Development and Standardization of a “Do–Eat” Activity of Daily Living Performance Test for Children

Naomi Josman, Ayelet Goffer, Sara Rosenblum

KEY WORDS
• activities of daily living
• ecosystem
• motor skills disorders
• reproducibility of results

BACKGROUND. The Do–Eat was developed to evaluate daily task performance abilities among children with developmental coordination disorder (DCD). This study investigated the tool’s reliability and validity.

METHOD. Participants were 59 children ages 5 to 6.5 years; 30 children diagnosed with DCD according to the DSM–IV–TR; and a control group of 29 children, who were matched for age, gender, and sociodemographic background.

RESULTS. Both the Do–Eat and the accompanying Parent Questionnaire yielded high internal consistency (α = .89–.93). Construct validity was demonstrated by significant between-group differences on the Do-Eat (t[57] = 14.09, p < .001) and the Parent Questionnaire (t[57] = 3.64, p < .001). Significant correlations between children’s scores on the sensory–motor component of the Do–Eat and the Movement Assessment Battery for Children final score confirmed concurrent validity (r = –.86, p < .001).

CONCLUSIONS. Results suggest that the Do–Eat is a reliable, valid tool for identifying children at risk for DCD.


Developmental coordination disorder (DCD) is characterized by motor impairment that significantly interferes with a child’s activities of daily living (ADLs) and academic achievement (Criterion A and B of the Diagnostic and Statistical Manual of Mental Disorders, 4th ed., text rev. [DSM–IV–TR]; American Psychiatric Association [APA], 2001; Dewey & Wilson, 2001; Miyahara & Mobs, 1995).

Research analyzing ADLs of children with DCD has pointed to evidence that these children participate less than their peers in daily household activities and in educational and social settings (Cermak & Larkin, 2002). Ayres (1985) claimed that children with sensory–motor difficulties learn daily skills later than their peers and do so in an ineffective manner. They become frustrated while trying to learn new skills and, as a result, avoid participating. The difficulties manifested in basic daily functions are evident in dressing, personal hygiene, and eating as well as in instrumental ADLs (IADLs), such as preparing food (May-Benson, Ingola, & Koomar, 2002).

A study conducted by May-Benson (1999) focused on children with dyspraxia during school years and found that 71% of children had difficulty using cutlery and tying shoelaces, 46% had difficulty dressing and buttoning, and 67% displayed messy eating. Hoare (1994) found that young children with DCD have difficulties related to eating, such as chewing different types of food, pouring milk into a glass, cutting food, and clearing dishes from the table. They have difficulty eating with cutlery and tend to soil themselves and their immediate surroundings. The manner in which

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they eat has a negative impact on their family environment at mealtimes and is used as a justification by classmates for taunting (Hoare, 1994). When children with DCD get to school, they experience difficulty in acquiring writing skills (Benbow, 1995) and, over time, increasingly fail to complete written tasks and assignments in a reasonable amount of time (Benbow, 2002). Because of impaired function, many children with DCD are referred for occupational or physical therapy (Dunford, Street, O’Connell, Kelly, & Sibert, 2004; Green et al., 2005; Peters, Henderson, & Dookun, 2004).

Reliable assessment tools for validating the DSM–IV–TR criteria for diagnosis of a child with DCD referred for treatment are scarce; although this state of affairs has been documented in the literature, the consequences are inadequate interventions for these children (Dewey & Wilson, 2001). For example, research into the course of treatment of children with DCD over several years found that by age 8, a typical child with DCD has been referred to 10 different therapeutic sources within the medical service. These sources often include two terms of treatment in occupational therapy within different frameworks (Missiuna, Moll, Law, King, & King, 2006). These findings demonstrate the need to develop a viable assessment tool that provides a clear and comprehensible indication of the function of children with DCD and facilitates the design of tailored intervention goals based on specific demonstrated needs (Dunford et al., 2004; Miller, Missiuna, Macnab, Malloy-Miller, & Polatajko, 2001).

According to the literature, functional difficulties of children with DCD manifest themselves in the children’s ability to dress, in eating-related activities, and in handwriting difficulty. The assessment tool described in this article addresses these specific areas. The need for viable tools that address function-related difficulties is especially amplified by the research literature, which has documented the impaired quality of life of the child and his or her family resulting from these difficulties (Sprinkle & Hammond, 1997). Because these children cannot perform daily functional activities, their lives and those of their families are fraught with intense feelings of frustration (Cermak & Larkin, 2002). Parents of children with DCD have reported that accomplishing tasks requires considerable time and energy (May-Benson, 1999), and severe tensions are aroused within the family, particularly during the early-morning rush routine and at mealtimes (Missiuna, 2001).

The significance of such children’s incompetent ADL performance has previously been discussed. Daving, Andren, and Grimby (2000) indicated that independence in everyday activities actually enhances adaptation to the environment and optimizes function. Likewise, having control over self-care activities contributes to the child’s feelings of competence and improves integration in school (Chapparo & Hooper, 2005). Therefore, impairments in everyday functioning interfere with the child’s ability to participate in family and school activities (Case-Smith, 1993).

In light of this evidence, the ability to assess daily activity functioning in children with DCD, emphasizing quality of performance and participation, is imperative (Cermak & Larkin, 2002; May-Benson et al., 2002). However, the puzzling plight of children with DCD, and the heterogeneous nature of their symptoms and presenting difficulties (comorbidities), make the process of assessment extremely complicated and raise many issues regarding the adequacy of various testing methods (Gibbs, Appleton, & Appleton, 2007; Henderson & Barnett, 1998; Wann, Mon-Williams, & Rushton, 1998; Wilson, 2005).

Existing methods for evaluating the performance of children with DCD include (1) both parent and teacher questionnaires—for example, the Developmental Coordination Disorder Questionnaire (Wilson, Kaplan, Crawford, Campbell, & Dewey, 2000) and the Children Activity Scale Parent and Teacher (ChAS–P–T; Rosenblum, 2006)—and (2) assessment tools—for example, the Movement Assessment Battery for Children (M–ABC; Henderson & Sugden, 1992) and the Bruininks–Oseretsky Test (Bruininks & Bruininks, 2005; for a discussion regarding evaluation of performance in children with DCD, see also Henderson & Barnett, 1998; Missiuna, Rivard, & Bartlett, 2003, 2007).

Most assessment tools developed for children with DCD are based on a “bottom-up” approach, whereby a child’s difficulties are evaluated by analyzing gross and fine motor skills (Mandich, Polatajko, Mancab, & Miller, 2001). These tests exclude any evaluation of performance related to daily activities (Crawford, Wilson, & Dewey, 2001). Moreover, they do not include cognitive performance skills, despite the importance of evaluating the relationships between cognition and sensory–motor skills (Ylvisaker & Szekeres, 1998) and their relationship to performance of daily tasks (Katz, 2005). In addition to these tools, more recent tools have been developed, based on a “top-down” approach (e.g., Perceived Efficacy and Goal Setting in Young Children; Missiuna & Pollock, 2000); however, these tools do not address IADLs. Both bottom-up and top-down tools for children with DCD described here raise questions regarding their ecological validity (Barnett & Peters, 2004).

According to Kvavilashvili and Ellis (2004), the term ecological validity refers to both the task’s degree of representativeness and the ability to generalize test results to ADLs in the natural environment. In that context, one may ask what relationships exist between specific tasks (such as drawing a triangle in the Beery–Buktenica Developmental Test
of Visual–Motor Integration (Beery & Buktenica, 1997) or
threading beads in the M–ABC) and the child’s everyday
home or school performance and participation. To the best
of our knowledge, only one assessment that includes the
child’s ability to perform functional everyday tasks has been
cited as a possible measure for children with DCD, namely
the Vineland Adaptive Behavior Scale (Sparrow, Cicchetti,
& Balla, 2005). This tool was actually developed for assess-
ing children with mental retardation and autism (De Bildt
et al., 2005) but was not initially intended for children with
atypical brain development (Kaplan, Wilson, Dewey, &
Crawford, 1998) or specific learning disabilities (Kirby,
Davies, & Bryant, 2005), such as DCD.

In summary, a review of the literature underscores the
paucity of viable top-down tools that are ecologically valid
and do not rely solely on parental reports. Most ADL assess-
ments were designed for children with complex disabilities
and are inappropriate for children with DCD, attention
deficit hyperactivity disorder, and learning disabilities.
Moreover, on the basis of several citations cited earlier in
this article, Misuina et al. (2007) recently indicated that an
accepted standard for the assessment of DCD is still
lacking.

This article presents the Do–Eat (Goffer, Josman, &
Rosenblum, 2009) as an assessment tool for IADL perfor-
ance among children with DCD. The Do–Eat is an ecologi-
cally valid assessment tool that focuses on food preparation
and on drawing, writing, and cutting. The assessment is
based on both top-down and bottom-up approaches. The
tool’s purpose is to evaluate relevant performance areas for
children with DCD and to assist in establishing customized
goals and objectives for intervention with these children.
In this article, we describe the development of the Do–Eat and
report respective reliability and validity measures, specifically
interrater and internal reliability and concurrent and con-
struct validity.

Method

Participants

Participants included 59 children, ages 5 to 6.5 years, who
were selected for the study as a convenience sample. We used
this constricted age group to reduce the likelihood of age
constituting an intervening variable in the study, given that
children’s performance abilities improve with age. All study
participants were Hebrew speakers who attended regular
schools and preschools. The study group consisted of 30
children who were diagnosed as having DCD, as defined by
the DSM–IV–TR (APA, 2001) and on the basis of scoring
<15th percentile on the Movement Assessment Battery for
Children (M–ABC; Henderson, & Sugden, 1992). The con-

control group consisted of 29 children who were matched on
age, gender, and sociodemographic background with the
study group. In both groups, 77% of children were boys,
and 23% were girls. No significant age differences between
the groups were evident (research group age range = 58–78
months, mean [M] = 68.2 months, standard deviation [SD]
= 5.19; control group age range = 59–81 months, M = 68.8
months, SD = 5.42). On the basis of information from a
survey that is routinely done in the Israeli educational sys-
tem, we excluded children with physical or communication
limitations (cerebral palsy, pervasive developmental delay,
visual impairment, or hearing impairment) and children
with mental retardation from the study.

All of the children in both groups had at least an “ade-
quate” cognitive and meta-cognitive performance level,
based on the results of the mean score of the cognitive and
meta-cognitive items of the ChAS–P–T (see the description
of this measure in the next section). The mean score for both
groups on both questionnaires was greater than the “almost
well” performance level (for the Children Activity Scale
Parent [ChAS–P]: children with DCD, M = 4.02, SD =
0.68; typically developing children, M = 4.54, SD = 0.38;
for the Children Activity Scale Teacher [ChAS–T]: children
with DCD, M = 3.79, SD = 0.73; typically developing
children, M = 4.44, SD = 0.54); the lowest score for the ChAS–P
was 2.29 (2 = adequate), and the lowest score for the ChAS–
T was 2.57.

Instruments

“Do–Eat” Questionnaire and Test. The Do–Eat is an eco-

logical test administered in the child’s natural surroundings,
such as the family kitchen or the kindergarten. The child is
asked to perform three tasks: (1) make a sandwich, (2) prepare
chocolate milk, and (3) fill out a certificate of outstanding
performance for him- or herself (see Figure 1). Throughout
the child’s performance, he or she receives (1) a score for
performing the task, (2) an analysis score for sensory–motor skills,
and (3) an analysis score for executive functions (EF). For
example, the task performance requires pouring milk into a
glass as part of preparing chocolate milk. The sensory–motor
analysis skills evaluated are motoricity, posture and movement
relationships, motor planning, bilateral coordination, fine
motor coordination, and sensation. The EF analysis compo-
ents evaluated are attention, initiation, sequencing, transi-
tion from one activity to another, spatial and temporal organi-
zaition, inhibition, problem solving, and remembering
instructions (see the Appendix).

Test scores range from 1 (unsatisfactory performance) to
5 (very good performance). As the test is administered to the
child, parents simultaneously complete a questionnaire
and 50 statements child (e.g., positive consisting of a milk drink, and (C) filling out a certificate of outstanding performance). The following outcome measures can be obtained from the tool: an overall total task performance score, an overall score analyzing sensory–motor skills, and an overall score analyzing EF associated with task performance. The test also provides a summary test score that incorporates the average of the three scores and a summary score for the parent questionnaire.

Recent research aimed at establishing the Do–Ear’s discriminant validity among three age groups of typically developing children (5–6, 6–7, 7–8) and gender has been revealing: Significant differences were obtained between age groups ($F_{2, 85} = 8.38, p = .000, \eta^2 = .16$), for gender differences ($F_{1, 85} = 8.45, p = .005, \eta^2 = .09$), and for their interaction ($F_{2, 85} = 3.61, p = .031, \eta^2 = .08$; for more details, see Frisch et al., 2009).

**Movement Assessment Battery for Children.** The M–ABC (Henderson & Sugden, 1992) was designed to identify and evaluate children with mild to moderate motor impairment. This assessment enjoys widespread use in clinical and research contexts and is currently considered the most appropriate tool of its kind for evaluating motor impairment (Crawford et al., 2001; Geuze, Jongmans, Schoemaker, & Smits-Engelman, 2001; Van Waalwijk, De Weerdt, De Cock, & Smits-Engelman, 2004). The battery consists of two parts: (1) a test that is performed on an individual basis with the child and (2) a questionnaire given to an adult who knows the child and observes him or her on a daily basis. It consists of eight subtests of motor function, including three that test manual dexterity, two that assess ball skills, and three that assess static and dynamic balance. The battery has been standardized for age, providing norms for children ages 4 to 12 in four age-related item sets. Children can score between 0 and 5 on each item, and the total score will range from 0 to 40, with increased impairment associated with higher scores. The final score is converted to a percentile, thus serving as a criterion for determining children at risk for DCD (15th percentile) and children at high risk for DCD (5th percentile).

Extensive information on the M–ABC’s validity and reliability is presented in the manual (Henderson & Sugden, 1992) and in Henderson and Barnet (1998). The M–ABC was translated into Hebrew (translation and backtranslation) with the publisher’s permission. In this study, we used the test only, without the questionnaire.

**Children Activity Scale—Parent and Teacher.** These questionnaires were developed to identify children ages 4 to 8 at risk for DCD, based on their parents’ or teacher’s report (Rosenblum, 2006) or both. The questionnaire is brief and requires 5 to 10 min to complete. The ChAS–P includes 27 items regarding activities that have been found to be deficient among children with DCD. The ChAS–T includes 22 items similar to those of the ChAS–P but referring to the

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**Figure 1. Do–Eat tasks:** (A) preparing a sandwich, (B) preparing a milk drink, and (C) filling out a certificate of outstanding performance for self.
school environment. The items address issues of gross and fine motor activities, learning, organization in space and time during performance of daily activities, self-care, mobility, and play. The parent or teacher is asked to rate how the child performs certain activities in comparison to his or her peers on a 5-point Likert scale (1 = less adequately, 2 = adequately, 3 = almost well, 4 = well, and 5 = very well). The outcome measure is an average score ranging from 1 to 5. Children who obtain a mean score ranging from 1 to 3.42 on the ChAS–T, a mean score ranging from 1 to 3.82 on the ChAS–P, or both are categorized as possibly having DCD.

Seven items on both the ChAS–P and the ChAS–T measure learning and organization abilities in various environments (e.g., Item 5, “learning new movement skills,” or Item 19, “organization in time and space in preparation for eating”; for further details, see Rosenblum, 2006). We computed a mean score for those seven items to screen for the cognitive and meta-cognitive level of performance of the participants in this study.

Internal consistency, construct validity, and concurrent validity with the M–ABC have been reported and suggest that the ChAS–T and ChAS–P are reliable tools to identify children at risk for DCD (for further details, see Rosenblum, 2006).

Procedure

The Board of Education’s Committee on Activities Involving Human Subjects approved all recruitment and intervention procedures. Parents signed a consent form and completed both the ChAS–P and the Do–Eat questionnaires. Teachers filled out the ChAS–T, and Ayelet Goffer collected all data. Each child underwent two sessions: (1) testing on the M–ABC and (2) testing on the Do–Eat. All assessments were conducted either at home or at school. The Do–Eat was conducted in a kitchen environment or in a room with a sink, faucet, and suitable worktable.

Data Analysis

To examine whether the groups with and without DCD differed with respect to the M–ABC items, we performed frequency and Mann–Whitney analyses. We computed the calculation of interrater reliability for the Do–Eat test overall final score according to Polit and Hungler’s (2003) formula, and we used Cronbach’s $\alpha$ coefficient to compute internal consistency for Do–Eat components.

We analyzed the differences between the group with DCD and the control group by means of a $t$ test for nonequivalent groups. We analyzed the questionnaire’s concurrent validity with Pearson correlation coefficients: Respective correlations were computed between the Do–Eat sensory–motor component score and the M–ABC overall score and between the Do–Eat and ChAS–P and ChAS–T overall scores. Likewise, we computed Pearson correlation coefficients to determine the relationships between the Do–Eat test and Do–Eat parent questionnaire overall scores.

Results

Before we present the Do–Eat reliability and validity results, we describe the participants’ performance on the eight M–ABC subtests. As presented in Table 1, Mann–Whitney analysis applied to these eight items yielded statistically significant differences between the children with and without DCD. The results of this analysis indicated that the children with DCD received significantly higher scores (i.e., performed worse) on all eight M–ABC subtests, meaning that their manual dexterity, ball skills, and static and dynamic balance abilities were inferior to those of the control group.

Content and Face Validity

The Do–Eat tasks were selected on the basis of the respective literatures relating to functional deficits among children with DCD. This background included (1) structured interviewing

### Table 1. A Comparison of Performance on the Eight Movement Assessment Battery for Children (M–ABC) Subtests for Children With and Without Developmental Coordination Disorder (DCD; Mann–Whitney Analysis)

<table>
<thead>
<tr>
<th>Subtest</th>
<th>M–ABC Item Description</th>
<th>Children With DCD ($n = 30$)</th>
<th>Children Without DCD ($n = 29$)</th>
<th>Z</th>
<th>$p &lt;$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual dexterity 1</td>
<td>Positioning coins in bank box</td>
<td>3.43 1.15</td>
<td>1.71 1.04</td>
<td>-5.04</td>
<td>.001</td>
</tr>
<tr>
<td>Manual dexterity 2</td>
<td>Threading a lace</td>
<td>4.50 1.13</td>
<td>2.46 1.79</td>
<td>-4.87</td>
<td>.001</td>
</tr>
<tr>
<td>Manual dexterity 3</td>
<td>Drawing a line into a trail</td>
<td>2.23 1.54</td>
<td>0.40 0.81</td>
<td>-4.66</td>
<td>.001</td>
</tr>
<tr>
<td>Ball skills 1</td>
<td>Bouncing and catching a ball with one hand</td>
<td>2.80 1.39</td>
<td>0.46 0.93</td>
<td>-5.61</td>
<td>.001</td>
</tr>
<tr>
<td>Ball skills 2</td>
<td>Throwing a bean bag into a box</td>
<td>2.76 1.56</td>
<td>0.30 0.46</td>
<td>-5.96</td>
<td>.001</td>
</tr>
<tr>
<td>Static balance</td>
<td>Standing on one leg</td>
<td>2.61 1.67</td>
<td>0.26 0.58</td>
<td>-5.72</td>
<td>.001</td>
</tr>
<tr>
<td>Dynamic balance 1</td>
<td>Jumping on a rope</td>
<td>1.96 2.07</td>
<td>0.23 0.72</td>
<td>-3.77</td>
<td>.001</td>
</tr>
<tr>
<td>Dynamic balance 2</td>
<td>Heel-to-toe walking on a line</td>
<td>2.76 1.61</td>
<td>0.10 0.30</td>
<td>-6.23</td>
<td>.001</td>
</tr>
</tbody>
</table>

Note. SD = standard deviation.
of teachers and parents of children with DCD on everyday functioning; (2) observation of children in kindergarten environments; and (3) analysis of functional tools developed for adults, such as the Assessment of Motor and Process Skills (Fisher, 1995) and the Revised Kitchen Task Assessment (Baum & Edwards, 1993).

On the basis of Fisher (1995) and Baum & Edwards (1993), the Do–Eat’s developers decided to focus on three main activities encompassing the main areas of performance in which children with DCD characteristically experience difficulties: basic activities of sustenance (eating), adaptation to the environment (dressing, tying apron), and crafting (drawing, writing, and cutting; Perr, 2004). Respective task requirements and scoring sheets were designed and constructed. Each of the three tasks was scored separately and included three measures: activity performance, sensory–motor performance skills, and executive function performance skills.

The content was validated by five expert consultants and five experienced pediatric occupational therapists. This process was used to determine the degree of correspondence between the tool scenario and prescribed instrument objectives and the consistency of both content and face validity, as described by Benson and Clark (1982).

Three experienced occupational therapists (with >10 years of experience in pediatric practice) were subsequently invited to evaluate a child with DCD, videotape the evaluation process, and then rate the performance. The therapists analyzed their evaluations in combination with the videotaping, approved the clarity of task and guidance instructions, agreed on a 25- to 30-min per child allotment for evaluation completion, and verified that the tool captured a reliable and satisfactory profile of everyday performance. In addition, the therapists observed that using Do–Eat was a meaningful experience, revealing unique and important everyday child activities. In addition, completion of the three scoring sheets provided them with further insight into the child’s functioning.

Reliability and Validity Studies

Once the final version of the tool was established, the subsequent phase of development involved a preliminary determination of the assessment tool’s reliability and validity.

Interrater reliability. An interrater reliability test was conducted for all assessment items. A child diagnosed with DCD was evaluated and videotaped while performing the Do–Eat. Two occupational therapists with >10 years of experience viewed the video and rated performance on the score sheets, contemporaneously with the researcher (Ayelet Goffer). These raters were aware of the study objectives but conducted their evaluations independently of one another. Moreover, these raters were not members of the initial focus groups conducted for instrument development. A high interrater reliability was obtained (rs = .92–1) among all three assessors.

Internal consistency. Internal consistency was evaluated for each of the three Do–Eat components on the basis of data from 59 participants, yielding satisfactory results. High internal consistency was obtained for performance skills (α = .93), sensory–motor skills (α = .90), and executive functions skills (α = .89). Internal consistency for the parents’ questionnaire was .91. Differences in performance between the two groups are presented in Table 2.

Construct and concurrent validity. Construct validity for the Do–Eat was assessed by gauging the tool’s ability to distinguish between the groups of children with and without DCD. We determined concurrent validity by comparing Do–Eat scores with those on the M–ABC (Henderson & Sugden, 1992) and the ChAS–P (Rosenblum, 2006).

<table>
<thead>
<tr>
<th>Table 2. Performance of Both Groups on Do–Eat Components</th>
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<tr>
<td><strong>Component</strong></td>
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<tr>
<td><strong>Children With DCD (n = 30)</strong></td>
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<tr>
<td><strong>Mean</strong></td>
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<tr>
<td>Tying an apron and making a sandwich</td>
</tr>
<tr>
<td>Task performance</td>
</tr>
<tr>
<td>Sensory–motor</td>
</tr>
<tr>
<td>Executive functions</td>
</tr>
<tr>
<td>Preparing chocolate milk</td>
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<tr>
<td>Task performance</td>
</tr>
<tr>
<td>Sensory–motor</td>
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<tr>
<td>Executive functions</td>
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<tr>
<td>Filling out a certificate</td>
</tr>
<tr>
<td>Task performance</td>
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<tr>
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<td>Executive functions</td>
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<td><strong>No. of Items</strong></td>
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<td><strong>Range of Scores</strong></td>
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*Note. DCD = developmental coordination disorder; SD = standard deviation.*
As presented in Table 3, the t test conducted for unrelated samples showed significant differences between the group with DCD and the control group on all Do–Eat components, with the control participants displaying better performance. We found significant differences on performance of the three different tasks (t[57] = 14.04, p < .001), for sensory–motor skills (t[57] = 16.82, p < .001), and for executive functions (t[57] = 6.92, p < .001). We also found significant differences between the groups for the overall score on the parents’ questionnaire (t[57] = 3.65, p < .001).

Concurrent validity.

**Correlation between the Do–Eat and the M–ABC.** To establish the correlation between the M–ABC assessment score and the Do–Eat assessment score, we pinpointed the relationship between the M–ABC and the Do–Eat sensory–motor component score on the basis of the rationale that the M–ABC essentially addresses sensory–motor skills. We obtained a strong negative correlation between the M–ABC and the sensory–motor score for the overall sample (r = −.86, p < .001). Analysis of the correlations between the M–ABC and Do–Eat sensory–motor scores for each study group indicated a weak negative significant correlation for the DCD group (r = −.37, p < .001), whereas no significant correlation was obtained for the control group.

**Correlation between Do–Eat and Children Activity Scale–Parent and Teacher.** A significant moderate correlation was found between the summary scores of the Do–Eat test and the ChAS–P questionnaire for the entire sample (r = .56, p = .00). We found no significant correlations in either of the groups (DCD or control). An examination of the correlation between the Do–Eat test and the ChAS–T questionnaire showed a high correlation throughout the entire sample (r = .75, p = .00). We obtained a similar trend when analyzing the correlations in each group: We found a significant high correlation for the DCD group (r = .63, p < .001) and a moderate correlation for the control group (r = .40, p < .05).

**Correlation between the Do–Eat test and the Do–Eat parents’ questionnaire.** We found significant moderate correlations between the Do–Eat summary score and the Do–Eat questionnaire final scores for the entire sample (r = .54, p < .00). In the DCD group, the correlation was .41 (p < .05), whereas for the control group, it was .40 (p < .05).

**Discussion**

Our objectives in this study were to describe the Do–Eat’s development and establish its reliability and validity. Both objectives were supported. We established the Do–Eat’s reliability by examining interrater reliability and internal consistency. A high rate of interrater reliability was obtained between three examiners for all of the assessment items. This concurrence is important because the Do–Eat is based on a structured observation. Dunn (2000) claimed that evaluating a structured observation is extremely difficult because it demands that the evaluator comprehensively use his or her knowledge and skill to glean significant information from a given interaction between the child and his or her environment. The internal consistency examination found a high degree of correspondence between the items analyzed in each category of the test and the questionnaire. This high item correspondence confirms that the items in each category do actually evaluate the same content (Anastasi, 1997).

The Do–Eat distinguished between children with DCD and typically developing children, thereby allowing one to draw significant conclusions regarding children’s general functioning in their day-to-day lives. These findings are especially pertinent in light of the dearth of performance-based assessment tools for children in general (Bundy, 1993) and for children with DCD in particular (Cermak & Larkin, 2002). The important implication is that the Do–Eat enables a comparison of child functioning in relation to peers by focusing on everyday performance in natural surroundings (Kramer & Hinojosa, 1999).

**Profile of Daily Functioning in Children With DCD**

Disparities between children with DCD and children with intact development. As noted earlier, we had two reasons for choosing to focus on children with DCD in this study: The first related to the DSM–IV–TR’s definition of DCD, and the second related to the heterogeneity of this group of children. The DSM–IV–TR definition of DCD (APA, 2001) implies a possible cause–effect relationship between deficits in motor coordination (Criterion A) and daily function–related difficulties (Criterion B; Guze et al., 2001). These links were not, however, specified and were overlooked because of the lack of appropriate assessment tools. Henderson and Barnett (1998) claimed that analysis of the relationship between motor impairment and daily difficulties is contingent on the availability of a satisfactory tool for assessing a child’s limitations in performing daily tasks.
The Do–Eat assessment provides relevant information regarding these links between motor impairment and performance of daily activities, thus supporting the handful of other studies that have addressed everyday functional performance using alternate methods to the customary questionnaire assessment. Rodger et al. (2003) studied motor and functional ability in children with DCD (ages 4–8); everyday functioning was analyzed on the basis of the Pediatric Evaluation of Disability Inventory (Haley, Coster, Ludlow, Haltiwanger, & Andrelos, 1992), although this inventory was designed to evaluate children with more severe limitations than DCD. A review of research by Missiuna et al. (2007) showed that children with DCD performed at average levels in mobility areas, whereas functioning in self-care areas was <1 standard deviation from the average point; these children showed difficulties in brushing their teeth, cleaning their noses, and tying shoelaces. We similarly corroborated these findings in this study: Children with DCD performed significantly more poorly than typically developing children on several types of everyday functioning and activities. These findings support the claim for a link between coordination deficits and impairment of daily functions.

Evaluating children with DCD poses a significant challenge because of the heterogeneous nature of this population. Missiuna et al. (2007) claimed that the heterogeneity of children with DCD is represented by a wide range of variation in their manifestations of everyday performance, from difficulties in performing many tasks to difficulties on specific tasks. Burton and Miller (1998) therefore emphasized the need to use an extensive battery of assessments to provide information about each child’s specific functioning. This heterogeneity is likewise characteristic of our participants with DCD, as is evident from their scores.

Scores ranged from 260 to 163 points on the Do–Eat test and from 35 to 13.5 points on the M–ABC. This wide range of scores demonstrates the significant variability in children’s functioning, even in cases with similar diagnoses. These differences cannot be explained by one score. The Do–Eat’s content and structure provide a detailed view of diagnostic information that goes beyond a single score. By reviewing the score components, one can pinpoint the specific nature of the impairment and the impact of each component and performance skill on the child’s general functioning, thus highlighting difficulties and functional strengths. The study results point to a disparity between children with DCD and typically developing children on all skills observed, including sensory–motor skills, executive functions, and performance.

Regarding cognitive and meta-cognitive skills, although children with DCD received an adequate score for this domain on the Children Activity Scale Parent and Teacher screening tool, they performed significantly more poorly on the EF component of the Do–Eat than did typically developing children. These results indicate that the Do–Eat is indeed sensitive to the sensory–motor and EF aspects of performance among children with DCD. These findings underline the assertion that DCD is not manifested merely in motor coordination difficulties but that it is a multicharacteristic deficit with a significant impact on functional ability and everyday participation (Cermak, Gubbay, & Larkin, 2002; Kadesjo & Gillberg, 1999).

Score gap between children with DCD and typically developing children on the DCD Parent Questionnaire. The Do–Eat evaluation includes a test and a questionnaire aimed at providing an extensive functional profile that may significantly serve the design of a personal intervention plan. This combination of test and questionnaire enables both components to validate one another. The parent questionnaire provides information about functioning in general, apart from the testing situation (Glascoe & Dworkin, 1995); promotes parental cooperation during the process; and focuses on the client’s needs (Wilson et al., 2000). The parent questionnaire significantly identified children with DCD, a finding compatible with reports by parents of children with DCD that underline their child’s difficulties with daily functioning in general and eating in particular (Hoare, 1994). Green et al. (2005) also obtained similar findings: the Developmental Coordination Disorder Questionnaire parent questionnaire (Wilson et al., 2000) distinguished between children with DCD and typically developing children, and children with DCD scored significantly more poorly.

Link between the Do–Eat and the M–ABC. We found a strong and significant correlation between the M–ABC and Do–Eat sensory–motor skills for all participants, but only a weak correlation was evident for the DCD group. The correlation between M–ABC and the Do–Eat sensory scale was .86 for the entire group but only -.37 for the DCD group. This result implies that sensory–motor performance skills do not fully impair the ability to perform. This result strengthens the claim that assessing DCD only via sensory–motor tasks limits a fuller depiction of daily functioning and cannot serve as a viable stand-alone diagnostic tool (Green et al., 2005). We found no significant correlation between M–ABC and Do–Eat sensory–motor skills for the typically developing group. A possible reason for this may be the lack of variability in this group, given the constricted age range of the children tested and the small group size.

Link between Do–Eat and the ChAS–T and ChAS–P. Correlations between the ChAS–T and ChAS–P and the Do–Eat assessment were similar to those reported in the literature between standardized assessments and parent and teacher questionnaires, ranging between .40 to .59.

in the control group) by means of a convenience sample. Therefore, care needs to be exercised in generalizing our findings and future research hypotheses to other groups of children.

**Recommendations for Future Research**

This study’s findings underscore the Do–Eat’s potential to distinguish between children with DCD and typically developing children ages 5 to 6.5. Future studies should include testing children diagnosed with DCD who are >6.5 and evaluating children with learning disabilities, attention deficit hyperactivity disorder, or both. In this study, we examined the reciprocal relationships among various assessment components. Future studies should examine the relationships among sensory–motor performance skills, executive functions, and general performance. A study to evaluate test–retest reliability is being conducted in the near future to explore the stability of scores over time for those with DCD and other populations. In the next step of validating the Do–Eat, a large-scale study with random samples should be conducted to build norms for this novel instrument. ▲

**References**


(Schoemaker, Smith-Engelsman, & Jongmans, 2003; Wilson et al., 2000). The strength of correlations is usually weak to moderate, thus supporting the currently accepted notion that although questionnaires may have advantages, they cannot substitute for an evaluation process (Wilson et al., 2000). In recent years, the viability and reliability of parent and educator reports on child functioning have been widely debated. Wilson et al. (2000) claimed that many factors influence questionnaire validity, such as coexisting deficits, thereby confounding reliable questionnaire reports. Moreover, a questionnaire is susceptible to both parents’ and teacher’s expectations of the child, as well as those of professionals (Case-Smith, 1995).

In addition, questionnaire responses may be influenced by the time and location of completion (e.g., the waiting room or the therapy clinic; Green et al., 2005). These contextual effects may also serve to clarify our study findings. As presented previously, correlations between the Do–Eat assessment and the teacher questionnaire (ChAS–T) were stronger than those obtained for the Do–Eat and the parent questionnaire (ChAS–P). By contrast, Rosenblum (2006) found stronger correlations between the M–ABC and the parent questionnaire. Likewise, Green et al. (2005) showed that the Developmental Coordination Disorder Questionnaire parent questionnaire enhanced identification of DCD compared with the M–ABC teacher questionnaire. This disparity may be attributable to the fact that our study was conducted mainly in kindergarten settings, teachers were briefed on study objectives and were invited to participate in the process, and teachers informed parents and allowed several to observe the assessment process. Relationships with most parents were limited, with the exception of those few parents of children who were the researcher’s clients. Therefore, teachers’ involvement and awareness may have influenced and even biased their questionnaire reports.

In summary, the analysis of the relationships between the overall Do–Eat score and other assessment tools provides evidence of a significant relationship. Specifically, significant correlations between the Do–Eat’s sensory–motor component and the other assessment tools were obtained for both the total sample and the sample of children with DCD. The Do–Eat evaluation tool therefore shows considerable promise for diagnosing DCD, substantially advancing our understanding of the deficit beyond mere functional difficulties in areas of motor coordination.

**Limitations**

Data collection for the study and the Do–Eat testing process was conducted by Ayelet Goffer, who was also involved in designing and developing the tool. The study sampled a limited number of children (30 in the study group and 29
Appendix. Scoring Example: Preparing Chocolate Milk

Scoring: 5 = excellent performance, 4 = good performance, 3 = fair performance, 2 = poor performance, 1 = very poor performance, 0 = not observed.

Child’s name: __________________________________________________

<table>
<thead>
<tr>
<th>Task performance</th>
<th>Score (0–5)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bringing box to the table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spreading out items on the table</td>
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<td></td>
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<tr>
<td>Putting chocolate powder and milk in the glass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixing the drink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washing hands</td>
<td></td>
<td></td>
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<tr>
<td>Cleaning the table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall score _____________________ = average score 9</td>
<td></td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Sensory–motor skills analysis</th>
<th>Score (0–5)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skills</td>
<td></td>
<td></td>
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<tr>
<td>Motoricity</td>
<td></td>
<td></td>
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<tr>
<td>Posture and movement relationships</td>
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<tr>
<td>Motor planning</td>
<td></td>
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<tr>
<td>Bilateral coordination</td>
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<tr>
<td>Fine motor coordination</td>
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<td></td>
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<tr>
<td>Sensation</td>
<td></td>
<td></td>
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<tr>
<td>Overall score _____________________ = average score 6</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Executive functions</th>
<th>Score (0–5)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skills</td>
<td></td>
<td></td>
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<tr>
<td>Attention</td>
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<tr>
<td>Initiation</td>
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<tr>
<td>Sequencing</td>
<td></td>
<td></td>
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<tr>
<td>Transition from one activity to another</td>
<td></td>
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<tr>
<td>Spatial and temporal organization</td>
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<tr>
<td>Inhibition</td>
<td></td>
<td></td>
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<tr>
<td>Problem solving</td>
<td></td>
<td></td>
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<tr>
<td>Remembering instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall score _____________________ = average score 9</td>
<td></td>
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</tbody>
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