School Function in Students With Down Syndrome

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MeSH TERMS
- cognition
- Down syndrome
- education of intellectually disabled
- executive function
- motor activity
- task performance and analysis

People with Down syndrome (DS) are predisposed to specific areas of relative developmental strength and challenge, but it is unclear whether and how this profile affects participation in school and community settings. In this study we characterized the nature of school participation and performance of functional tasks in the school context for 26 elementary students with DS (mean age = 7.86 yr; standard deviation = 1.75). Students participated in assessments of cognitive status and language development. Their teachers completed the School Function Assessment (Coster, Deeney, Haltiwanger, & Haley, 1998) questionnaire and a standardized questionnaire on executive functioning (EF). Students demonstrated a pronounced pattern of assistance- and adaptation-related needs across various domains of school function. The strongest predictor of school function was EF skills, as reported by teachers (adjusted $R^2 = .47$, $p = .003$). Findings from this study should inform future intervention and school-related planning for elementary school students with DS.

Daunhauer, L. A., Fidler, D. J., & Will, E. (2014). School function in students with Down syndrome. *American Journal of Occupational Therapy, 68,* 167–176. http://dx.doi.org/10.5014/ajot.2014.009274

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Over the past decade, calls have increased for improving quality-of-life outcomes for people with Down syndrome (DS), the most common neurogenetic cause of intellectual disability with a prevalence of 1 in 732 live births (Canfield et al., 2006). DS has been linked with intellectual disability in the scientific literature for more than 150 yr and has been studied by developmental researchers for decades (see Daunhauer & Fidler, 2011, for a review). Yet, few comprehensive behavioral intervention studies have aimed at promoting participation and adaptation in home and school environments for people with DS. In fact, little is currently known about the nature of school function in students with DS. Understanding the nature of school function in students with DS is critical so that targeted, evidence-based intervention can be developed to promote optimal outcomes in this population.

Most people with DS experience mild to moderate intellectual disability (IQs ranging from 40 to 70; Hodapp, Evans, & Gray, 1999). However, as in many other neurogenetic syndromes, outcomes associated with DS are more complex than global delayed cognitive development. Several decades of research indicate that DS predisposes people to a specific phenotypic pattern of relative strengths and challenges in various areas of development that are likely related to atypical constraints on neurodevelopment (for a review, see Dykens, 1995; Dykens, Hodapp, & Finucane, 2000; Hodapp & Dykens, 1994; Nadel, 2003). In DS, this pattern includes relative strengths or mental age (MA)–appropriate performance in the areas of receptive language, some aspects of socioemotional functioning, and visual processing and relative challenges in expressive language, motor development, and verbal processing (see Daunhauer & Fidler, 2011, for a review). Additionally, pertinent to school function, evidence indicates that challenges performing daily living skills (Daunhauer, 2011) and specific challenges in aspects of executive functioning (EF; Daunhauer & Fidler,

2013; Lee et al., 2011; Rowe, Lavender, & Turk, 2006) contribute to this phenotypic profile. It is unclear whether and how specific areas of challenge may affect school function for students with DS.

Identifying and understanding patterns of school function in DS and other neurogenetic disorders may be critical because effective engagement in functional school tasks serves as a foundation for further academic instruction. *School function* involves "a student's ability to perform important functional activities that support or enable participation in the academic and related social aspects of an educational program" (Coster, Deeney, Haltiwanger, & Haley, 1998, p. 2). Examples of school function abilities include using school-related materials appropriately (such as writing tools and books), the ability to move around the school environment, the ability to manage self-care and personal needs, and requesting assistance when needed (Coster et al., 1998). A distinction is made between school function and the academic aspects of schooling, which involve class instruction and homework assignments focused on acquisition of knowledge in specific content areas such as reading, mathematics, and science (Coster et al., 1998). With foundational school function skills, students are able to engage in academic-related activities without the need for assistance or accommodations.

Existing research on students with other disabilities has shown that specific areas of developmental functioning may be foundational for optimal function in the school environment. For example, Leung, Chan, Chung, and Pang (2011) reported that social, motor, and attentional factors significantly predicted school participation outcomes in 5-yr-old Chinese students with heterogeneous developmental disabilities. The combination of these variables accounted for approximately 35% of the variance in scores on the Chinese versions of the School Function Assessment (SFA; Coster et al., 1998) and the Vineland Adaptive Behavior Scales (Wu, Chang, Lu, & Chiu, 2004). In another study, Zingerevich and LaVesser (2009) examined the relationship between school function (as measured by the SFA) and both sensory processing (as measured by the Sensory Profile; Dunn, 1999) and EF (as measured by the Behavior Rating Inventory of Executive Function [BRIEF]; Gioia, Espy, & Isquith, 2003) in a group of 24 children with autism spectrum disorders. Zingerevich and LaVesser (2009) found a strong association between EF and participation in school activities even when controlling for the effects of sensory processing dysfunction in this sample. Similarly, other researchers (e.g., McClelland, Morrison, & Holmes, 2000) who have examined children with typical development or children at risk for developmental delays have also reported a relationship between EF and functional performance in the school context.

Thus, various domains have been linked to school function in children with different disabilities, and existing work in this area suggests that an array of domains may be critical to school function in different disability groups. In one of the only existing studies of school function in DS, Wuang and Su (2011) found moderate correlations (*r*s between .31 and .33) between participation scores on the School Function Assessment–Chinese version (SFA–C) and IQ as measured by the Wechsler Intelligence Scale for Children—Third Edition (WISC–III; Wechsler, 1991) composite score. Associations between SFA–C participation and sensory processing (Sensory Profile; *r*s between .38 and .40) and with a standardized measure of visual perception (*r*s between .17 and .40) were similar in magnitude. No measure of EF was reported in the Wuang and Su (2011) study; it therefore remains unclear whether the strong relationship between EF skills and school function reported in the Zingerevich and LaVesser (2009) and McClelland et al. (2000) studies is observed in students with DS as well. Examining how EF relates to school function in students with DS is important given the evidence supporting specific challenges associated with EF in the DS phenotype (e.g., Lee et al., 2011).

At present, little descriptive work has been conducted to examine the specific school function profile associated with DS. Although more extensive work has been conducted on the various developmental and behavioral components of the DS phenotypic profile, it is not yet known how these patterns of strength and challenge influence the foundations necessary for participation or engagement in various contexts (classroom, playground–recess, transportation, bathroom–toileting, transitions, and meal–snack time) in the school environment. Therefore, in this study, we examined the profile of school-based function (participation, use of task supports, and activity performance) in a sample of school-age children with DS. We also characterized the extent to which task supports were used in the domains of physical activity and cognitive–behavioral tasks for students with DS in this sample. In addition, we examined the predictors of within-DS variability in school function by examining the relationship between IQ scores, language functioning, EF, and school functioning composite measures. As such, this study presents the first set of descriptive findings related to school function for students with DS in the United States.

Method

Research Design

This study used both descriptive and correlational methods to examine the profile of school-based function in a sample of children with DS. The study was conducted with institutional review board approval at Colorado State University. Participants were a subset from a larger research study funded by the National Institute of Disability and Rehabilitation Research (H133G100197) and the Institute of Educational Science, U.S. Department of Education (R324A110136).

Participants

Participants were elementary school–aged students with a confirmed diagnosis of DS and their teachers. They were accepted into the study on the basis of the following inclusion criteria: (1) an SFA by their primary teacher; (2) chronological age as determined by developmental assessment within the normative sample age range for the SFA, which is kindergarten through sixth grade; (3) no history of traumatic events such as a head injury; (4) no medical–genetic conditions beyond those associated with DS; and (5) absence of a diagnosis of a co-occurring autism spectrum disorder as reported by the parents.

Participants were recruited using convenience sampling through the Rocky Mountain Down Syndrome Association; the Poudre School District in Fort Collins, CO; and JFK Partners, a University Center of Excellence in Developmental Disabilities at the University of Colorado–Denver. Parents of child participants provided written consent prior to completing any measures. We also obtained consent from parents to contact their child's primary teacher (regular or special educator), from whom consent was also obtained. Children provided assent for participating in developmental measures.

Measures

Leiter International Performance Scale–Revised. Experienced researchers administered the Leiter International Performance Scale–Revised Brief IQ composite (Leiter–R; Roid & Miller, 1997) to child participants to assess overall nonverbal MA. The Brief IQ composite score on the Leiter–R is derived from four domains: Figure Ground, Form Completion, Sequential Order, and Repeated Patterns. The Leiter–R is well suited for assessing children with DS, because procedures allow for correct nonverbal responses from the participant and expressive language demands are minimized. The Leiter–R also involves minimal verbal instruction from the examiner. Therefore, confounds of language delays were minimized in the assessment of overall nonverbal IQ in this study. The Leiter–R has been standardized on a national sample, and adequate concurrent validity has been reported with the WISC–III Full Scale and Performance IQ (r = .85). High test–retest reliability has also been reported (rs = .80s–.90s). Nonverbal MA was estimated using the MA composite scores obtained for each participant.

Oral and Written Language Scales. The Oral and Written Language Scales (OWLS; Carrow-Woolfolk, 1995) comprise three scales—Listening Comprehension, Oral Expression, and Written Expression—and is used as an individual assessment of oral and written language abilities in young people ages 3 yr–21 yr. The OWLS was standardized across all age groups in a nationwide sample of 1,985 participants (Carrow-Woolfolk, 1995). It is reported to be valid and reliable with adequate test–retest reliability (rs ranging from .73–.89) and high interrater reliability (rs = .90–.99). We used the Listening Comprehension and Oral Expression subscales to assess receptive and expressive language abilities for each participant. The Listening Comprehension and Oral Expression subscales were combined to form a composite score of overall language functioning.

Behavior Rating Inventory of Executive Function—Preschool version. Teachers were asked to report the participants' EF in the classroom context using the BRIEF–Preschool version (BRIEF–P; Gioia et al., 2003). We used the preschool version rather than the school-age version of the BRIEF because it was a more developmentally appropriate assessment of everyday EF for our sample. The BRIEF–P is a 63-item assessment of a child's behaviors rated on a 3-point Likert scale of how frequently the child engages in a specific behavior (*never*, *sometimes*, or *often*). Higher scores on the BRIEF–P denote greater levels of EF impairment. The BRIEF–P has been normed on a sample of 460 children from age 2 yr 0 mo–5 yr 11 mo. It comprises five clinical scales, three indexes, and a global executive composite. Gioia et al. (2003) reported adequate internal consistency (ranging from .80 to .97) and adequate test–retest reliability (.65–.94 for teachers).

School Function Assessment. Teachers were asked to report on the participants' functional performance in the school context using the SFA (see Table 1 for domains and scoring details). The SFA comprises three domains: (1) Participation, (2) Task Supports, and (3) Activity Performance. Part 1, Participation, evaluates the level at which students participate in six settings within the

Table 1. School Function Assessment: Domains and Scoring

Part	Domain	Scale	Content	Likert Ratings
1	Participation	1	6 school environments: classroom (regular or special education), playground, transportation, bathroom, transitions, mealtime	6-point rating; 1(*participation extremely limited*) to 6 (*full participation*)
2	Task Supports	3	Amount of assistance and adaptation given for physical tasks, cognitive–behavioral tasks, and optional tasks	4-point rating for both assistance and adaptation; 1 (*extensive assistance–adaptation*) to 4 (*no assistance–adaptation*)
3	Activity Performance	21	Functional tasks that are physical and cognitive–behavioral	4-point rating; 1 (*does not perform*) to 4 (*consistent performance*)

school context (e.g., classroom and playground). Task Supports, Part 2, examines the amount of assistance or help from an adult and adaptations (modifications) that are currently made available to the student during key functional tasks (e.g., remembering the teacher's instructions). Activity Performance, Part 3, assesses a student's consistency in performing specific physical and cognitive tasks (e.g., carrying lunch tray).

The SFA was standardized on a population of more than 300 students with various disabilities attending kindergarten through sixth grade across 112 different sites in the United States using Rasch item response theory methodology. The SFA has demonstrated content and construct validity (Coster et al., 1998). It also has adequate test–retest reliability ($rs \geq .82$–$.98$) and interrater reliability ($r > .63$; Coster et al., 1998; Davies, Soon, Young, & Clausen-Yamaki, 2004). Authors also reported adequate content and construct validity measured across multiple studies with disability-related service professionals (Coster et al., 1998; Hwang, Davies, Taylor, & Gavin, 2002).

Items in each domain are scored on a Likert scale; lower numbers indicate less developmentally competent behavior, and higher numbers indicate more developmentally competent behavior. Scores from each domain are summed to obtain raw scores and then converted to composite criterion scores. Criterion cutoff scores are used for comparison on each domain to evaluate a student's performance in relation to his or her typically performing peers. A teacher rates all items based on actual observation of the student's classroom performance.

Data Analyses

We obtained scores for use in analyses from each measure as follows. The Brief IQ composite score on the Leiter–R was derived from four domains: Figure Ground, Form Completion, Sequential Order, and Repeated Patterns. Nonverbal MA was estimated using the MA composite scores obtained for each participant. To obtain BRIEF–P scores for analyses, the raw scores from each of the five clinical scales (Inhibit, Shift, Emotional Control, Working Memory, and Plan–Organize) were summed to form the global EF composite. Raw scores from each of the scales–indexes were converted to age- and gender-referenced normative T scores. On the BRIEF–P, T scores ≥65 are suggestive of clinical significance. Because children with DS show a discrepancy between their chronological age and MA, T scores were calculated using the child's nonverbal MA (not chronological age), as measured by the Leiter–R Brief IQ subtests (see Lee et al., 2011). For the SFA, raw scores for Parts 1–3 were transformed into criterion scores on a scale of 0–100. To describe the results and examine within-group variability, we calculated both the mean (*M*) and standard deviation (*SD*) for each criterion score. For the regression determining predictors of school function, we used the overall criterion score from Part 1, Participation.

Results

Participant Characteristics

Twenty-nine students with DS were enrolled in the study; 3 were withdrawn from these analyses because of missing data required to calculate scores for the SFA. Therefore, the final sample size was 26 school-age children with DS who were, on average, age 7.86 yr (*SD* = 1.75 yr; see Table 2 for more information regarding participant

Table 2. Demographic Information

Variable	Mean (*SD*)
Chronological age, mo	94.35 (20.98)
Chronological age, yr	7.86 (1.75)
MA, mo (n = 25)	47.88 (9.65)
Language age, mo	33.96 (12.70)
Mother's age, yr	43.08 (6.97)
Father's age, yr	45.08 (8.26)

	n	%
Gender, male	20	76.92
Race (n = 22)		
Black	0	0
White	20	90.91
Hispanic	1	4.55
Unknown or unreported	1	4.55

Note. MA = mental age; *SD* = standard deviation.

demographics). Most students (68.2%) were educated in public elementary schools (see Table 3 for school characteristics). The remaining students were educated in a combination of home-based and private special educational settings. For the students educated in public school settings, approximately half were primarily educated through inclusion in regular education classroom settings, and the other half were primarily educated in special education classroom settings.

Data on specific supports received at the time of assessment were available for 21 student participants. A majority of these students were receiving adult aide supports (57.1%, $n = 12$), occupational therapy (81.0%, $n = 17$), and speech therapy (81.0%, $n = 17$) in their school setting. Only 1 participant (4.8%) received physical therapy services at school.

Participation and School Function in DS

Criterion scores for the SFA were available for all 26 participants. We examined all domains (Participation, Task Supports, and Activity Performance) to identify areas of relative strength and challenge within the educational context (see Table 4). According to Coster et al. (1998), a criterion score of 100 represents full, grade-appropriate functioning in a specific domain. The average overall composite Participation criterion score in this sample of students with DS was 61.9 ($SD = 14.7$).

The degree of assistance and adaptation necessary for participating in both physical tasks and cognitive–behavioral tasks was also analyzed using criterion scores (see Table 4). Lower scores represent the need for more frequent, extensive, and individualized help or modifications for student task performance in the relevant subdomain, whereas higher scores suggest that the supports received by the student are similar to those received by mainstreamed grade-level peers with various disabilities (Coster et al., 1998). A repeated-measures analysis of variance was conducted with the four criterion scores for assistance and adaptation scores for both physical tasks and cognitive–behavioral tasks. Results demonstrated significant within-group differences across these four dimensions, $F(3, 69) = 19.84$, $p = .0001$.

Post hoc paired t tests demonstrated that students with DS were reported to need more assistance than adaptations on Task Supports. In particular, students with DS were reported to require more assistance than

Table 3. School Characteristics ($N = 19$)

Characteristic	*n* (%)
School type ($N = 22$)	
Public elementary	15 (68)
Private special day care	1 (5)
Independent	1 (5)
Private special residence	1 (5)
Other	4 (18)
Classroom setting ($N = 19$)	
Regular education	9 (47)
Special education	10 (53)
Total	19 (100)
Classroom services ($N = 21$)	
Regular education	16 (76)
Special education	16 (76)
Adult aide	12 (57)
Academic support	12 (57)
Occupational therapy	17 (81)
Physical therapy	1 (5)
Speech	17 (81)
Medical assistance	1 (5)
Other (adaptive physical education)	1 (5)

Note. Individual students received more than one type of classroom services.

Table 4. School Function Assessment (SFA) Criterion Scores by Domain

SFA Domain and Areas	Criterion Score, *M (SD)*
Part 1: Participation	
Regular education or special education	61.9 (14.7)
Part 2: Task Supports	
Physical task assistance	58.8 (16.9)
Physical task adaptation	74.1 (17.2)
Cognitive–behavioral task assistance	38.6 (20.7)
Cognitive–behavioral task adaptation	53.1 (22.0)
Part 3: Activity Performance	
Activity Performance–Physical Tasks	
Travel	78.4 (13.7)
Maintaining and changing position	78.4 (13.9)
Recreational movement	59.0 (14.2)
Manipulation with movement	73.3 (16.1)
Using materials	61.0 (14.1)
Setup and cleanup	70.3 (15.2)
Eating and drinking	71.3 (17.9)
Hygiene	67.6 (15.0)
Clothing management	63.4 (12.4)
Up–down stairs	76.9 (19.2)
Written work	38.2 (24.7)
Computer and equipment use	52.4 (19.5)
Activity Performance–Cognitive–Behavioral Tasks	
Functional communication	52.5 (19.4)
Memory and understanding	66.3 (14.8)
Following social conventions	51.7 (15.8)
Compliance with adult directives and school rules	57.1 (17.2)
Task behavior–completion	51.4 (15.2)
Positive interaction	53.8 (15.7)
Behavior regulation	50.5 (18.2)
Personal care awareness	58.3 (17.7)
Safety	49.4 (17.8)

Note. On the SFA, a criterion score of 100 is considered full grade-appropriate functioning in a specific domain. M = mean; SD = standard deviation.

adaptations on both physical tasks, $t(23) = 3.92$, $p = .001$, and cognitive–behavioral tasks, $t(24) = 2.97$, $p = .007$. Additional post hoc comparisons suggested that students with DS in this sample used higher levels of assistance on cognitive–behavioral tasks than physical tasks, $t(23) = 6.31$, $p = .0001$. A similar pattern was observed for cross-domain comparison of adaptation levels; higher levels of adaptation were observed on cognitive–behavioral tasks than physical tasks, $t(24) = 4.95$, $p = .0001$. With a mean criterion score of 38.6, assistance on cognitive–behavioral tasks was the subdomain in which the participants were reported to require the most assistance.

Activity Performance

Students with DS in this sample demonstrated their strongest mean Activity Performance (mean criterion scores >70) in the areas of travel, maintaining and changing position, manipulation with movement, setup and cleanup, eating and drinking, and up–down stairs (see Table 4). Students with DS demonstrated a moderate level of challenge (mean criterion scores between 60 and 69) in several areas as well, including using materials, clothing management, hygiene, and memory and understanding. Areas of greatest challenge (mean criterion scores <60) included recreational movement, computer and equipment use, following social conventions, functional communication, compliance with adult directives and school rules, personal care awareness, task behavior–completion, positive interaction, safety, behavior regulation, and written work.

Predicting Overall School Function

Multiple linear regression was used to estimate the magnitude of the relationship between various developmental domains and overall Participation composite criterion scores. School function composite criterion scores were regressed on Leiter–R Brief IQ age-equivalent scores, OWLS composite language age-equivalent scores, and teacher-reported global EF T scores. The adjusted R^2 was .68 for this equation, $F(3, 17) = 6.89$, $p = .003$ with global executive composite on the teacher-reported BRIEF–P emerging as the sole statistically significant predictor of the model.

Discussion

In this study, we were among the first to examine the nature of school function in a sample of elementary school students with DS. DS is the most common neurogenetic cause of intellectual disability, yet relatively little is known regarding the critical area of school function in this population. The majority of the students with DS in this study were educated in public elementary schools in the United States, and half were educated primarily in regular education settings. Findings from this study suggest that, rather than showing an overall flat profile of general difficulty, elementary school students with DS showed a distinct pattern of strengths and challenges in the area of school function. The complex profile demonstrated may inform school-based education planning and intervention in this population.

Strengths and Challenges Related to SFA Task Supports and Activity Performance

On average, students with DS in our study demonstrated within-group strengths and challenges in both Task Supports and Activity Performance. The students with DS were reported by their teachers to need less assistance and adaptations for physical tasks than for cognitive–behavioral tasks. The students' decreased need for both assistance and adaptations for the SFA's Task Supports–Physical Tasks domain, as opposed to Task Supports–Cognitive–Behavioral Tasks domain, also corresponded with their more competent abilities in the SFA Activity Performance–Physical Tasks domain. Areas in the Activity Performance–Physical Tasks domain such as maintaining and changing position ("Maintains adequate posture to complete seat work and throughout all required classroom activities"), travel ("Enters room and takes seat/place without bumping into obstacles/people"), eating and drinking ("Brings food from plate/container to mouth using fork or spoon"), and up–down stairs ("Walks/moves up and down stairs at regular speed when carrying an object") were among the areas in which students with DS earned the highest criterion scores on the SFA.

Children with DS have been reported to have delays in physical and gross motor development (e.g., de Campos, Rocha, & Savelsbergh, 2009; Jobling, 1999) and functional activities with physical–gross motor demands (Dolva, Coster, & Lilja, 2004). However, the findings from this study appear to be congruent with those of Palisano et al. (2001), who noted that, despite delays, children with DS show competence in areas of gross motor development once milestones have been reached. Participants' reported performance in physical tasks under both the Task Supports and Activity Performance domains for this study are a relative strength as opposed to performance of cognitive–behavioral tasks under the same domains. Nonetheless, compared with Coster et al.'s (1998) SFA standardization, this sample still performed below indicated chronological age–appropriate performance (criterion scores of 100).

Teachers reported that participants had moderate challenge with the SFA's Activity Performance in several physical tasks areas (for the purpose of this study we considered criterion scores of 60–69 to indicate moderate challenges in activity performance). Some of these areas related to self-care skills, such as hygiene ("Wipes nose," "Cares for toileting needs in timely fashion to avoid wetting") and clothing management ("Removes pullover garment top," "Secures shoes by tying or using Velcro"). Other moderate areas of difficulty were related to Activity Performance–Cognitive–Behavioral Tasks, such as memory and understanding ("Demonstrates memory for where materials belong," "Demonstrates understanding of two-step directions or instructions") and using materials ("Spreads paste or glue on paper and places another paper on top to stick," "Inserts paper into folder pocket"). Both of these areas draw on EF skills, including working memory and planning skills—areas that have been documented as areas of pronounced challenge in everyday living for children with DS (Daunhauer, et al., in press; Lee et al., 2011).

The areas in which teachers reported children demonstrated the greatest challenges (criterion scores <60) are, of course, of greatest significance for both practice and intervention planning. First, it is notable that one of the lowest criterion scores earned overall in this sample of students with DS was in the area of safety. The SFA's Activity Performance–Cognitive–Behavioral Tasks safety area includes items such as, "Keeps unsafe objects out of mouth," "Identifies an accident or emergency situation and reports it to a teacher or adult," and "Recognizes dangerous areas and situations and adjusts behavior accordingly." These results highlighting safety issues for students with DS are in line with parent-reported behavior of 5-yr-old children with DS using the Pediatric Evaluation of Disability Inventory (Dolva et al., 2004), a measure of functional performance in everyday life. It is clear that improving safety-related behaviors and facilitating increased competence and awareness in the area of safety management will be a fundamentally critical target for improving school function in DS. Dolva, Lilja, and Hemmingsson (2007) also reported that concerns regarding safety may be persistent for children with DS. At a follow-up at age 7 yr, parent reports of their child's safety awareness had not significantly changed from their reports when their children were 5 yr of age, and concern for their child's safety was found to be a significant factor in deciding to delay their child's entry into elementary school.

In addition to the critical area of safety, teachers rated the participants as least competent in the SFA's Activity Performance–Cognitive–Behavioral Tasks areas of behavior regulation (e.g., "Handles frustration when experiencing difficulties with school tasks/activities," "Accepts unexpected changes in routine"), following social conventions ("Maintains appropriate social/physical boundaries by keeping hands to self, sitting/standing at appropriate distance," "Asks permission in contexts where it is expected"), and Positive Interactions ("Waits for turn in group activities," "Listens/pays attention while others in group are speaking"). These areas of difficulty suggest that self-regulation and behavior management are areas that may weaken the school function of students with DS, and improving outcomes in these areas would likely contribute to overall improved participation and performance in school settings for students with DS. These findings are in line with studies that have identified challenges in the area of behavior regulation and problem behaviors in people with DS (Fidler, Hepburn, & Rogers, 2006; Myers & Pueschel, 1991). In this study, we are among the first, however, to report the impact of behavior management issues on school function in this population.

Predictors of School Function

Beyond these descriptive findings, additional analyses were conducted to identify which developmental domains made the largest contribution to variability in school function. On the basis of multiple regression analyses, it was demonstrated that teacher-reported EF skills scores (as measured by the BRIEF–P) was the only statistically significant predictor of overall school function in this group. Other critical areas included in these analyses—overall IQ and language functioning—were not found to be statistically significant predictors of school function.

This finding has two implications. First, EF may play a more prominent role in academic contexts for children with DS than has previously been noted in the literature. Although the extant literature examining EF and functional performance in children with developmental disabilities is scant, this finding corresponds with research on executive function and behaviors related to school success in DS (Daunhauer et al., in press), other neurogenetic disorders (e.g., Zingerevich & LaVesser, 2009), and typically developing students (e.g., Blair & Razza, 2007; Bull, Espy, & Wiebe, 2008; McClelland et al., 2007; Riggs, Blair, & Greenberg, 2004). Second, these findings suggest that improving EF may be of particular use for improving overall school function in DS. For example, we found emerging evidence for a specific EF profile in school-age children with DS (Daunhauer et al., in press; Lee et al., 2011), including areas of distinct strength and challenge. Future intervention work should seek to target

these specific areas of challenge for children with DS to improve overall school functioning outcomes in this population.

Limitations and Future Research

This study has several limitations, and as such, findings should be interpreted as preliminary. First, we conducted this study with a relatively small sample size (with an overrepresentation of male participants) from a specific geographic location in the United States. Follow-up studies should examine the phenomenon of school function with a larger, more nationally representative sample over time to determine the generalizability of the patterns observed in our study.

In addition, we focused only on students with DS and did not include a comparison group of children with other types of developmental disabilities. Therefore, this study answered questions regarding patterns of performance observed in students with DS and predictors of within-syndrome variability on the dimension of overall school function. In this study, however, we did not address questions regarding the specificity of the pattern observed in the DS group when compared with other students with disabilities. Although numerous studies and edited volumes have addressed the issue of specificity of outcomes in DS (e.g., Rondal & Perera, 2011), subsequent studies should seek to determine the degree to which this pattern is uniquely observed in students with DS or whether the areas of strength and challenge observed in this sample of students with DS are more widely observed among children with other neurogenetic disorders and neurodevelopmental disabilities. Additionally, other factors such as sensory processing (e.g., Leung et al., 2011) and motor abilities (Volman, Visser, & Lensvelt-Mulders, 2007) should also be examined in relationship to EF to better understand relative contributions to school function.

Implications for Occupational Therapy Practice

This study contributes to the literature on school function for students with DS. It emphasizes that just as distinctive patterns of relative strengths and challenges are observed in developmental assessments of children with DS (e.g., challenges in working memory; Lee et al., 2011), distinctive patterns of relative strengths and challenges are also observable in the amounts of task support and activity performance during participation in school contexts.

- In this study, school-aged children with DS demonstrated that they needed less support and were more successful when performing physical activities in contrast to cognitive–behavioral activities in the school context.
- It needs to be emphasized that although this study group needed less support to perform physical activities at school, participants' performance was still below age expectations as measured by the SFA. The physical activities that were reported to be the most challenging for this group to perform were recreational movement, computer and equipment use, and written work.
- The students were reported to demonstrate the greatest challenges in cognitive–behavioral tasks. The group was reported to have the most challenges with the following cognitive–behavioral activities: following social conventions, functional communication, compliance with adult directives and school rules, personal care awareness, task behavior–completion, positive interaction, and safety.
- Furthermore, teacher reports of the students' EF skills better predicted school function outcomes on the SFA than either IQ or language competence. Therefore, EF may play an important role in predicting outcomes in school function and may be an important target for intervention.

In the field of occupational therapy and occupational science, there has been little discussion regarding behavioral phenotypes—the patterns of relative strengths and weakness associated with genetic disorders such as DS—and how they may guide practice. Further compounding this lack of discussion is the small and often confusing body of literature on intervention in DS, highlighting how some interventions may have differential effects for this population (e.g., for a review, see Daunhauer & Fidler, 2011). Despite these confusions regarding best practices for intervention, evidence suggests that the DS behavioral phenotype is modifiable (e.g., Buckley, Bird, Sacks, & Archer, 2006). Therefore, given that each child with DS has a heightened probability of exhibiting aspects of the DS phenotypic profile (e.g., difficulty participating in activities requiring safety and behavioral regulation skills in the school context), occupational therapy practitioners are encouraged to consider current evidence regarding the DS phenotype in addition to their expertise in activity analysis and knowledge regarding contextual factors that affect participation and functional performance. By using this process, practitioners can, as suggested by Fidler, Philofsky, and Hepburn (2007), use anticipatory guidance to be on the lookout for heightened vulnerabilities such as safety awareness for children with DS. ▲

Acknowledgments

This study was funded in part by the National Institute of Disability and Rehabilitation Research (H133G100197) and the Institute of Educational Science, U.S. Department of Education (R324A110136).

References

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development, 78,* 647–663. http://dx.doi.org/10.1111/j.1467-8624.2007.01019.x

Buckley, S., Bird, G., Sacks, B., & Archer, T. (2006). A comparison of mainstream and special education for teenagers with Down syndrome: Implications for parents and teachers. *Down Syndrome Research and Practice, 9,* 54–67.

Bull, R., Espy, K. A., & Wiebe, S. A. (2008). Short-term memory, working memory, and executive functioning in preschoolers: Longitudinal predictors of mathematical achievement at age 7 years. *Developmental Neuropsychology, 33,* 205–228. http://dx.doi.org/10.1080/87565640801982312

Canfield, M. A., Honein, M. A., Yuskiv, N., Xing, J., Mai, C. T., Collins, J. S., . . . Kirby, R. S. (2006). National estimates and race/ethnic-specific variation of selected birth defects in the United States, 1999–2001. *Birth Defects Research Part A: Clinical and Molecular Teratology, 76,* 747–756. http://dx.doi.org/10.1002/bdra.20294

Carrow-Woolfolk, E. (1995). *Oral and Written Language Scales.* Circle Pines, MN: American Guidance Service.

Coster, W., Deeney, T., Haltiwanger, J., & Haley, S. (1998). *School Function Assessment (SFA).* San Antonio: Psychological Corporation.

Daunhauer, L. A. (2011). The early development of adaptive behavior and functional performance in young children with Down syndrome: Current knowledge and future directions. *International Review of Research in Developmental Disabilities, 40,* 109–131. http://dx.doi.org/10.1016/B978-0-12-374478-4.00005-8

Daunhauer, L. A., & Fidler, D. J. (2013). Introduction to section four: Overview and analysis. In K. C. Barrett & G. Morgan (Eds.), *Handbook of self-regulatory processes in development: New directions and international perspectives* (pp. 405–408). New York: Psychology Press.

Daunhauer, L. A., & Fidler, D. J. (2011). The Down syndrome behavioral phenotype: Implications for practice and research in occupational therapy. *Occupational Therapy in Health Care, 25,* 7–25. http://dx.doi.org/10.3109/07380577.2010.535601

Daunhauer, L. A., Fidler, D. J., Hahn, L., Lee, N. R., Will, E., & Hepburn, S. (in press). Profiles of everyday executive functioning in young children with Down syndrome. *American Journal of Intellectual and Developmental Disabilities.*

Davies, P. L., Soon, P. L., Young, M., & Clausen-Yamaki, A. (2004). Validity and reliability of the School Function Assessment in elementary school students with disabilities. *Physical and Occupational Therapy in Pediatrics, 24,* 23–43. http://dx.doi.org/10.1300/J006v24n03_03

de Campos, A. C., Rocha, N. A., & Savelsbergh, G. J. (2009). Reaching and grasping movements in infants at risk: A review. *Research in Developmental Disabilities, 30,* 819–826. http://dx.doi.org/10.1016/j.ridd.2009.01.004

Dolva, A. S., Coster, W., & Lilja, M. (2004). Functional performance in children with Down syndrome. *American Journal of Occupational Therapy, 58,* 621–629. http://dx.doi.org/10.5014/ajot.58.6.621

Dolva, A. S., Lilja, M., & Hemmingsson, H. (2007). Functional performance characteristics associated with postponing elementary school entry among children with Down syndrome. *American Journal of Occupational Therapy, 61,* 414–420. http://dx.doi.org/10.5014/ajot.61.4.414

Dunn, W. (1999). *The Sensory Profile manual.* San Antonio, TX: Psychological Corporation.

Dykens, E. M. (1995). Measuring behavioral phenotypes: Provocations from the "new genetics." *American Journal of Mental Retardation, 99,* 522–532.

Dykens, E. M., Hodapp, R. M., & Finucane, B. M. (2000). *Genetics and mental retardation syndromes: A new look at behavior and interventions.* Baltimore: Brookes.

Fidler, D., Hepburn, S., & Rogers, S. (2006). Early learning and adaptive behaviour in toddlers with Down syndrome: Evidence for an emerging behavioural phenotype? *Down Syndrome Research and Practice, 9,* 37–44.

Fidler, D. J., Philofsky, A., & Hepburn, S. L. (2007). Language phenotypes and intervention planning: Bridging research and practice. *Mental Retardation and Developmental Disabilities Research Reviews, 13,* 47–57. http://dx.doi.org/10.1002/mrdd.20132

Gioia, G. A., Espy, K. A., & Isquith, P. K. (2003). *Behavior Rating Inventory of Executive Function, Preschool version (BRIEF–P).* Odessa, FL: Psychological Assessment Resources.

Hodapp, R. M., & Dykens, E. M. (1994). Mental retardation's two cultures of behavioral research. *American Journal of Mental Retardation, 98,* 675–687.

Hodapp, R., Evans, D., & Gray, F. (1999). Intellectual development in children with Down syndrome. In J. A. Rondal, J. Perera, & L. Nadel (Eds.), *Down syndrome: A review of current knowledge* (pp. 124–132). London: Whurr Publishers.

Hwang, J. L., Davies, P. L., Taylor, M. P., & Gavin, W. J. (2002). Validation of School Function Assessment with elementary school children. *OTJR: Occupation, Participation and Health, 22,* 48–58.

Jobling, A. (1999). Attainment of motor proficiency in school-aged children with Down syndrome. *Adapted Physical Activity Quarterly, 16,* 344–361.

Lee, N. R., Fidler, D. J., Blakeley-Smith, A., Daunhauer, L., Robinson, C., & Hepburn, S. L. (2011). Caregiver report of executive functioning in a population-based sample of young children with Down syndrome. *American Journal on Intellectual and Developmental Disabilities, 116,* 290–304. http://dx.doi.org/10.1352/1944-7558-116.4.290

Leung, G. P., Chan, C. C., Chung, R. C., & Pang, M. Y. (2011). Determinants of activity and participation in preschoolers with developmental delay. *Research in Developmental*

Disabilities, 32, 289–296. http://dx.doi.org/10.1016/j.ridd.2010.10.005

McClelland, M. M., Cameron, C. E., Connor, C. M., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology, 43,* 947–959. http://dx.doi.org/10.1037/0012-1649.43.4.947

McClelland, M. M., Morrison, F. J., & Holmes, D. L. (2000). Children at risk for early academic problems: Role of learning-related social skills. *Early Childhood Research Quarterly, 15,* 307–329. http://dx.doi.org/10.1016/S0885-2006(00)00069-7

Myers, B. A., & Pueschel, S. M. (1991). Psychiatric disorders in persons with Down syndrome. *Journal of Nervous and Mental Disease, 179,* 609–613. http://dx.doi.org/10.1097/00005053-199110000-00004

Nadel, L. (2003). Down's syndrome: A genetic disorder in biobehavioral perspective. *Genes, Brain and Behavior, 2,* 156–166. http://dx.doi.org/10.1034/j.1601-183X.2003.00026.x

Palisano, R. J., Walter, S. D., Russell, D. J., Rosenbaum, P. L., Gémus, M., Galuppi, B. E., & Cunningham, L. (2001). Gross motor function of children with Down syndrome: Creation of motor growth curves. *Archives of Physical Medicine and Rehabilitation, 82,* 494–500. http://dx.doi.org/10.1053/apmr.2001.21956

Riggs, N. R., Blair, C. B., & Greenberg, M. T. (2004). Concurrent and 2-year longitudinal relations between executive function and the behavior of 1st and 2nd grade children. *Child Neuropsychology, 9,* 267–276. http://dx.doi.org/10.1076/chin.9.4.267.23513

Roid, G. H., & Miller, L. J. (1997). *Leiter International Performance Scale—Revised: Examiner's manual.* Wood Dale, IL: Stoelting.

Rondal, J. A., & Perera, J. (2011). *Down syndrome neurobehavioral specificity.* New York: Wiley.

Rowe, J., Lavender, A., & Turk, V. (2006). Cognitive executive function in Down's syndrome. *British Journal of Clinical Psychology, 45,* 5–17. http://dx.doi.org/10.1348/014466505X29594

Volman, M. J., Visser, J. J. W., & Lensvelt-Mulders, G. J. L. M. (2007). Functional status in 5 to 7-year-old children with Down syndrome in relation to motor ability and performance mental ability. *Disability and Rehabilitation, 29,* 25–31. http://dx.doi.org/10.1080/09638280600947617

Wechsler, D. (1991). *The Wechsler Intelligence Scale for Children—Third edition.* San Antonio, TX: Psychological Corporation.

Wu, W. T., Cheng, C. F., Lu, H. H., & Chiu, S. C. (2004). *Vineland Adaptive Behavior Scales: Classroom edition, manual (Chinese version).* Taipei, Taiwan: Psychological Publishing.

Wuang, Y. P., & Su, C. Y. (2011). Correlations of sensory processing and visual organization ability with participation in school-aged children with Down syndrome. *Research in Developmental Disabilities, 32,* 2398–2407. http://dx.doi.org/10.1016/j.ridd.2011.07.020

Zingerevich, C., & LaVesser, P. D. (2009). The contribution of executive functions to participation in school activities of children with high functioning autism spectrum disorder. *Research in Autism Spectrum Disorders, 3,* 429–437. http://dx.doi.org/10.1016/j.rasd.2008.09.002