
The Dynamic Occupational Therapy Cognitive Assessment for Children (DOTCA–Ch): A New Instrument for Assessing Learning Potential

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KEY WORDS

- attention deficit hyperactivity disorder (ADHD)
- cognition
- learning disability
- pediatric
- traumatic brain injury (TBI)

OBJECTIVE. To describe the development and psychometric properties of the Dynamic Occupational Therapy Cognitive Assessment for Children (DOTCA–Ch), a dynamic criterion-referenced assessment of cognitive abilities and learning potential for children with cognitive and learning difficulties.

METHOD. A series of studies analyzed the age standards, criterion cutoff scores, and percentage of mediation cues required for typically developing children 6–12 years of age, as well as reliability and validity.

RESULTS. MANOVA analyses determined four age groups that best fit the outcome data: 6–6.11, 7–8.11, 9–10.11, and 11–12 years. Criterion cutoff scores of 25% for at-risk and under 10% for deficient performance were obtained for each age group. Dynamic percentage scores were determined. Significant high interrater reliability and moderate to high internal consistency reliability were found. Construct validity was supported by comparing children with traumatic brain injury and learning disabilities to typically developing children, and ecological validity of children with attention deficit hyperactivity disorder by comparing performance on the DOTCA–Ch to the School Function Assessment.

CONCLUSIONS. The DOTCA–Ch is a reliable and valid assessment that provides learning potential and can facilitate intervention for cognitive difficulties that manifest themselves in daily functions among school-age children.

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Introduction

This article describes the development and validation of a new instrument designed to assess the cognitive abilities and learning potential of children from ages 6 to 12 years via a dynamic mediation testing process. Currently, no other standardized occupational therapy assessment battery of children's cognitive abilities exists. This lack of an instrument presents a limitation for pediatric occupational therapists, who are uniquely suited and often called on to treat and facilitate the participation and performance of children with cognitive deficits in a wide variety of occupational domains. The Dynamic Occupational Therapy Cognitive Assessment for children (DOTCA–Ch), a criterion-referenced assessment, was designed to fill this need. Originally based on the Loewenstein Occupational Therapy Cognitive Assessment (LOTCA), an assessment for adults with neuropsychological deficits (Itzkovich, Averbuch, Elazar, & Katz, 2000; Katz, Itzkovich, Averbuch, & Elazar, 1989), and the LOTCA Geriatric version for elderly persons (Itzkovich, Elazar, & Katz, 1996), the DOTCA–Ch represents an adapted and modified format that is appropriate for use with school-age children.

The DOTCA–Ch was designed to serve two major purposes. First, it provides a baseline measure for the intervention of children referred for occupational therapy treatment because of various cognitive and learning difficulties. In addition, due to its dynamic properties, the DOTCA–Ch identifies potential areas of cognitive strength that can be tapped so children may benefit from mediated learning.

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Table 1. DOTCA–Ch Subtests

Cognitive Domains	Subtests	No. of Items
<i>Orientation:</i> Awareness of self in relation to surroundings. Requires consistent and reliable integration of attention, perception, and memory.	1. Orientation to Place (OP)	4
	2. Orientation to Time (OT)	4
<i>Spatial Perception:</i> The active process of searching for corresponding information, distinguishing the essential features of an object, comparing the features of an object, comparing the features with each other, creating appropriate hypotheses, and comparing these hypothesis with the original data.	3. Directions on Body (SP1)	4
	4. Spatial Relations Between Child and Objects in Near Space (SP2)	4
	5. Spatial Relations in a Picture (SP3)	4
<i>Praxis:</i> The ability to plan and perform purposeful movement.	6. Motor Imitation (MI)	12
	7. Utilization of Objects (UO)	5
	8. Symbolic Actions (SA)	5
<i>Visuomotor Construction:</i> The ability to integrate visual stimuli and to construct or draw a reproduction (Cermak, 1984). It consists of three activities: copying, drawing, and building or assembling.	9. Copy Geometric Forms* (GF)	
	10. Reproduction of 2-D Model* (2-DM)	
	11. Pegboard Construction* (PC)	
	12. Colored Block Design* (CB)	
	13. Plain Block Design* (PB)	
	14. Reproduction of Puzzle (RP)	
	15. Drawing a Clock (DC)	
<i>Thinking Operations:</i> Includes the ability to identify discrete features of objects, to appreciate them hierarchically, and to classify them.	16. Categorization (CA)	
	17. ROC Unstructured (RU)	
	18. ROC Structured (RS)	
	19. Pictorial Sequence A (PS–A)	
	20. Pictorial Sequence B (PS–B)	
	21. Geometrical Sequence A (GS–A)	
	22. Geometrical Sequence B (GS–B)	

Note. DOTCA–Ch = Dynamic Occupational Therapy Cognitive Assessment for Children.

*Include immediate and delayed memory testing.

This table was adapted from Ziviani, Rodger, Pacheco, Rootsey, Smith, and Katz (2004) with permission from the publishers.

The DOTCA–Ch battery consists of 22 subtests in 5 cognitive domains: Orientation, Spatial Perception, Praxis, Visuomotor Construction, and Thinking Operations (see Table 1). During the test development process, the tasks within each of the domains were determined to follow a hierarchal progression that corresponds to the development of cognitive function in children. In addition, to enhance the sensitivity of the measures, the subtests within the Visuomotor Construction and Thinking Operations domains were designed to provide the examiner with information regarding speed of performance. Finally, immediate and delayed memory is tested in five of the Visuomotor Construction subtests.

Dynamic Assessment

Conventional standardized cognitive tests are static in nature, examining the current performance of a person for the purpose of identifying and quantifying cognitive deficits (Toglia, 1998). Such static tests, however, fall short of the goal of cognitive testing as described by Thorndike in 1924: that, ideally, estimates of intelligence should be estimates of the ability to learn (as cited in Guthke & Beckmann, 2000).

Evidence suggests that in human development, brain growth continues into adolescence, which stimulates cogni-

tive development, including the capacity for abstract reasoning and the ability to use ever-more sophisticated strategies for problem solving (Kipke, 1998). In recent years researchers have seen an increased awareness of the potential ability of dynamic assessment techniques (Rothman & Semmel, 1990) to provide professionals with the opportunity to estimate a child's cognitive and learning potential and receptiveness to instruction (Fabio, 2005; Feuerstein, 1979; Lidz & Elliot, 2000).

Dynamic assessment is based on Vygotsky's (1978) concept of the zone of proximal development, which refers to the discrepancy between what a child can do independently and what he or she can do with the help and guidance of others (Grigorenko & Sternberg, 1998). This concept is somewhat similar to the mediated learning experience, a concept that was independently developed by Feuerstein, Rand, Hoffman, and Miller (1980). In mediated learning, adults serve as catalysts for learning by modifying the child's internal arousal, as well as the specific task demands, to allow for improved cognitive performance. Thus, according to mediated learning theorists, the beneficial effects of dynamic assessment and teaching techniques on children's ability to learn and use more effective cognitive strategies are not limited to children with deficits but

also can be applied to typically developing children in regular school settings (Grigorenko & Sternberg, 1998). In line with these considerations, one should expect that even among typically developing children, initial scores on dynamic assessments, such as the DOTCA–Ch, should improve after the dynamic mediation phase of the testing procedure, especially in the younger age ranges and the more complex cognitive domains.

Toglia introduced the use of a structured, graded system of cues to the evaluation of cognitive and perceptual deficits among adults with cognitive impairments (Toglia, 1998, 2005). Following in the footsteps of earlier dynamic cognitive theorists, she believed that the examiner could learn much about underlying information-processing strategies through the observation of a client's responses to such cues. In this way, dynamic assessment becomes naturally linked to intervention and can be used as a baseline for choosing and designing an intervention program (Toglia, 1994, 2005).

Specifically, in dynamic assessments such as the DOTCA–Ch, a child's initial incorrect response is not taken as the final outcome measure of his or her performance. Instead, the examiner uses a systematic approach to modify the task through prompts or other forms of mediation, which provides an understanding of the types of information essential for the child in completing the task. This feature, which is unique to dynamic assessments, also enables the examiner to collect information that can be helpful in developing effective intervention strategies (Rothman & Semmel, 1990). Indeed, the use of such feedback during and after testing demonstrates how dynamic assessment ascribes to the principle underlying the learning test concept, specifically that learning can take place even within the actual testing process (Guthke & Beckmann, 2000).

Test Development

The history of the DOTCA–Ch began in 1974 with the development of the LOTCA battery by a team of clinicians from the Loewenstein Rehabilitation Hospital, Israel. The LOTCA, designed as a primary cognitive evaluation for persons with head injuries (Itzkovich et al., 2000), was derived from a cumulation of clinical experience as well as from neuropsychological and developmental theories and evaluation procedures (Averbuch & Katz, 2005). The LOTCA battery has been standardized and researched extensively for its reliability and validity in various populations and cultures (Annes, Katz, & Cermak, 1996; Averbuch & Katz, 2005; Cermak et al., 1995; Itzkovich et al., 2000; Katz, Hartman Maeir, Ring, & Soroker, 2000; Katz et al., 1989).

Results from research performed on a sample of typically developing children ($N = 240$) from ages 6 to 12 years indicated that the LOTCA test items follow a hierarchical progression that corresponds to the development of cognitive abilities in children (Averbuch & Katz, 1991; Itzkovich et al., 2000). These findings highlighted the test's potential suitability as an assessment for children. Later, the test was used in a study performed on two different cultural groups (i.e., Ethiopian and Bedouin children who were typically developing), the results of which determined the LOTCA's sensitivity to cultural and environmentally based influences on children's cognitive developmental performance (Katz, Kizony, & Parush, 2002; Parush, Sharoni, Hahn-Markowitz, & Katz, 2000; Rosenblum, Katz, Hahn-Markowitz, & Parush, 2000).

As a result of these findings, the original LOTCA battery underwent a series of modifications to adapt it for use with children. For example, in the subtests for Visuomotor Construction, in addition to crediting children for completing the test items, the test developers added a measure of response time for each item. This modification results from the understanding that the time required for an individual to respond to a visual perception-based task is a more sensitive measure of processing ability than task accuracy alone (Hung, Fisher, & Cermak, 1987; Solan, 1987; Solan & Mozlin, 1986). Mozlin (1995) used the term *perceptual speed* to describe the time required to respond to visual-perceptual tasks. These researchers suggested that the child with a perceptual speed deficit would require more time and more of his or her attentional reserves to complete an assignment than his or her peers.

Another modification made by test developers was the evaluation of the individual's immediate and delayed memory. This assessment component was added to five of the seven subtests included in the Visuomotor Construction domain of the DOTCA–Ch. Immediate memory (short-term working memory) typically lasts from about 30 seconds to several minutes and serves as a limited capacity store from which information is transferred to a more permanent store. It need be only of sufficient duration to enable a person to respond to ongoing events. In contrast, delayed memory refers to the person's ability to store information for a longer period (Lezak, 1995).

The major design modification made by the authors of the DOTCA–Ch, however, was the introduction of a structured dynamic test procedure, in addition to the original static testing procedure. This modification followed from the increased awareness that dynamic assessment techniques can supply information beyond what is obtainable through traditional static assessments. Specifically, these techniques inform clinicians as to the person's problem-solving style and

ability to benefit from instruction (Fabio, 2005; Rothman & Semmel, 1990; Toglia, 1998, 2005).

In accordance with the changes in test design that resulted from these modifications, test developers established a three-phase administration format (see Figure 1). The initial phase of the test administration is the static phase, in which the child's cognitive status, or baseline cognitive performance, is measured. After this, in the dynamic phase of the test battery (i.e., Phase II), the examiner provides the child with structured hierarchical cues as required, designed to elicit his or her maximum learning potential. The final retest phase of the DOTCA-Ch was designed to determine the child's learning potential and receptiveness to instruction. This is accomplished by having the examiner *readminister* the test items and analyze whether the child's performance has improved since the initial testing phase. It is important to note that mediation was incorporated into all test domains except for Orientation. This section of the battery is the only one requiring a verbal response alone and has a built-in recognition phase if the child cannot answer the questions.

The five structured levels of mediation used in the dynamic phase of the DOTCA-Ch administration were adapted with permission from Toglia (1994). In order of increasing intensity of mediation, the levels are Level 1—general intervention; Level 2—general feedback; Level 3—specific feedback; Level 4—structured feedback, pictorial examples, or demonstration; and Level 5—reduced task complexity. Each level indicates a type of mediation that is most helpful to a specific child. Thus, the mediation level required for a child to succeed serves to guide the clinician in determining whether and how intervention should proceed.

The flexibility of the test design allows the DOTCA-Ch to be used in either of two ways. If the purpose of test administration is to establish a baseline measure of a child's cognitive performance, the static testing phase can be administered alone. If the test, however, is being administered to determine a child's ability to benefit from mediation or to plan intervention, all three phases of the battery should be used.

Another advantage of the DOTCA-Ch is its practicality. Although the administration of the entire battery can take up to 1 hour and a half, it does not have to be com-

pleted in a single session. The only constraint is that all of the items within each individual cognitive domain must be completed within a single testing session. Further, administration requires only limited space, a child-size table, and two chairs; all other materials are provided in the test kit. The testing room should be well lit and ventilated and also free from noise and other distracting influences.

Having completed the necessary modifications to the test battery, the next stage of the DOTCA-Ch test development process involved the determination of its psychometric properties. This article describes the steps taken for this stage of the test development process.

Method

We conducted a series of studies to determine the psychometric properties of the DOTCA-Ch with respect to these three outcome categories: (a) *Step 1*—standards of performance of typically developing children, such as age standards, criterion cutoff scores, and dynamic percentage scores (i.e., percentage of mediation cues required across test domains and age groups); (b) *Step 2*—interrater reliability and internal consistency; and (c) *Step 3*—construct and ecological validity.

Permission to perform the research studies was obtained from the Israeli Ministry of Education and the Human Rights Committee of the Ministry of Health before the data were collected. Additionally, written consent was obtained from the participants' parents and school principals. In all phases of this research the DOTCA-Ch was administered by experienced occupational therapists trained in its use, in accordance with the standardized protocol described in the manual (Katz, Parush, & Traub Bar-Ilan, 2005). All participants were tested individually under similar environmental conditions.

Step 1: Standards of Performance of Typically Developing Children

Methods and procedure. Data were collected from a convenience sample of 381 typically developing children between ages 6 and 12 years, in various schools around Israel. The participants were recruited by occupational therapists who worked at the schools at the time of the study. The age and gender distribution of the participants can be found in Table 2.

The DOTCA-Ch was administered by six trained and experienced occupational therapists. Reliability of scoring among these examiners was established by having each of them individually score a videotape of a child. Overall agreement between them was found to be high, 91.8 (i.e., Orientation, 83%; Spatial Perception, 98.6%; Praxis,

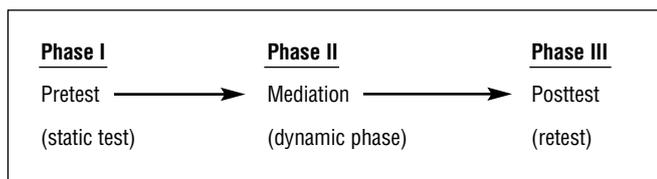


Figure 1. A Three-Phase Administration Format

Table 2. Gender Distribution in the Four Age Groups

Age Range (in years)	No. of Boys	No. of Girls	Total
6–6.11	20	18	38
7–8.11	57	59	116
9–10.11	68	86	154
11–12.0	36	37	73
Total	181	200	381

Note. No significant difference chi square; (3) = 1.31, $p = 0.73$.

88.9%; Visuomotor Construction, 95%; Thinking Operations, 88.6%). For the few specific points in which raters disagreed, consensus was reached after a group discussion.

Data analysis. After the data were collected, multivariate analysis of variance (MANOVA) was performed to determine the age group divisions that would reflect statistically significant differences between group performance across test domains. In addition, computations of one-way ANOVA with post hoc Scheffé comparisons were applied to compare the groups' performance.

Next, chi-square analysis was performed to determine whether significant differences in test performance would be found between boys and girls within age groups. Descriptive statistics for all five domain scores and their respective subtests (mean, standard deviations, minimum, and maximum) were performed for each of the four age groups found to best fit the data. For each age group, cutoff scores were calculated, as well as the mean percentage level of mediation that was required for performance in each cognitive domain (referred to as *dynamic percentage scores*). Finally, pretest and posttest scores of the children in all age groups and cognitive domains were compared using paired t tests.

Results.

• **Standards of performance.** On the basis of the MANOVA analysis, statistically significant differences for all of the DOTCA–Ch total domain scores were found between participants grouped according to the following age ranges: 6–6.11 years, 7–8.11 years, 9–10.11 years, and 11–12.0 years (Table 3). In addition, chi-square analysis found no significant differences across genders for participants within the four age groups ($\chi^2 = [3] = 1.31, p = 0.73$).

The data indicate that mean performance increased with age for all total scores in the five cognitive domains, including immediate and delayed memory components of Visuomotor Construction, whereas mean performance time significantly decreased (Figures 2 and 3). The ANOVA results demonstrated a similar pattern. These differences, however, leveled out with increasing age, as can be seen by the post hoc comparisons that are significant with the exception of the results of the comparison between the two older age groups (Table 3).

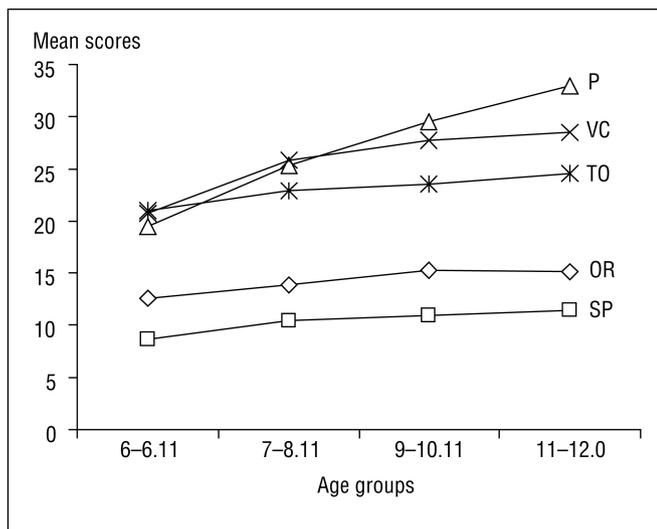
• **Cutoff scores by age groups.** Criterion cutoff scores were obtained from the frequency analyses of scores received by children in each age group for all domains of the DOTCA–Ch (Katz et al., 2005). These scores enable the examiner to get a relative measure of a child's cognitive performance in each domain in comparison to his or her age-group peers in the standardization sample. Specifically, children who obtain scores at or below the 10% level (i.e., performed less well than 90% of the sample) scored between minus 1–2 standard deviations of the mean standardized score, indicating that their cognitive performance is defi-

Table 3. One-Way ANOVA for Total Cognitive Domain Scores of the DOTCA–Ch Between Four Age Groups

DOTCA–Ch Domains	A (6–6.11 Years)		B (7–8.11 Years)		C (9–10.11 Years)		D (11–12.0 Years)		F
	M	(SD)	M	(SD)	M	(SD)	M	(SD)	
Orientation	12.61	(1.59)	13.97	(1.51)	15.28	(0.97)	15.22	(0.77)	$F_{(3,377)} = 68.79$
Spatial Perception	8.63	(2.19)	10.5	(1.76)	10.99	(1.58)	11.42	(1.15)	$F_{(3,372)} = 27.21$
Praxis	19.55	(4.27)	25.29	(6.7)	29.54	(5.66)	33.05	(4.38)	$F_{(3,200)} = 36.21$
Visuomotor Construction	20.79	(4.22)	25.83	(3.84)	27.74	(3.59)	28.47	(3.19)	$F_{(3,373)} = 41.48$
Immediate Memory	13.59	(4.07)	17.93	(4.20)	18.02	(4.06)	19.60	(4.16)	$F_{(3,373)} = 16.59$
Delayed Memory	20.18	(3.26)	21.35	(3.02)	23.03	(1.82)	23.38	(1.07)	$F_{(3,192)} = 13.49$
Thinking Operations	20.96	(3.88)	22.87	(4.59)	23.6	(4.02)	24.6	(2.15)	$F_{(3,377)} = 7.98$
Post Hoc Scheffé									
Total Area Scores	A vs. B	A vs. C	A vs. D	B vs. C	B vs. D	D vs. C			
Orientation	*	*	*	*	*				
Spatial Perception	*	*	*	*	*				
Praxis	*	*	*	*	*				
Visuomotor Construction	*	*	*	*	*				
Immediate Memory	*	*	*	*	*				
Delayed Memory		*	*	*	*				
Thinking Operations		*	*	*	*				

Note. DOTCA–Ch = Dynamic Occupational Therapy Cognitive Assessment for Children, ANOVA = analysis of variance. $p < .0001$ for all comparisons. Range of scores possible: Orientation, 1–16; Spatial Perception, 1–12; Praxis, 1–44; Visuomotor Construction, 7–35; immediate, 5–25; Thinking Operations, 7–35.

* Indicates significant differences between 2 groups.

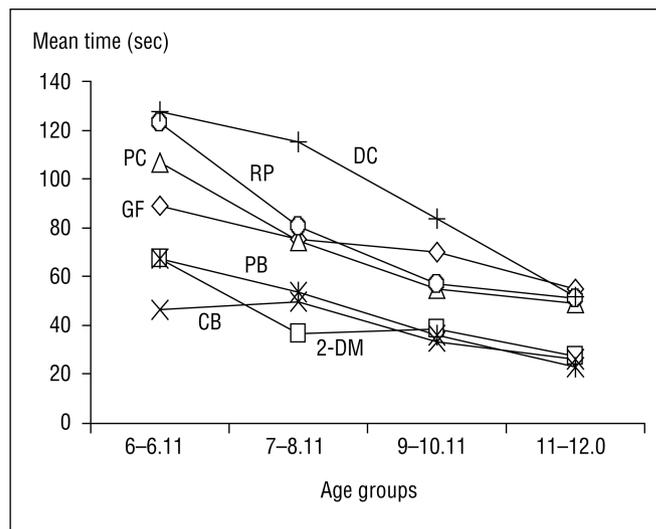


Note. OR = Orientation; SP = Spatial Perception; P = Praxis; VC = Visuomotor Construction; TO = Thinking Operations. One-way ANOVA significant at $p < .0001$ for all domains; post hoc Scheffé varies.

Figure 2. DOTCA-Ch Pretest Domain Means, by Age Groups: Typically Developing Children

cient. Further, children who obtained scores at or below the 25% level (i.e., performed less well than 75% of the sample) scored between minus $\frac{1}{2}$ –1 standard deviations of the mean standardized score, indicating that they are at risk for cognitive dysfunction. Thus, for example, a 6-year-old child who obtains a total Visuomotor Construction score of 15, corresponding to the 10% cutoff score for this domain, performs at -1.37 z score below the mean ($M = 20.79$, $SD = 4.22$) of the standardized sample within his or her age group. This result would indicate to the examiner that the child has a cognitive deficiency in this domain relative to same-age peers. Further, if this same 6-year-old had obtained a score below 18.75, which corresponds to the 25% cutoff score for Visuomotor Construction, this score is -0.48 z score below the mean of the standardized sample of this age group. This score would indicate to the examiner that the child is at risk for deficiency in this cognitive domain.

- *Dynamic percentage scores by age groups.* The dynamic percentage scores indicate the mean of the mediation level used in each cognitive area for each age group. A score of 0 indicates that no mediation was necessary, as is the case for children who performed at the maximal score on the pretest (static phase of the DOTCA-Ch). A score of 1 indicates that only general intervention was required, representing minimal mediation, whereas a score of 5 indicates that either the child required the maximum amount of mediation to perform a task, or that even given the maximum mediation, he or she was unable to accomplish the task. For example, in the Praxis subtest, about 88% of the older chil-



Note. GF = copy geometric forms; 2-DM = reproduction of 2-D model; PC = pegboard construction; CB = colored block design; PB = plain block design; RP = reproduction of puzzle; DC = drawing a clock. One-way ANOVA significant at $p < .000$ for all domains except 2-DM; post hoc Scheffé varies.

Figure 3. Mean Times for Visuomotor Construction Subtests by Age Groups: Typically Developing Children

dren (i.e., 11–12.0 years) required no mediation (i.e., a score of 0). The percentage of children requiring mediation (i.e., with a score > 0) increases within each of the successively younger age group, to a level of 36% in the youngest group (ages 6–6.11 years), among whom about 10% to 17% required the use of maximum mediation (mediation at all available levels).

The data indicate that even typically developing children benefited from mediation, especially in the performance of the tasks in the more complex cognitive domains, such as Visuomotor Construction and Thinking Operations (Katz et al., 2005). In addition, when pretest and posttest scores of the typically developing children were compared in these cognitive domains, t test analyses revealed a significant improvement following mediation ($t = 9.61$, $p < .001$ for Visuomotor Construction; $t = 23.36$, $p < .0001$ for Thinking Operations).

Step 2: Reliability Studies

Methods and procedure. Interrater reliability of the test was determined on a group of 20 children who were typically developing. These children were randomly selected from all the age groups within the original sample of 381 children who were tested to determine performance standards of the DOTCA-Ch. Interrater reliability was examined through intraclass correlation (ICC) analysis, comparing the results of the participants' scores as obtained by two expert DOTCA-Ch administrators. Internal consistency reliability was performed using Cronbach's alpha on the entire sample.

Results. Results of the ICC analysis revealed very high reliability coefficients for all cognitive domains, ranging from .87 to .99 (Table 4). In addition, internal consistency reliability, analyzed from the whole data pool, resulted in moderate-to-high alpha coefficients ranging from .61 to .77 for the different domains (Table 4).

Step 3: Validity Studies

Construct validity.

- **Methods and procedure.** Construct validity was established by comparing DOTCA–Ch scores of typically developing children to an age-matched and gender-matched group of children with traumatic brain injury (TBI) and, in two separate comparative studies, to two samples of children with learning disabilities. Data analyses were performed on pretest and posttest scores using MANOVA analyses over the 5 cognitive domains and 2 groups.

In the TBI versus control study, a consecutive sample of 44 children with TBI (ages ranging from 6 to 12 years, mean age 9.3 years, $SD = 1.6$; 26 girls and 18 boys), as determined by a pediatric neurologist and confirmed by CT scanning, were recruited from two rehabilitation hospitals' day treatment centers. These participants were matched by age and gender to 43 typically developing children (mean age = 9.7, $SD = 1.5$; 25 girls and 19 boys) selected from the original pool of 381 typically developing children used to determine DOTCA–Ch performance standards.

In the children with learning disabilities versus control studies, a convenience sample of 30 second-grade children (mean age = 7.5 years, $SD = 0.6$; 9 girls and 24 boys) and 32 third-grade children (mean age = 9.0 years, $SD = 0.4$; 22

girls and 7 boys) with learning disabilities were recruited from a sampling of regular schools across central Israel. These children were reported by specially licensed educational psychologists (approved by the Israeli Board of Education) as having learning disabilities. Next, the DOTCA–Ch was administered to an age-matched convenience group of 60 second-grade and third-grade children who were typically developing (mean age = 8.14 years, $SD = 0.6$; 35 girls and 25 boys) and who had no history of learning difficulties.

- **Results.** Comparison of children with TBI to children who were typically developing showed significant differences at pretest for all cognitive domains ($p < .000$) and time to complete the Visuomotor Construction domain, except for Praxis (Table 5). Significant differences in posttest scores were found for two domains (i.e., Visuomotor Construction [$p < .002$] and Thinking Operations [$p < .000$]). When scores in the other three domains were examined, children with TBI had improved with mediation and performed more similarly to the typically developing children. Although differences were still found, they were nonsignificant. Unfortunately, in this study only the items from the original short version of the Praxis domain were administered, which was the probable reason that no significant differences were found. In fact, these results were the reason for the further, extensive elaboration of the Praxis domain (Katz et al., 2005).

For the two studies in which the scores of children with learning disabilities were compared to those of typically developing children, only Visuomotor Construction and Thinking Operations were tested. MANOVA analysis revealed significant ($p < .01$) differences between sample groups in scores for all subtests at pretest and posttest except one comparison at posttest ($p < .05$). Time to complete the Visuomotor Construction domain also was significantly different at $p < .01$ (Table 5).

Overall, children with disabilities performed less well and were slower during the pretest static phase (i.e., baseline); however, all improved with mediation, including children who were typically developing. In addition, statistically significant differences were found between pretest and posttest scores of children in the three populations (typically developing, with learning disabilities, with TBI) (Katz & Parush, 2003). See Figure 4 for means of performance in the groups with learning disabilities and TBI.

Ecological Validity.

- **Methods and procedure.** The initial examination of ecological validity was performed by administering the DOTCA–Ch to a convenience sample of 30 second-grade to fourth-grade children with attention deficit hyperactivity

Table 4. Interrater and Internal Consistency Reliability

Interrater Reliability ($n = 20$)	
DOTCA–Ch Domains ICC	
Orientation	.93
Spatial Perception	.95
Praxis	.91
Visuomotor Construction	.99
Immediate Memory	.99
Thinking Operations	.87
Internal Consistency Reliability ($n = 381$)	
DOTCA–Ch Domains Alpha Coefficient	
Orientation	.61 (8 items)
Spatial Perception	.74 (12 items)
Praxis	.70 (23 items)
Visuomotor Construction	.61 (7 items)
Immediate Memory	.64 (5 items)
Thinking Operations	.77 (8 items)

Note. DOTCA–Ch = Dynamic Occupational Therapy Cognitive Assessment for Children, ICC = interclass correlation coefficient.

Table 5. MANOVA Analyses Comparing DOTCA–Ch Domain Scores of Three Groups of Children

DOTCA-CH Domains	Children With TBI (<i>n</i> = 44) vs. TD Children (<i>n</i> = 43)				*Children With LD 2nd grade (<i>n</i> = 30), 3rd grade (<i>n</i> = 32) vs. TD Children 2nd grade (<i>n</i> = 30), 3rd grade (<i>n</i> = 30)							
	Pretest		Posttest		Pretest				Posttest			
	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i> (2nd grade)	<i>p</i>	<i>F</i> (3rd grade)	<i>p</i>	<i>F</i> (2nd grade)	<i>p</i>	<i>F</i> (3rd grade)	<i>p</i>
Orientation	33.16	.000	—	—	—	—	—	—	—	—	—	—
Spatial Perception	19.22	.000	0.004	.949	—	—	—	—	—	—	—	—
Praxis	1.04	.311*	3.49	.065	—	—	—	—	—	—	—	—
Visuomotor Construction	14.62	.000	10.03	.002	48.99	.01	16.15	.01	27.84	.01	5.80	.05
Immediate Memory	—	—	—	—	13.28	.01	12.30	.01	—	—	—	—
Thinking Operation	12.88	.000	19.81	.000	35.21	.01	12.64	.01	31.95	.01	17.07	.01

Note. DOTCA–Ch = Dynamic Occupational Therapy Cognitive Assessment for Children, MANOVA = multivariate analysis of variance, TBI = traumatic brain injury, TD = typically developing, LD = learning disabilities.

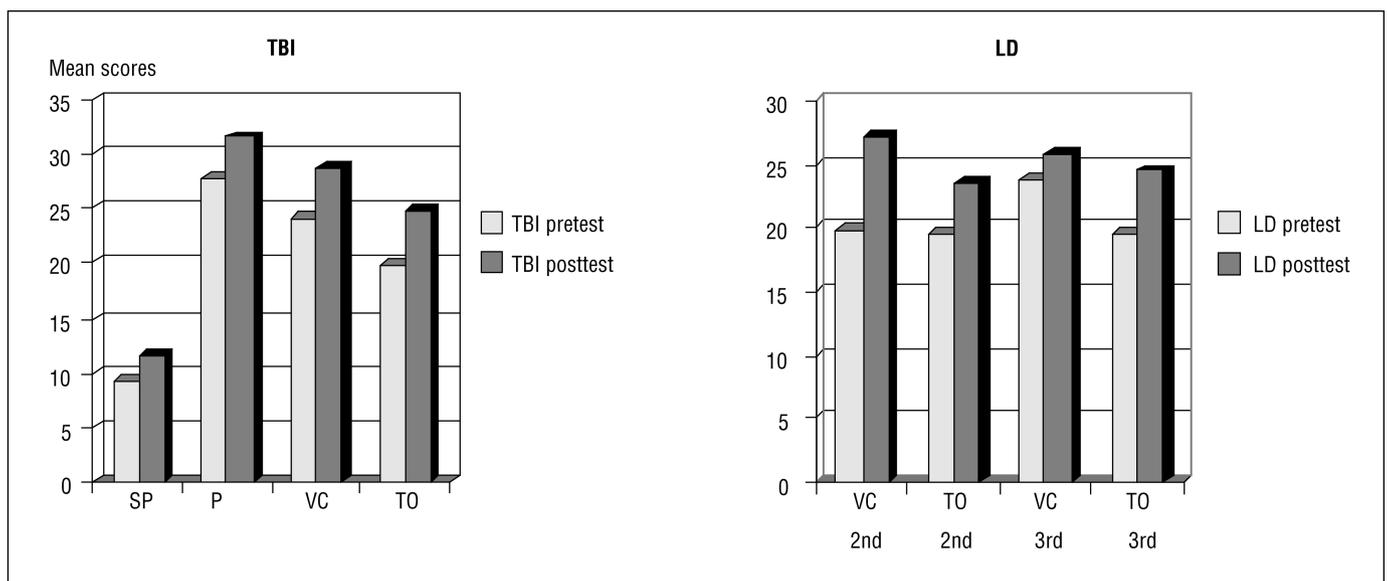
* Only 2 domains were tested; — = not administered.

* Original brief version of Praxis subtest was used in this study.

disorder (ADHD) (mean age 8.5 years, *SD* = 1.0; 25 boys and 5 girls) recruited from regular elementary schools in northern Israel (De la Vega, 2004). The children’s diagnosis had been determined by a developmental pediatrician according to the criteria of the *DSM-IV* (American Psychiatric Association, 1994) and was confirmed by the scores obtained by their classroom teachers on the Conners Teacher Rating Scale–Revised (Conners, 1997), a questionnaire commonly used to identify the presence of characteristic behavioral symptoms of ADHD. In addition, the children’s teachers were asked to complete the School Function Assessment (SFA), a tool used to rate children’s functional performance in both physical and cognitive–behavioral tasks that they are expected to perform in the school environment (Coster, Deeney, Haltiwanger, & Haley, 1998).

Next, the relationship between the 5 total cognitive domain scores on the DOTCA–Ch and teachers’ ratings of children’s functional performance in both physical and cognitive/behavioral tasks of the SFA were analyzed by calculating Pearson correlation coefficients.

• *Results.* The study revealed significant correlations (range .35–.71, *p* < .05) between the children’s scores in the Orientation, Visuomotor Construction, and Thinking Operations domains of the DOTCA–Ch and their performance of cognitive–behavioral tasks according to the SFA. Moreover, significant correlations, ranging from *r* = .36–.63 (*p* < .05) were obtained between the children’s scores in the Spatial Perception, Praxis, Visuomotor Construction domains of the DOTCA–Ch and their performance of functional physical tasks of the SFA.



Note. DOTCA–Ch = Dynamic Occupational Therapy Cognitive Assessment for Children, TBI = traumatic brain injury, LD = learning disability, SP = Spatial Perception, P = Praxis, VC = Visuomotor Construction, TO = Thinking Operations. All comparisons statistically significant.

Figure 4. Mean Performance of Children With Traumatic Brain Injury and Learning Disabilities on DOTCA–Ch Domains at Pretest and Posttest

Discussion

Currently, no standardized occupational therapy assessment exists for the evaluation of cognitive functioning among children. The DOTCA–Ch, originally based on the LOTCA cognitive assessment for adults, was developed for two main purposes. First, it provides an efficient and child-friendly measure of cognition among children ages 6–12 years. Further, through its dynamic testing properties, the DOTCA–Ch provides a means of identifying potential areas of cognitive strength. It is believed that the dynamic testing properties of the DOTCA–Ch could enable its use by pediatric practitioners as a tool for planning intervention strategies tailor-made for the individual child under treatment.

As described previously, a series of studies were undertaken with respect to 3 outcome categories related to the DOTCA–Ch: performance of typically developing children within four age groups (i.e., 6–6.11 years; 7–8.11 years; 9–10.11 years; and 11–12.0 years), test reliability, and test validity.

The results of the studies described revealed that the mean performance of typically developing children significantly increased in all of the cognitive domains of the DOTCA–Ch, with a concomitant decrease in the mean performance times for each successive age group (Katz et al., 2005). These results strengthen the previous research findings that the test items sensitively measure the expected developmental progression of cognitive abilities in children (Averbuch & Katz, 1991; Itzkovich et al., 2000). Thus, research on the DOTCA–Ch seems to highlight its potential to accurately assess the difficulties experienced by some children in progressing in accordance with expected norms, with respect to their cognitive growth and development.

The study of performance on the DOTCA–Ch by typically developing children also resulted in the determination of cutoff percentiles. These data are intended to provide clinicians with the means to correctly identify children who are deficient in specific cognitive domains (i.e., performance at percentiles $\leq 10\%$) and those who are at risk for learning difficulties and academic underachievement (i.e., performance at percentiles $\leq 25\%$). Early identification of potential cognitive deficiencies are vital to provide timely interventions and prevent the development of secondary behavioral and psychological sequelae (Creedy et al., 2005; Williams & Holmes, 2004) that may lead to lower participation in daily functioning.

Finally, the research findings indicated that even the scores of typically developing children improved from pretest to posttest DOTCA–Ch scores, and a substantial percentage of typically developing participants required moderate and maximum levels of mediation in the more

complex cognitive domains (i.e., Visuomotor Construction and Thinking Operations), as determined by the percentage of mean dynamic mediation scores. These findings—in addition to the parallel findings of even greater improvements between pretest and posttest scores among the children with disabilities—support the validity of the dynamic mediational component of the DOTCA–Ch in facilitating improvements in problem solving and learning potential in children with and without disabilities. In fact, it is this property of the mediated learning approach on which the assessment and educational programs of classical dynamic assessment theorists Vygotsky and Feuerstein were derived (Grigorenko & Sternberg, 1998).

Reliability

The reliability of an assessment refers to the stability and dependability of its scores across time (test–retest reliability) or examiners (interrater reliability) or of the items within a scale (internal consistency reliability) (Crocker & Algina, 1986). Assessment reliability ensures that consistent scores are obtained with each use and irrespective of the specific person administering the test.

In the analysis performed on 381 typically developing children, the internal consistency of the DOTCA–Ch domains ranged from $r = .61$ – $.77$, indicating a medium, albeit adequate, level of homogeneity between the various subtests in each area. Most likely these relatively moderate coefficient values were a consequence of the small number of subtests in each area. With respect to the examination of the interrater reliability of the DOTCA–Ch, as reported previously, the scores obtained by two independent expert examiners on a group of 20 children were found to be high for all 5 test domains. These results were similar to those of a recent pilot study in which high Kappa coefficients and percentage of agreement were found between rater scores in a small group of Australian children ($n = 11$) (Ziviani et al., 2004). This similarity indicates that, overall, the process of administering and rating the DOTCA–Ch scores is clear and structured well enough so as to enable objective and reproducible results between examiners.

Validity

The construct validity of an instrument refers to its ability to perform in a way that is consistent with the presumed underlying constructs (Law, 2001), which is critical in enabling users to judge the test results' significance.

The findings of significantly better mean performance scores and decreases in performance time among the typically developing children within four progressively older age groups (i.e., ages 6–12 years) indicated the validity of the DOTCA–Ch as a developmental measure of cognitive

function. Furthermore, the results supported the validity of the dynamic assessment procedure of the DOTCA–Ch. Specifically, dynamic percentage score calculations indicated that even these children who were typically developing benefited from the mediation procedure, especially in the more complex cognitive domains (i.e., Visuomotor Construction and Thinking Operations). Moreover, *t* test analysis comparing pretest and posttest scores in these domains indicated significantly better scores.

Construct validity also was examined through a known-groups comparison technique in which the scores obtained by typically developing children on the pretest, posttest, and dynamic phases were compared to those of children with disabilities known to affect cognitive abilities, such as children with learning disabilities and TBI.

Results indicated that significantly better scores in all three test phases were obtained by typically developing children, as compared to those of age-matched children with learning disabilities. Similarly, when the scores of typically developing children were compared to those of age- and gender-matched children with TBI, significant differences were found across cognitive domains with respect to pretest, posttest, and mediation scores.

These findings support the ability of the DOTCA–Ch to distinguish between the baseline cognitive status of children who are typically developing and those with known cognitive difficulties and also reveals significant differences with respect to the amount of mediation they required. A much higher percentage of mediation is apparent among children with cognitive disabilities, indicating that they require more elaborate and specific cuing during intervention. Hence, this research supports the contention of the tool's developers, that the DOTCA–Ch provides a measure of children's strengths and weakness across cognitive domains and can inform practitioners regarding the types of mediational techniques that are successful in facilitating task performance. The DOTCA–Ch, therefore, enables therapists to treat children with cognitive impairments through interventions individually tailored to the individual child. Specifically, the intervention provided to a child can accommodate his or her learning potential through the use of the appropriate mediation approach (e.g., refocusing, verbal cuing, demonstration, and reducing task complexity).

The current study findings regarding the validity of the DOTCA–Ch were strengthened by the findings of Yu (2004). In her study, Yu compared the performance on the DOTCA–Ch battery of 20 Taiwanese children (mean age 9 years, 5 months) who had been diagnosed with developmental cognitive disabilities (DCD) but no other learning difficulties to that of 20 gender and age-matched children

without DCD who were typically developing. As expected in Yu's study, of all the cognitive domains tested by the DOTCA–Ch, the children with DCD scored significantly lower than the typically developing children only on the Praxis domain. Thus, her findings support the validity of the Praxis subtests of the DOTCA–Ch in evaluating the motor planning abilities of children.

Moreover, Yu's study provided initial indications of the concurrent validity of the praxis domain of the DOTCA–Ch. Yu compared the DOTCA–Ch Praxis scores of her study sample to scores obtained for them on two other well-known assessments used for children with DCD. Specifically, these included the Movement Assessment Battery for Children (MABC; Henderson, & Sugden, 1992), a widely used and well-recognized test to identify children with praxis and movement difficulties, and the Parent Questionnaire from the Perceived Efficacy Goal Setting System (PEGS; Missiuna, Pollock, & Law, 2004), a survey that assesses parental perceptions of the child's performance on everyday motor tasks. Results revealed significant moderate correlations between the Praxis subtests' scores of the children with DCD with the results of the MABC and the PEGS Parent Questionnaire.

Finally, as previously described, De la Vega's (2004) findings of significant correlations between the scores of children with ADHD on the DOTCA–Ch and results of the SFA provide an initial indication of the ecological validity of the DOTCA–Ch. *Ecological validity* refers to the functional and predictive relationship between assessment scores and behavior in a functional real-world setting (Long & Sbordone, 1996; Silver, 2000). Thus, De la Vega's study provides support for the ability of the DOTCA–Ch scores to reflect the functional performance of children with cognitive disabilities within the context of the school environment. These relationships were discussed recently by Cermak (2005), emphasizing the issues of attention and executive functions in her in-depth writing of cognitive rehabilitation for children with ADHD.

In summary, the results of the research on the psychometric properties of the DOTCA–Ch assessment indicate its suitability to evaluate the cognitive status and learning potential of children with cognitive difficulties that manifest themselves in daily functions among school-age children. Further studies are indicated to establish its reliability and validity in different cultural and diagnostic populations. ▲

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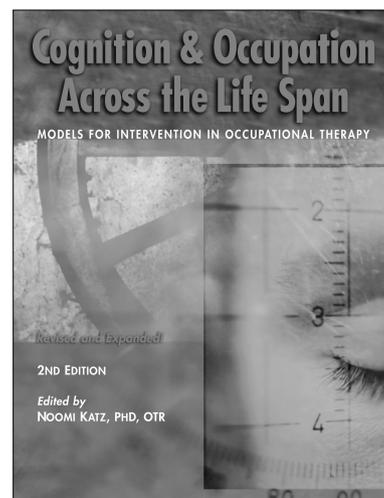
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