Children With Down Syndrome: Implications for Assessment and Intervention in the School

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Down syndrome is the most common genetic cause of mental retardation and one of the most frequently occurring neurodevelopmental genetic disorders in children. Children with Down syndrome typically experience a constellation of symptomology that includes developmental motor and language delay, specific deficits in verbal memory, and broad cognitive deficits. Children with Down syndrome are also at increased risk of medical problems, which can exacerbate their cognitive deficits. Although the diagnosis of Down syndrome is facilitated by cytogenetic testing and the unique physical phenotype, the development of proper interventions for this group of children is less obvious. Despite their functional deficits, children with Down syndrome possess relative strengths, which can be the focus of interventions. This article reviews the etiology and developmental course of Down syndrome, appraises examples of empirically validated interventions, and discusses neurocognitive processing issues that should be considered during a psychoeducational evaluation for intervention.

Keywords: Down syndrome, assessment, intervention, special education, school psychology

The prevalence of Down syndrome has been reported to occur in about one out of every 600 live births. Down syndrome is the most common genetic disorder found in children and the most common genetic disorder associated with mental retardation (Lamb et al., 1997). Although Down syndrome is clearly a neurodevelopmental genetic disorder, epigenetic factors such as maternal age during pregnancy have also been implicated in the etiology. Down syndrome remains one of the easiest neurodevelopmental disorders to identify because of the presence of physical anomalies associated with the disorder, and the ease of genetic testing. Physical characteristics of Down syndrome include dysmorphic facial features, growth retardation, hypotonia, epicanthal folds, and broad hands (Roberts, Price, & Malkin, 2007). There are salient neurocognitive deficits associated with Down syndrome, most notably impairment in communication, language, and memory (Laws, Byrne, & Buckley, 2000). Children with Down syndrome are also at increased risk of comorbid conditions, which may exacerbate cognitive, behavioral, and social problems and include Attention-Deficit/Hyperactivity Disorder and Autism (e.g., Kent, Evans, Paul, & Sharp, 1999; Roizen & Patterson, 2003). Although children with Down syndrome typically display global intellectual deficits, there are variations in cognitive abilities between and among individuals with Down syndrome. Thus, a “Down syndrome profile” should not be assumed.

Merrick, Kandel, and Vardi (2004) described three possible etiologies for the extra chromosome associated with Down syndrome. The most common etiology (i.e., about 92%) occurs when either the egg or sperm develops with an extra chromosome, and the resulting fertilized egg has three Chromosome 21s instead of two. This process of nondisjunction (i.e., failure of one of the paired chromosomes to separate during meiosis) is more common in women, especially older women, given that women’s eggs are present before birth (Pennington, Moon, Edgin, Stedron, & Nadel, 2003). When the embryo develops, the extra chromosome is repeated in every cell. Merrick, Kandel, and Vardi (2004) reported that the second possibility of the extra chromosome occurs in about 2% to 4% of individuals with Down syndrome as the result of
“mosaic trisomy.” The etiology is similar to the first condition, but instead results in some cells with 46 chromosomes, whereas other cells have 47. Merrick et al. described the third etiology of Down syndrome, which occurs in about 3% to 4% of cases, as “translocation trisomy.” This occurs when “material from one chromosome 21 gets stuck or translocated onto another chromosome, either before or at conception. Cells from individuals with Down syndrome have two normal chromosomes 21, but also have additional chromosome material on the translocated chromosome.” (Merrick et al., p. 14).

Progression and Neuropsychology of Down Syndrome

There is an insidious neurological progression in Down syndrome, from a nearly normal brain at birth to signs of Alzheimer’s neuropathology by age 35 (Nadel, 1999). By adulthood, there are salient signs of microcephaly with reduced volume in the hippocampus, prefrontal cortex, and cerebellum (e.g., Teipel, 2004). Schimmel, Hammerman, Bromiker, and Berger (2006) examined head sonographic scans of infants with Down syndrome within 7 days of birth. In comparison to healthy controls, they found the infants with Down syndrome had larger third ventricles. The authors postulated that the enlarged third ventricle is related to abnormal development of a surrounding brain area such as the thalamus, hypothalamus, or deep white matter of the brain. These areas surrounding the third ventricle are important areas in cognitive processing, which helps explain some of the cognitive deficits that are present in very young children with Down syndrome (Schimmel et al., 2006). Other areas of altered development in the brains of children with Down syndrome include the frontal lobe, temporal lobe, cerebellum, and the myelination process (e.g., Nadel, 1999; Pinter, Eliez, Schmitt, Capone, & Reiss, 2001).

Although all of these areas of brain development are important for cognitive processing, the cerebellar anomalies should be of special interest to school psychologists. The cerebellum is traditionally associated with motor timing, motor coordination, dysarthria, and balance, which is consistent with the type of hypotonia, articulation, and motor coordination problems seen in children with Down syndrome (Pinter, Eliez, Schmitt, Capone, & Reiss, 2001). Research during the past decade has increasingly linked the cerebellum to higher-order processing, including executive functioning, reading, sequencing, motor learning, and language (e.g., Brookes & Stirling, 2005; Nicolson, Fawcett, & Dean, 2001; Schmahmann, 2004), which partially accounts for some of the neurocognitive deficits seen in school-age children with Down syndrome.

Adolescence is an important time of change and development in a child’s life. Whereas adolescents with Down syndrome progress through the same stages of development as do normally developing children, their cognitive and behavioral differences can bring special challenges to the adolescent, their family, and the school (Merrick et al., 2004). Physical differences become even more pronounced during adolescence, which can increase the social stigma of Down syndrome. For example, height is reduced by about two standard deviations for adolescents with Down syndrome when compared to their normally developing peers (Merrick et al., 2004). Some of the health problems present in children with Down syndrome are resolved in childhood, and children with Down syndrome may reach adolescence relatively healthy, although they may experience increasing problems with vision, hearing, and infections (Merrick et al., 2004). There are some medical risks that become pronounced during adolescence, such as an increased risk of mitral valve prolapse and complications from sleep apnea (Van Cleve, Cannon, & Cohen, 2006). Another significant concern for adolescents with Down syndrome is obesity. By age 13, females with Down syndrome weigh 133% of her ideal weight, whereas males are 124% of ideal weight. By age 18, these numbers increase to 158% and 144%, respectively (Roizen, 2002). Roizen (2002) advocates decreasing caloric intake (along with vitamin supplements), increasing exercise, and advocating friendships and social and leisure activities as methods of controlling obesity in children with Down syndrome. Following a review of the literature, Merrick et al. listed several recommendations in regards to healthy practice for adolescents with Down syndrome, many of which school psychologists should discuss with parents. These suggestions include annual audiologic exams, discussions of skin care, explanations about the
genetic nature of Down syndrome in regards to having children, and discussions about the need for supervision and counsel in regards to issues related to sexuality, contraception, and routine gynecological care.

Although the discussion of sexuality can be controversial in the schools, Van Dyke, McBrien, and Sherbondy (1995) point out that the cognitive and language deficits with which individuals with Down syndrome present predispose them to unwanted pregnancies, sexually transmitted diseases, and sexual exploitation and abuse. This may be further complicated by the finding that pregnant women with Down syndrome have a 50% chance of having a child who also has the disorder (Van Cleve, Cannon, & Cohen, 2006). Van Cleve, Cannon, and Cohen recommended sexuality education, including counseling for contraception and contraceptive interventions, if appropriate, for adolescents with Down syndrome. This may also include education about appropriately displaying affection, how to refuse inappropriate touching, and how to talk to their parents about inappropriate touching.

Assessment and Intervention

Unlike other childhood disorders with less accurate, or nonexistent, genetic testing, the purpose of psychoeducational assessment for children with Down syndrome is not to provide differential diagnosis for special education placement. Rather, the primary rationale of the assessment process should be to generate intervention strategies based upon the child’s unique profile. Although this is certainly a goal in other conditions of childhood, the deemphasis on diagnosis allows for the selection of measures that primarily focus on exploring strengths and weaknesses, as compared to using rating scales or other assessment tools that aim to compare symptomologies among similar conditions (such as the pervasive developmental disorders). This provides more time, an always-important issue in psychoeducational assessment in the schools, for the use of nontraditional measures, which would be suitable for assessing symptom profiles in children with Down syndrome. This may include standardized measures of sensory-motor functioning, an emphasis on visual-based processing and learning differences, and a more thorough assessment of language.

Cognitive assessment will be a key component of psychoeducational assessment for children with Down syndrome, but practitioners should be wary of instruments that have restricted floors. When tests of cognitive processing are applied to children who have extremely low index scores, psychologists are often unable to generate significant ipsative comparisons because of the flatness of the profile. A child with a flat profile may either truly be exhibiting little spread between cognitive abilities, or the flatness of the profile may be indicative of a limited range of standard scores on the test itself. This is a particularly salient problem for children with Down syndrome given that they tend to demonstrate uneven, although generally low, cognitive profiles. Although children with Down syndrome demonstrate an upward progression in mental age, declines in IQ, as measured by norm-referenced tests, have demonstrated longitudinal declines. Carr (2005) concluded that individuals with Down syndrome show greater declines in crystallized processing than do their peers, although the decline in fluid abilities is less striking. This greater verbal and nonverbal decline into adulthood is consistent with other findings that reveal greater deficits in verbal as opposed to visual processing skills in children with Down syndrome (Carr, 2005). Assessment measures should carefully evaluate verbal memory, visual memory, language, visual-spatial learning and processing, behavior, social skills, adaptive skills, and motor skills.

One of the approaches to designing and implementing individualized interventions for children with Down syndrome is to focus on behavior phenotypes. Fidler (2005) described this approach as, “education and intervention may be effective when it targets the developmental trajectory associated with a particular syndrome. The behavioral phenotype approach is housed within the larger movement of developmental interventions, where programming decisions are informed by developmental theory...” (p. 94). Thus, it is critical that individuals who are responsible for interventions within the schools be familiar with the specific nature of the child’s syndrome, especially in regards to age-related changes and processing strengths and weaknesses. In addition to using evidenced-based interventions and developing interventions specific to the child’s behavioral phenotype and individual neurocognitive pro-
file, it is critical that interventions be timely, which usually means that early intervention is more effective than later intervention. For example, Sanz and Menendez (1996) reported that a 2-month delay in onset of treatment for children with Down syndrome resulted in poorer development of gross and fine motor, language, and social skills. Similarly, Aparicio, and Balana (2002) found that the outcome of language acquisition for children with Down syndrome could be improved if interventions were started earlier.

Language Development

Language development is a significant area of weakness in children with Down syndrome, which is not surprising given that language development has been closely tied to cognitive development. Problems with language development can be seen at young ages with this population; atypical language development has been observed in canonical babbling, vocal imitation, and the production of nonspeech sounds (Fidler, 2005). Receptive language has been shown to be better preserved in comparison to expressive language in children with Down syndrome (Abbeduto et al., 2003). This certainly suggests that educators and parents should be vigilant not to use expressive language, which is more easily observed as a benchmark for receptive language ability. There are differences in the developmental trajectory of receptive language, suggesting that regular reevaluations should include a measure of language functioning. Receptive language ability declines relative to same-aged peers as children with Down syndrome age in regards to syntax comprehension, whereas receptive vocabulary development keeps pace with the child’s nonverbal mental age (Abbeduto et al., 2003). These differences reinforce the necessity of comprehensive language and vocabulary assessments at regular intervals (as opposed to only reassessing cognitive skills).

Fidler (2005) suggested oral dyspraxia be targeted early in speech and language therapy with techniques such as back chaining and prompt fading. Fidler (2005) also recommended that nonverbal communication be used in conjunction with language development to reduce frustration. Nonverbal communication, including sign language and gestures, may actually be preferred over verbal communication in young children with Down syndrome, which may be secondary to their relative strength in visual-spatial skills (e.g., Caselli et al., 1998; Jarrold & Baddeley, 1997). However, parents may be concerned that using signs or gestures will actually impede the development of spoken language. As a counter argument, Clibbens, Powell, and Atkinson (2002) suggested that the use of signing will not only facilitate communication with nonsigners, but will also foster language development.

Verbal Memory

Verbal memory is one of the most commonly reported cognitive deficits from which children with Down syndrome suffer. Using current models of working memory (e.g., Baddeley & Larson, 2007), verbal information is stored and refreshed by rehearsing the information, which wards off forgetting. The more quickly the information can be rehearsed, the less forgetting that will occur, and the more quickly the information can be removed from storage via verbal output, the less degradation will occur (Jarrold, Baddeley, & Hewes, 2000). The role of the phonological loop in verbal memory was investigated by Jarrold et al. (2000), who confirmed children with Down syndrome suffer from short-term verbal memory deficits relative to children with moderate learning difficulties and healthy controls. They also discovered that the children with Down syndrome were not using subvocal rehearsal to aid verbal-short term memory, although they also concluded that these deficits in rehearsal skills are likely not the root cause of the verbal memory deficits. Jarrold et al. noted that subvocal articulatory rehearsal does not generally take place before age 7, and many children with Down syndrome may not reach this verbal mental age, which suggests that some children with Down syndrome are unlikely to develop this important skill. Furthermore, of critical importance to educators, the improvements noted by teaching verbal rehearsal skills are unlikely to be maintained given that children with Down syndrome are unlikely to independently use rehearsal skills, and deficits (Jarrold et al., 2000). Other possible causes for verbal short-term memory deficits in children with Down syndrome include more rapid storage decay, less storage capacity of the
phonological store, encoding deficits, and poor hearing (Jarrold et al., 2000). Therefore, caution is strongly suggested to educators who may be working on improving verbal or subvocal rehearsal strategies for children with Down syndrome to improve verbal short-term memory. Compensatory interventions should include using relative strengths, if present, such as visual memory.

**Motor Development**

The quantitative assessment of simple and complex motor skills is an area that school psychologists often leave to other professions and are not included in many psychoeducational evaluations. For example, Shapiro and Heick (2004) conducted a study that investigated the most commonly used assessment measure with 648 school psychologists. Measures of motor skills were not among the 14 types of assessment methods investigated by the authors. Perceptual-motor tasks were included, which measure construction ability and visual-motor integration, but this is only a small component of the many types of motor functioning that can impede academic and social development. The noninclusion of motor assessment devices by school psychologists represents a significant oversight given that children with Down syndrome can display different types of motor problems that a simple qualitative evaluation of fine or gross motor skills will not encapsulate. For example, although much of the literature relates motor development problems in children with Down syndrome to hypertonia and hyperflexia, there is also evidence of motor planning, coordination, and motor organization deficits (Fidler, Hepburn, & Rogers, 2006), all of which should be assessed. School psychologists who are not familiar or comfortable with neuropsychological assessment batteries that assess these skills may wish to consider the relatively new **Dean Woodcock Sensory-Motor Battery** (Dean & Woodcock, 2003), which is easy to learn to administer and can generally be completed in about 30 to 45 minutes.

Motor interventions, such as occupational and physical therapy, are common for children with Down syndrome, although some researchers have doubted the effectiveness of widely used techniques. Virji-Babul, Kerns, Zhou, Kapur, and Shiffrrar (2006) wrote, “The focus of many early intervention programs continues to be on facilitating motor skills within the confines of typical developmental trajectories without considering the broader context of functional motor behavior” (p. 74). An example of this is muscle tone, which may be one of the focuses of motor interventions, but when examined and treated in isolation bears little relationship to the use of muscle tone in activities such as standing or walking (Virji-Baibil et al., 2006). Another problem with traditional motor interventions may be related to the lack of parental involvement. Mahoney, Robinson, and Fewell (2001) tracked the progress of a group of children with Down syndrome who were being treated with motor interventions. They reported that, although children made improvements over the course of one year, there was not evidence that the improvement was based on anything other than maturation. Regarding the same study, Mahoney and Perales (2006) reported that parents were only present in an average of 57% of the sessions and were given less than two suggestions a month from the providers of the motor intervention. They also concluded that the intervention had no effect on parent–child interactions and parents were largely not viewed as participants in the therapy.

Mahoney and Perales (2006) proposed that the lack of parental involvement in early motor interventions is one of the reasons why contemporary motor interventions are not successful for children with Down syndrome. Parents have significantly more opportunities to work with their children on motor and other developmental skills than do school-based therapists; if a child were scheduled for motor therapy once per week, parents would have 200,000 more interactions with their child than would the motor therapist (Mahoney & Perales, 2006). To increase parental involvement in motor therapy, Mahoney and Perales recommended the work of Ulrich, Ulrich, Angulu-Kinzler, and Yun, (2001). These researchers noted that infants with Down syndrome learn to walk about one year later than their same-aged peers and were interested to see if home-based parental training could augment traditional motor therapy. In this study, parents were taught to help their infants with Down syndrome learn to walk by using a miniature treadmill for only eight minutes each day, whereas a control group did not receive any at-home instruction. The group of children who received treadmill training learned to walk
with help 73.8 days sooner than the control group, and they learned to walk independently 101 days sooner than the control group. This study highlights the importance of parental involvement in motor therapy given that they only provide 8 minutes of daily intervention, and suggests that parental involvement may need to be considered in other modalities of therapy.

**Visual-Spatial Processing**

Interestingly, despite the global delay and mental retardation exhibited by many children with Down syndrome, visual-spatial processing abilities tend to be relatively spared, along with the associated areas of the brain (Pinter, Eliez, et al., 2001). Fidler (2005) noted that children with Down syndrome display variations within visual-spatial processing, including strengths in visual memory, visual-motor integration, and visual imitation. This certainly suggests that school psychologists and other educators should draw upon these visual-spatial skills for strength-based accommodations. School psychologists should also be vigilant that psychoeducational assessment evaluate multiple conditions of visual processing, not only visual-motor integration.

Although learning how to read is usually associated with language ability, especially when using the phonetic approach, children with ipsative strengths in visual processing (like those with Down syndrome) may benefit from a visual processing-based sight-word approach to reading. Based on a study of visual processing and word identification, Fidler, Most, and Guiberson (2005) postulated that children with Down syndrome rely upon the visual components of letters to recognize words. Although learning sight-words does not readily allow for the acquisition of new words and generalization of learned skills to new words (such as in a phonics approach), learning sight words can be an excellent way to learn functional words for children with Down syndrome to increase their ability to function more independently in their communities. Additionally, Fidler, Most, and Guiberson (2005) noted that using a whole-word approach to teaching reading, as opposed to a phonological-based model, would alleviate demand on short-term auditory memory, which is an area found to be impaired in children with Down syndrome. However, there is little evidence-based data to support this suggestion.

**Social and Behavioral Development**

When compared to other groups of children with neurodevelopmental disorders, social and behavioral development is an area of strength for many children with Down syndrome. Indeed, children with Down syndrome are viewed by their parents as more joyful and possessing more social competence than are children with mental retardation with an unknown etiology or Williams or Prader-Willi Syndrome (Rosner, Hodapp, Fidler, Sagun, & Dykens, 2004). Children with Down syndrome also demonstrate less frequent and severe behavior problems when compared to other children with genetic disorders and mental retardation (Dykens & Kasari, 1997). However, it is important to note that, when compared to their normally developing peers, children with Down syndrome are still at risk for behavior problems, including disobedience and stubbornness (Dykens, Shah, Sagun, Beck, & King, 2002). When compared to normal developing peers, children with Down syndrome have a more limited repertoire of play, engage in more stereotypic and repetitive acts during play, and are less likely to initiate play (Hines & Bennett, 1996). As individuals with Down syndrome age, they are at risk for the behavioral and psychiatric problems that are present in patients with Alzheimer’s disorder. This includes problems with agitation, depression, anger, and other personality changes.

Errorless compliance training is an intervention that can easily be conducted in the schools for behavior problems in children with Down syndrome. Ducharme and DiAdamo (2005) used this technique with two 5-year old girls with Down syndrome who had a history of noncompliance. Ducharme and DiAdamo described errorless compliance training by writing: “Noncompliant responses are treated like errors. Such responses are minimized at the beginning of treatment through parent delivery of requests that are easy to follow and are associated with high rates of compliance. More demanding requests are introduced gradually over several weeks, with parent reinforcement for child compliance. Because of the graduated nature of intervention, noncompliance is minimized through treatment, rendering reductive consequences unnecessary to suppress oppositional responses” (p. 108). The authors followed
this program using a multiple baseline approach, and found significant improvements in classroom compliance in both subjects. The results from this study are encouraging considering this approach avoids the type of aversive behavioral management that is commonly used in the classroom (Ducharme & DiAdamo, 2005).

**Hearing Loss**

Developmental differences have been noted in the auditory brain-stem responses, cochlear functioning, and anomalies in ear, nose, and throat development in children with Down syndrome, which are associated with ear infections and early hearing loss (Shott, 2006). Otitis media (i.e., inner-ear infection) and hearing loss, even mild, have been associated with problems with language and speech development, which are both common problems in children with Down syndrome. Roberts et al. (2007) reported that children with Down syndrome are more vulnerable to future language problems because of otitis media associated hearing problems. One obvious intervention for hearing loss is amplification. Bennetts and Flynn (2002) investigated the effects of 10dBA sound-field amplification on the speech perception of four children with Down syndrome in the classroom. The authors discovered that this intervention had a positive impact on the children’s speech perception and ability to understand their teachers. The power of the findings are increased when it is considered that the children only had mild hearing loss, suggesting that the benefits would be even greater for children with Down syndrome who had increased hearing loss (Bennetts & Flynn). Given that many children with Down syndrome may also have attention problems, increasing the volume of the teacher’s voice may also facilitate attention considering background noise is often present in classrooms.

**Reading Acquisition**

When parents and teachers are faced with the neurocognitive deficits expressed by many children with Down syndrome, learning to read even single, functional words may not seem to be a realistic goal. Although the above-described visually based reading approaches may hold promise, there has been debate in the literature about whether children with Down syndrome can benefit from interventions in phonological awareness, an important predictor of reading ability. However, many studies have shown that learning to read and teaching phonological awareness should remain an academic priority for many children with Down syndrome (e.g., Cupples & Iacono, 2000; Fletcher & Buckley, 2002). Byrne, MacDonald, and Buckley (2002) followed the longitudinal progress of children with Down syndrome over a 2-year period. The children were able to make significant advances in their ability to read single words, although their reading comprehension skills grew at a slower rate. The differences between single word reading and comprehension may be because of the overreliance on processing the visual, as opposed to the phonological, aspects of words. Based on their results, the authors argued that teaching children with Down syndrome to read can start when other children learn to read; it is not necessary to wait for their other cognitive skills to progress. Despite their relative strength in visual processing, research has also demonstrated that children with Down syndrome can benefit from instruction in phonological awareness in regards to reading. Kennedy and Flynn (2003) conducted a multiple baseline across behaviors intervention study in a phonological awareness intervention study. A 1-week, three-session baseline of testing was conducted, followed by eight 1-hr sessions in a 4-week period, concluded by a 1-week, three-session posttesting session. The goals of the intervention study were to teach alliteration detection, initial-phoneme isolation, spelling, and recognition of rhyme across words. Following the intervention, Kennedy and Flynn (2003) noted improvements in phonological awareness, including improvement in the grapheme-phoneme connection. Although only three subjects were used in this study, the rigorous methodology and short-time period of the intervention suggest that children with Down syndrome can indeed improve their phonological awareness skills, which is an important predictor in reading ability.

**Inclusion**

It is a generally accepted truism that “mainstreaming,” “inclusion,” or attempts to include children with disabilities (including Down syn-
drome) in a regular education classroom will benefit children’s social and emotional development given that they will have access to appropriately behaving role models and friends (e.g., Cuckle & Wilson, 2002). Buckley, Bird, Sacks, and Archer (2006) reported the results of survey studies conducted in 1987 and 1999 with children with Down syndrome who were either placed in mainstream or “special schools” based upon where they lived. The authors estimated the children should be of equal cognitive potential when they started school. They reported children with Down syndrome in mainstream schools had language skills 2 years and 6 months ahead of the children in “special schools.” Seventy-eight percent of teenagers in mainstream schools were rated as being “intelligible” to strangers, compared with only 56% (and 42% in the 1987 study) of teenagers in “special schools.” Additionally, there was more than a 3-year superiority in reading and writing skills for the group in mainstream schools. The authors concluded that teenagers with Down syndrome greatly benefit from being in mainstream classrooms in the areas of expressive language, speech, behavior, social development, and academic skills.

**Medicinal and Nutritional Interventions**

Nutritional supplements have long been a popular treatment for children with Down syndrome who may be seeking alternative therapies. Roizen (2005) reported that nutritional supplements first gained popularity in the 1960s for treating Down syndrome after Dr. Henry Turkel promoted the “U series of drugs,” which contained ingredients such as bone meal, thyroid globulin, and organic iodine. Although he claimed that this combination would increase intelligence and improve the appearance of children with Down syndrome, subsequent scientific research failed to back this claim. Since that time, other formulas and combinations of supplements have been promoted, some in the media and others in scientific journals. Salman (2002) conducted an extensive analysis of published studies regarding the use drugs, vitamins, and minerals to treat the cognitive problems associated with Down syndrome. He found only 11 published studies that met the scientific rigor associated with most modern drug studies. Out of these studies, he reported that there was no scientific evidence that the drugs, vitamins, and/or minerals offered any improvement in the cognitive and psychomotor problems associated with Down syndrome. Based on his results Salman advocated that parents be discouraged from trying what he called miracle drugs.

For example, Piracetam, purported to improve cognitive functioning in several disorders, is a drug that has received attention for its possible use in improving cognition in Down syndrome (Roizen, 2005). To investigate the effectiveness of Piracetam, Lobaugh et al., (2001) conducted a randomized, double blind, placebo controlled study with 25 children with Down syndrome who received either Piracetam or a placebo. After a 4-week treatment with Piracetam, children did not improve in attention, learning, or memory. However, they did exhibit several adverse side effects that are often associated with stimulants, such as aggression, irritability, sexual arousal, poor sleep, and decreased appetite. This study certainly suggests that parents should exercise extreme caution before giving Piracetam to their children with Down syndrome, despite anecdotal evidence.

By comparison, donepezil and galantamine are both acetylcholinesterase inhibitors, which work to inhibit the breakdown of acetylcholine, a neurotransmitter that may be important in memory and cognition. Although these types of drugs are typically used in older individuals suffering from dementia, some promising research has shown that acetylcholinesterase inhibitors may improve memory and language in children with Down syndrome (Spiridigliozzi et al., 2007). Although this is new research and the sample size was relatively small (i.e., 7), this line of research could hold tremendous potential for children with Down syndrome. Other areas of research for alternative treatments of Down syndrome that may need further investigation include antiamyloid strategies (associated with senile plaque formation in Alzheimer’s disease) and antioxidant therapy (trying to prevent cell damage; Roizen, 2005).

**Need for Evidence-Based Interventions**

Down syndrome is one of the most common and well-researched neurodevelopmental genetic disorders and is the leading cause of genetic-based mental retardation. School psychol-
ogists and other educators may not have traditionally thought of children with Down syndrome as a high-need group in regards to psychoeducational assessment. However, this group of children does tend to present with great variations in cognitive ability and ipsative processing differences are salient. Considering that one of the goals of psychoeducational assessment for children with Down syndrome is to inform intervention, it is critical to use the assessment data to tailor specific interventions to each child. However, despite the cognitive, behavioral, social, and medical problems displayed by children with Down syndrome, the amount of sound empirically researched evidence-based interventions remain relatively scarce. Additionally, many of the evidence-based interventions for children with Down syndrome, including some in this manuscript, suffer from small sample sizes and may be difficult to replicate in the classroom. This is a significant oversight considering children with Down syndrome are often educated in mainstream schools where the support staff needed to implement evidence-based interventions is in place. More research is needed in the area of evidence-based interventions in the classroom for children with Down syndrome, especially as the movement toward Response to Intervention (RTI) proceeds.

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