examiner of 29 boys with Down syndrome to those of typically developing boys. The boys with Down syndrome provided less elaborative information to maintain the topic, but did not differ in the proportion of overall turns in which they maintained or changed the topic, compared with the typically developing boys after controlling for mental age. Thus, the findings of these studies are somewhat inconsistent, particularly on overall ability of children with Down syndrome to initiate a conversational topic. The studies do suggest that children with Down syndrome may differ from mental age matched children in their use of requests and ability to elaborate information on a topic of conversation.

Examining repair strategies, Coggins and Stoel-Gammon [1982] found that four children with Down syndrome repaired all communication breakdowns when their conversational partner asked for clarification. However, children with Down syndrome are less likely to take into account the needs of their listener either by signaling the need for clarification during a communication breakdown or by using referential frames or scaffolding to assist the listener in understanding their message than mental age matched typical children [Abbeduto and Murphy, 2004; Abbeduto et al., 2006]. Weaknesses in referential communication were related to expressive language deficits in adolescents and young adults with Down syndrome [Abbeduto et al., 2006].

In narrative skills, adolescents with Down syndrome demonstrate relative strengths when visual supports are available. When telling stories with visual support (from either a wordless picture book or a wordless film), adolescents with Down syndrome narrated more story elements than did controls matched on syntax comprehension or syntax production [Boudreau and Chapman, 2000; Miles and Chapman, 2002], and they narrated the same number of story elements, but used fewer cohesive devices, than did typically developing children matched on nonverbal cognitive level [Boudreau and Chapman, 2000]. However, when stories were presented auditorily with no visual support, adolescents with Down syndrome recalled less information than did mental age matches [Kay-Raining Bird et al., 2004].

Further research is needed to define the pragmatic skills in individuals with Down syndrome at different linguistic stages and age levels. For example, the research on conversation is generally from children, while the data from narratives is from adolescents. Further research should also examine whether linguistic deficits such as impaired expressive language, cognitive deficits such as attention disorders, or social factors contribute to pragmatic difficulties.

Language and Aging

Cognitive declines are often reported in adults with Down syndrome. By age 60 years, 75% of individuals with Down syndrome show symptoms of Alzheimer's disease [Roizen and Patterson, 2003]. However, several studies have shown that the language skills of young and middle-aged adults do not decline. See Chapman and Hesketh [2000] for a more detailed review of the language skills of adults with Down syndrome. Receptive vocabulary and reading scores remained stable from ages 30–35 years for 37 adults with Down syndrome [Carr, 2003]. Rondal and Comblain [1996, 2002] reported that expressive morphosyntax, measured by MLU, and expressive vocabulary did not decrease between late adolescence and early adulthood and that receptive morphosyntactic skills, including comprehension of tense inflections and articles, did not decline between late adolescence and age 50 years in a cross-sectional study. However, some literature indicates that communication skills decline in later adulthood. Prasher [1996] reported that 20% of individuals with Down syndrome aged 50–70 years experience declines in speech skills, while Nelson et al. [2001] found declines in receptive vocabulary and pragmatic skills in adults with Down syndrome (mean age, 40 years) who also had neurological evidence of dementia. Future research should further explore communication trajectories during adulthood and the relationship between the onset of dementia and declines in communication skills in individuals with Down syndrome.

INTERVENTION

There are considerable individual differences in the skill levels of individuals with Down syndrome. Each individual's profile of strengths and weaknesses will determine the specific strategies that should be assessed and targeted in intervention. In this section, we will review intervention guidelines that have been used with individuals with Down syndrome, other special populations, or typically developing individuals and are likely effective for individuals with Down syndrome. Relatively little research has focused on the effectiveness of intervention strategies for improving the communication skills of individuals with Down syndrome.

Manage OME and Associated Hearing Loss

Individuals with Down syndrome should be routinely screened for middle ear problems and associated hearing loss [Roberts et al., 2004]. Children should have their hearing tested when OME persists for 3 months or longer [American Academy of Pediatrics, 2004] following procedures recommended by the American Speech-Language-Hearing Association [1996]. When children have OME lasting longer than 4 months, clinical practice guidelines recommend the use of tympanotomy tubes for at-risk individuals [American Academy of Pediatrics, 2004]. At the same time that OME is medically managed in individuals with Down syndrome, their speech and language should be monitored. Because of the importance of hearing for language learning, low gain hearing aids or other amplification devices such as frequency modulation [FM] sound field systems in classrooms can be useful [ASHA, 2002]. Strategies for optimizing the language learning environment and the listening–learning environment for children with OME and associated hearing loss have been described and may be useful for individuals with Down syndrome [Roberts and Wallace, 1997; American Academy of Pediatrics, 2004; Roberts et al., 2004].

Initiate Language Intervention Early in Development

A number of parent-oriented interventions have demonstrated that communication intervention during the first 3 years of life fosters prelinguistic and/or early linguistic skills in individuals with Down syndrome. For a review of these and other intervention approaches in different populations, see McCauley and Fey [2006] and more specifically for the Down syndrome population, see Brady et al. [in press]. Sanz Aparicio and Balana [2002] reported that during the newborn period 36 infants with Down syndrome who received early intervention (i.e., stimulation for specific communicative skills, provided by their mother and clinician) in the first month of life, rather than at 3 or 6 months of age, had higher overall language scores at 18 months of age. Warren and colleagues [Yoder and Warren, 2002; Fey et al., 2006] have examined the effectiveness of responsivity education/prelinguistic milieu teaching (RE/PMT) during which toddlers with developmental disabilities (including toddlers with Down syndrome) were taught to use gestures,

vocalizations, and coordinated eye gaze during natural interactions and parents were taught to respond to children's verbal and nonverbal behaviors. Yoder and Warren [2002] found that children with lower rates of prelinguistic commenting and canonical vocalizations demonstrated more growth in their rate of posttreatment prelinguistic commenting if they were enrolled in RE/PMT rather than the control group. Interestingly, children with Down syndrome showed lower rates of requesting if they were in the treatment group. In a follow-up study, Fey et al. [2006] made important modifications to the study design of Yoder and Warren [2002] by limiting participants to 2-year-olds with developmental disabilities (26 of whom had Down syndrome) at very early prelinguistic communication levels and instructing clinicians to not persist in prompting requests when children were unresponsive to these prompts. Children who received RE/PMT produced more

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intentional communication than did the control group, and the effect was also evident for the toddlers with Down syndrome. In another parent intervention program, the effectiveness of the Hanen program [Manolson, 1992], a parent training program targeting prelinguistic and early linguistic behaviors, was examined by Girolametto et al. [1998]. They reported that 2- and 3-year-olds with Down syndrome in their treatment group used more targets during free-play and according to parent report. These studies demonstrate the efficacy of particular interventions to increase the communication skills of children with Down syndrome in the prelinguistic stage of development.

Provide Intervention to Increase Speech Intelligibility

Intervention to improve speech intelligibility is important for individuals with Down syndrome given the high

prevalence of speech difficulties [Stoel-Gammon, 2001]. Assessment of speech in single words and conversation should be done to determine sound pattern accuracy and speech intelligibility and factors affecting speech intelligibility in conversation. Suprasegmental factors such as pitch and rate, oral motor structures and function, and speech-related factors such as phonological working memory should also be assessed. Some individuals with Down syndrome also have speech motor control problems and/or muscle weakness, and so assessments for developmental apraxia of speech and/or dysarthria are also important for planning speech intervention. Based on the profile of speech errors in boys with Down syndrome, assessment should also examine certain phonological processes, including syllable structure processes such as syllable deletion, cluster reduction, and deletion of final consonants. In order to assess these processes, it is important to use a single word articulation test and/or collect a language sample that includes the opportunity to use consonant clusters and multisyllabic words with varying stress.

Speech intervention in individuals with Down syndrome should be individualized to target specific phonological processes and speech errors that persist. An overall focus should be on increasing speech intelligibility. Intervention methods similar to those described for individuals with phonological delay [Stoel-Gammon, 2001] as well individuals with poor speech intelligibility, and verbal dyspraxia may be particularly useful. For example, interventions that focus on syllable structure processes and the establishment of "syllableness" as described by Hodson and Paden [1991] can be used. See Smit [2004] and Bauman–Waengler [2004] Kamhi [2006] for specific speech intervention methods and Barlow [2002] for reviews of speech intervention research. There are very few published speech intervention studies with individuals with Down syndrome. Studies with small numbers of preschoolers with Down syndrome showed phonological growth after parent-implemented treatment programs designed to increase speech accuracy [Cholmain, 1994; Dodd et al., 1994].

Assess Language in a Variety of Communication Contexts to Determine Language Goals for Intervention

All individuals with Down syndrome should have their language

assessed to determine their current level of functioning and profile their strengths and weaknesses in vocabulary, syntax, and pragmatics. Because receptive language and cognitive skills may exceed expressive language skills, language input should be at an individual's receptive rather than expressive language level. Although some individuals with Down syndrome may have particular deficits in expressive syntax when compared to vocabulary or their language use, language assessment should profile all language domains. Language should be assessed using standardized tests as well as language samples and a variety of elicitation methods. Differences in language levels on these measures may be due to the elicitation method and/or characteristics of the instrument. Research has shown that conversational samples may elicit different language complexity than standardized measures [compare Chapman et al., 1998 and Glenn and Cunningham, 2005], narratives elicit more complex language than conversational speech samples [Miles et al., 2006], and tests of vocabulary may be designed to elicit more basic versus more complex and conceptual forms and functions [Miolo et al., 2005]. Language assessments should occur in a variety of contexts such as in the classroom, with peers, at home, and in the community to determine whether aspects of language such as the ability to elaborate on a conversational topic differ in certain contexts or with different conversational partners. Rather than being completed at one point in time, assessments should also be an ongoing gathering of information. Finally, although the relationship between autism and communication skills has not been explored in individuals with Down syndrome, determining whether an individual with Down syndrome also has an ASD may have important implications for intervention practices.

Target-Specific Vocabulary, Syntax, and Pragmatic Skills

Language intervention in individuals with Down syndrome should be individualized based on their current level of functioning and communication needs. Goals for intervention should be selected that will have a meaningful impact on communication as well as social, academic, and vocational functioning in a variety of settings [American Speech-Language Association, 2005]. Specific intervention targets can focus on syntax (e.g., producing grammatical morphemes like past tense –ed and third person singular –s), vocabulary (e.g., comprehending directional words such as *between* and *behind*), or discourse (e.g., increasing topic initiations). There are many different intervention approaches to develop language skills, with some more clinician directed, child directed, or a combination of both, and they are described in detail in Paul [2007] and McCauley and Fey [2006]. The use of conversational recasts is an example of an approach to develop complex syntax production, an area of deficit for many individuals with Down syndrome. In a conversational recast, the child's utterance is expanded with grammatical or semantic information and so "baby cry" becomes "The baby is crying." See Camarata and Nelson [2006] for a description of the recast procedure and research support.

Children with Down syndrome have been reported to provide little elaboration in conversation. An example of an approach to increase elaboration in conversation was suggested by Bliss [2002]. The individual with Down syndrome gives directions or plans an event (e.g., describe how to make a sandwich or plan a birthday party). The clinician then directs the individual to provide additional information (e.g., Tell me more.) if his or her response is unclear. To increase the ability to negotiate requests for clarification, a pragmatic deficit in many adolescents with Down syndrome, Paul [2007] suggested using barrier games in which the clinician takes the role as speaker and gives unclear messages, (e.g., are unintelligible or include nonsense words), thus providing opportunities for the child to ask for clarification. The child can then take the role of speaker, with the clinician modeling requests for clarification and creating opportunities for the child to repair. Increasing language skills and language-related skills such as phonological working memory may also impact literacy development [see Gillon, 2006]. For a review of language intervention approaches to encourage advanced language and literacy, see McCauley and Fey [2006] and Paul [2007].

Promote Generalization of Communication Targets

A lack of generalization of communication skills may be characteristic of many individuals with Down syndrome; therefore, generalization of communication skills should be integrated into intervention plans. Language teaching techniques should include approaches that provide multiple exemplars and opportunities for practice of communication skills in a systematic way. Some teaching techniques using naturalistic language methods, such as milieu language teaching (where the environment is arranged to encourage a request) have considerable research support and can help facilitate generalization [American Speech-Language Association, 2005; McCauley and Fey, 2006; Paul, 2007]. Use of other teaching strategies such as models, prompts, and conversational recasts may also help promote generalization. Regardless of the specific teaching strategies, the opportunity to practice communication targets in the natural environment, including the classroom, home, and neighborhood, and with a variety of communication partners, such as teachers, parents, siblings, and classmates, should help promote generalization. Materials from the natural environment, such as story books from a child's classroom or an older child's textbooks, can also be integrated into intervention. Although some service delivery models may be more consistent with goals focusing on functional communication in everyday contexts, it is important to provide opportunities for an individual with Down syndrome to practice multiple exemplars of the target form and/or function and to create opportunities to use communication in contexts that will facilitate generalization.

Consider Augmentative or Alternative Communication

The delay in onset of speech, a motor speech disorder, or poor speech intelligibility or not being able to rely on speech to communicate are all reasons that augmentative or alternative communication (AAC) methods should be part of facilitating and enhancing the speech and language development of individuals with Down syndrome. Depending on the specific needs of the individual, AAC systems can be used for primary means, short term use, or as a supplement to verbal communication. AAC can be described as two main types: unaided and aided. Unaided systems refer to natural gestures such as pointing, body language, facial expressions and manual sign language. They are visually based, portable, and often easily understood. Aided methods refer to external symbol systems such as objects, pictures, graphics (e.g., Bliss, Picture Communication Symbols), and/or the alphabet. These systems can be utilized through a variety of modes,

including communication boards or books and computerized speech production devices known as a Voice Output Communication Aid or VOCA. Though efficacy studies of the use of unaided or aided systems for children with Down syndrome are lacking, sign language has been reported as a commonly used means of communication for children with Down syndrome [Kumin, 2003]. Kay-Raining Bird et al. [2000] found that children with Down syndrome imitated words more frequently when words were paired with sign than when presented only in the sign or spoken modality, similar to previous findings [Foreman and Crews, 1998]. Implementing multimodal methods, including speech and aided and unaided methods, has been advocated [Brady, in press] because it increases the variety of communication options and aids communication across multiple environments. While further studies are needed, it is clear from the published reports that supporting communication through AAC has many benefits for individuals with Down syndrome and does not inhibit or discourage verbal speech development or production [Millar et al., 2006].

CONCLUSION

In addition to mental retardation, individuals with Down syndrome have language deficits, particularly in expressive language and syntax, and poor speech intelligibility relative to nonverbal cognitive and comprehension skills. There is increasing evidence of specific deficits beyond mental age in some aspects of vocabulary and pragmatic skills. Language differences in individuals with Down syndrome are evident at the onset of first words and continue through adolescence and into adulthood with some indication of changes in language strengths throughout their lifespan. Potential explanations for the specific difficulties in language and their implications for literacy development have been studied. Phonological working memory, hearing sensitivity, and visual short term memory have been shown to be related to comprehension and production of both syntax and vocabulary [Chapman et al., 2000, 2002; Laws and Gunn, 2004; Chapman, 2006], while difficulties in oral language skills and auditory working memory have been reported to be related to phonological awareness and reading decoding and comprehension [Byrne et al., 2002; Laws Gunn, 2002; Verucci et al., 2006].

Further research should define the language phenotype in Down syndrome using longitudinal data that will provide information on the rate of growth of a particular language skill. It is possible that a specific domain of language may be more vulnerable to language deficits at a certain age period. For example, when children are developmentally around 4 years of age, more complex language skills in vocabulary, syntax, and pragmatics may be more vulnerable. Further, as children progress through school, the demands of the academic curriculum may place greater demands for language comprehension and expression on a student. Research is also needed to define the cognitive and other communication-related factors that predict individual differences in language development and the impact of specific communication skills on social, literacy, and other academic skills. If the predictors of particular language deficits and the language skills that are most important for social and academic skills in individuals with Down syndrome can be identified, then it can be determined who is at greatest risk for language difficulties and on which domains of language to focus intervention strategies. In addition, given that a small percentage of individuals with Down syndrome also have a diagnosis of ASD, research is needed to understand how a diagnosis of both Down syndrome and ASD affects language development and whether a specific phenotype characterizes an individual with both diagnoses.

The deficits in prelinguistic communication emphasize the need for early intervention, while the continued growth of language during the school age and adolescent years highlight the continued need for language intervention. The uneven profile of language skills in individuals with Down syndrome suggests that interventions need to be individualized, focusing on specific domains of language. Well-controlled intervention studies examining the efficacy of interventions to increase language development and communication skills for individuals with Down syndrome are definitely needed. Specifically, studies are needed to determine the efficacy of amplification, augmentative/alternative communication methods, and language teaching methods for promoting gains in speech intelligibility, language, and generalization to everyday contexts, and whether the effectiveness of interventions varies according to particular developmental stages. ■

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