CHAPTER

17

The Effects of the Seria-Think Program (STP) on Planning, Self-Regulation, and Math Performance Among Grade 3 Children with Attention Deficit Hyperactivity Disorder (ADHD)

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INTRODUCTION

Children with attention deficit hyperactivity disorder (ADHD) who are included in regular classes often have a normal range of intelligence. It is not rare to see the internal contradiction between their normal IQ and their much poorer than expected academic achievement. These children are often aware of the gap between their intellectual ability and their underachievement (Barkley, 2003, 2006, 2012). The fact that most children with ADHD are within the normal range of intelligence allows relatively immediate changes to occur following an intervention focused on cognitive strategies aimed at improving self-regulation and planning behavior. Consequently, these changes are expected to affect school achievement. The objective of the current study is to demonstrate the effectiveness of one such intervention, the Seria-Think Program (STP; Tzuriel & Trabelsi, 2010), in enhancing self-regulation, planning, and math skills of children with ADHD.

Cognition, Intelligence, and Achievement.
DOI: http://dx.doi.org/10.1016/B978-0-12-410388-7.00017-8

First, we discuss the characteristics of children with ADHD and then the importance of self-regulation and planning for efficient school achievements and, especially in math, various intervention programs with ADHD children, and, finally, the STP program.

CHARACTERISTICS OF ADHD

ADHD is a behavioral condition that makes focusing on everyday requests and routines challenging. Children with ADHD typically have trouble getting organized, staying focused, making realistic plans, and thinking before acting. They may be fidgety, noisy, and unable to adapt to changing situations. Children with ADHD can be defiant, socially inept, or aggressive (American Psychiatric Association, 2000).

ADHD is currently identified by diagnostic criteria that include two related symptom dimensions consisting of difficulties with inattention and with hyperactive–impulsive behavior (*Diagnostic and Statistical Manual for Mental Disorders*, 4th edition; *DSM–IV-TR;* American Psychiatric Association, 2000). According to *DSM–IV-TR*, three subtypes of ADHD can be diagnosed: Predominantly Inattentive (ADHD-I), Predominantly Hyperactive–Impulsive (ADHD-HI), and Combined (ADHD-C). The Combined subtype is diagnosed when six or more symptoms of both inattention and hyperactivity–impulsivity are present. ADHD is diagnosed only when the symptoms are evident in two or more environments (e.g., home and school) and are associated with functional impairment. Early research suggested validity of differentiating the ADHD-I type from the ADHD-C type (Carlson, Lahey, & Neeper, 1986; Carlson & Mann, 2002; Milich, Balentine, & Lynam, 2001), as did some studies using neuropsychological measures (Solanto et al., 2007). However, more recent reviews comparing these subtypes have indicated that the traditional typology does not so much identify distinct subtypes of a disorder as variations in disorder severity (Baeyens, Toeyers, & Walle, 2006; Lahey & Willcutt, 2010; Nigg, Tannock, & Rohde, 2010). The subtypes are also unreliable in that they are highly related to the methods and sources of information used to assess ADHD (Valo & Tannock, 2010) and not especially stable over the lifespan (Barkley, 2012; Lahey & Willcutt, 2010).

ADHD is one of the most commonly diagnosed mental disorders of childhood, accounting for a large proportion of referrals to school psychologists and other school mental health professionals. According to the *DSM-IV-TR*, 3%–7% of school-age children have ADHD. Several researchers claim that 15%–17% of children in developed countries may have some kind of an attention problem that hinders their day-to-day functioning (Das & Papadopoulos, 2003; Skounti, Philalithis, & Galanakis, 2007).

For many children and adolescents, ADHD is associated with academic problems as evidenced by significant underachievement (Barkley, Anastopoulos, Guevremont, & Fletcher, 1991; Todd et al., 2002). Evidence from clinical and scientific literature indicates that children with ADHD demonstrate negative academic and emotional consequences of poor cognitive self-regulation. Children with ADHD also are more likely to exhibit impairments in reading and academic achievement as well as higher rates of learning disabilities (LD) and school dysfunction (Biederman et al., 1996). Poor organizational skills, manifested by misplacing or losing materials, forgetting materials, and failing to record assignments and due dates, can be detrimental to school performance and scholastic attainment (Power, Werba, Watkins, Angelucci, & Eiraldi, 2006).

The implications include a high level of frustration on school activities and achievement, low self-esteem, negative self-concept, and a self-reference of low intelligence (Baird, Scott, Dearing, & Hamill, 2009; Galéra, Melchior, Chastang, Bouvard, & Fombonne, 2009; Garner, 2009). The negative implications intensify with the increase in the number of reported symptoms (Edbom, Granlund, Lichtenstein, & Larsson, 2006, 2008). Given the high rate of academic problems, school-based interventions for children with ADHD are highly recommended (Schultz, Storer, Watabe, Sadler, & Evans, 2011).

THE IMPORTANCE OF SELF-REGULATION AND PLANNING FOR SCHOOL ACHIEVEMENT

The importance of self-regulation and planning as major executive functions necessary for school achievement is emphasized by many researchers (e.g., Barkley, 2003, 2006, 2012; Barkley & Fischer, 2011; Naglieri & Das, 2005). From a theoretical perspective, self-regulation is defined as a proactive process whereby individuals consistently organize and manage their thoughts, emotions, behaviors, and environment in order to attain academic goals (Boekaerts & Corno, 2005; Zimmerman, 2000; Zimmerman & Ramdass, 2011). Zimmerman (2008) claims that although self-regulation has been examined in many studies that have measured it in many different ways and provided valuable new information, it is still important to understand the influence of strategies for self-regulation on students' school achievements across ages (see also Cleary, Platten, & Nelson, 2008).

Naglieri and Das (2005) argue that children with ADHD are frequently described as displaying difficulty with executive functions or metacognition. Barkley and Fischer (2011) showed that difficulties in organization, time management, and planning, features of ADHD adversely affect children's functioning and persist through adulthood. Several researchers have reported that impairments in executive functioning lead to poorer academic outcomes across all ADHD subtypes, even under medications' influence (e.g., Abikoff et al., 2013; Alloway et al., 2009; Barkley, 2006; Capano, Minden, Chen, Schachar & Ickowicz, 2008; DeVito et al., 2009; Galéra et al., 2009; Hong, 1995; Pennington & Ozonoff, 1996; Winstanley, Eagle, & Robbins, 2006). Impairments in arousal, inhibitory control, delay tolerance, working memory, and time perception likely impede self-regulatory behaviors and interfere with organizing actions and planning (Barkley, Koplowitz, Anderson, & McMurray, 1997; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). A common approach for ameliorating organization, time management, and planning difficulties may be through interventions that address executive function deficits. However, there is no evidence from controlled studies that efforts to improve executive processes in children with ADHD do actually ameliorate their organization, time management, and planning difficulties (Abikoff et al., 2013).

INTERVENTION PROGRAMS FOR CHILDREN WITH ADHD

Despite the negative impact of ADHD on academic and other daily life situations, few systematic efforts have targeted these domains in elementary school-age children (DuPaul & Eckert, 1997; DuPaul, Eckert, & Vilardo, 2012). Intervention programs are crucial, especially for young children who first encounter expectations for many independent, organized behaviors at home and in school. Several researchers comment that given the high rate of academic deficits, school-based interventions for children with ADHD should be developed and recommended as much or even more than clinic-based interventions (Iseman & Naglieri, 2011; Schultz et al., 2011). Results from interventions for children with ADHD have varied between the medical, behavioral, cognitive-behavioral, and cognitive approaches. Some researchers argue that behavioral techniques appear to be best suited to address problems with disruptive behavior, whereas cognitive interventions appear most promising for some comorbid disorders (e.g., Greene et al., 2004) or as part of treatments involving caregivers (e.g., Chronis, Gamble, Roberts, & Pelham, 2006; Levine & Anshel, 2011). Goldstein and Naglieri (2008) argue that systematically applied cognitive behavioral therapy has been found to lead to symptom and impairment reduction in adults with ADHD. In a review of school-based interventions for children with

ADHD, Reid, Vasa, Maag, and Wright (1994) indicated that although teacher implemented interventions are effective in reducing ADHD-related behaviors, they are less effective in enhancing academic performance.

Some researchers argue that treatment of ADHD must be multidisciplinary and multimodal, and it must be maintained over a long period of time (Goldstein & Goldstein, 1998; Goldstein & Naglieri, 2008; Goldstein & Teeter-Ellison, 2002; Teeter, 1998). Fabiano et al. (2007) reported that in spite of the fact that much of the treatment literature on ADHD has focused on stimulant medications, it is clear that psychosocial and cognitive interventions are often warranted. Similarly, Schultz et al. (2011) mentioned that by far the most effective short-term interventions for ADHD reflect the combined use of medical, behavioral, and environmental techniques. Other researchers have emphasized the fact that the academic successes of individuals with ADHD are usually dependent on the mediation they receive at the cognitive level. They believe that mediation for self-regulation and planning (Iseman & Naglieri, 2011) and metacognitive therapy (Solanto et al., 2010) may significantly improve children's performance at the strategies level as well as the content level (Shimabukuro, Prater, Jenkins, & Edelen- Smith, 1999). In their study, Iseman and Naglieri (2011) examined the effectiveness of a cognitive strategy intervention based on the Planning, Attention, Simultaneous, and Successive (PASS) approach (Das, Kar, & Parrila, 1996; Das, Naglieri, & Kirby, 1994; Naglieri & Das, 2005). Students in the experimental group received cognitive strategy instruction for 10 days, designed to encourage development and application of effective planning for mathematical computation. A comparison group received standard math instruction for an equal period of time. The results indicate that compared with the control group, students with ADHD in the experimental group evidenced greater improvement in math performance, showed far transfer to standardized tests of math (reflecting generalization of learned strategies to other similar tasks), and continued to show the advantage in a follow-up measurement one year later.

THE SERIA-THINK PROGRAM (STP)

The Seria-Think Program (STP; Tzuriel & Trabelsi, 2010) is based on the *Mediated Learning Experience* (MLE) theory (Feuerstein, Feuerstein, Falik, & Rand, 2002) and the *Seria-Think Instrument* (Tzuriel, 2000). MLE processes describe a special quality of interaction between a mediator and a learner (Feuerstein, Rand, & Hoffman, 1979; Tzuriel, 2002, 2011a, 2013). In this qualitative interactional process, parents, teachers, or peers interpose themselves between a set of stimuli and the learner and modify the stimuli for the learner (Tzuriel, 1999, 2001). The mediator presents stimuli to the children by modifying their frequency, order, intensity, and context; by arousing in the children curiosity, vigilance, and perceptual acuity; and by trying to improve and/or create in the child the cognitive functions required for temporal, spatial, and cause-effect relationships. Feuerstein and Feuerstein (1991) suggest 12 criteria of MLE, but only the first three are conceived as necessary and sufficient for an interaction to be classified as MLE: *Intentionality and Reciprocity*, *Meaning*, and *Transcendence* (for detailed description of all MLE criteria, readers are referred to Feuerstein & Feuerstein, 1991). MLE processes are considered as the proximal factor that explains *cognitive modifiability*. Cognitive modifiability is defined as the individual's propensity to learn from new experiences and learning opportunities and to change one's own cognitive structures.

The STP is based on the *Seria-Think Instrument* (Tzuriel, 1998, 2000) that is a dynamic assessment measure. It assesses basic cognitive processes in the mathematics domain and a variety of arithmetic skills, especially seriation, estimation, counting, and computation. The problems presented to the participant require cognitive functions such as planning, self-regulation and inhibition of impulsivity, systematic exploratory behavior, and simultaneous consideration of several sources of information. The Seria-Think Instrument was constructed with three versions for different ages: the 3×5 version (grades 1–3), the 5×5 version (grades 4–6), and the 7×7 version (grades 7–9). In the current study, we used the 5×5 version.

The instrument (5×5 version) contains a wooden block ($10 \times 6 \times 12$ cm) with five rows of holes, a set of cylinders (with heights of 3, 5, 7, 9, 11, 13, 15, 17, and 19 cm), and a measuring rod divided equally into 11 units (1 cm each). The wooden block has five rows of holes with five holes in each row (see Figure 17.1). The holes in the first row all have the same depth (1 cm). The depths of the holes in the second row increase progressively (1, 3, 5, 7, and 9 cm), whereas the depths of the holes in the third to fifth rows are mixed. The tasks in the Seria-Think Instrument involve insertion of the cylinders into the holes to get lines of cylinders with either equal height, regularly increasing height, or regularly decreasing height. The problems may be presented when the wooden block is turned to each of the four possible positions. The main rule in solving the problems is creating the line of cylinders with as few insertions as possible. Children are instructed to be as careful as possible when inserting the cylinders inside the holes. In order to avoid trial-and-error behavior, children are encouraged to use the measuring rod as many times as they wish and plan the solution.

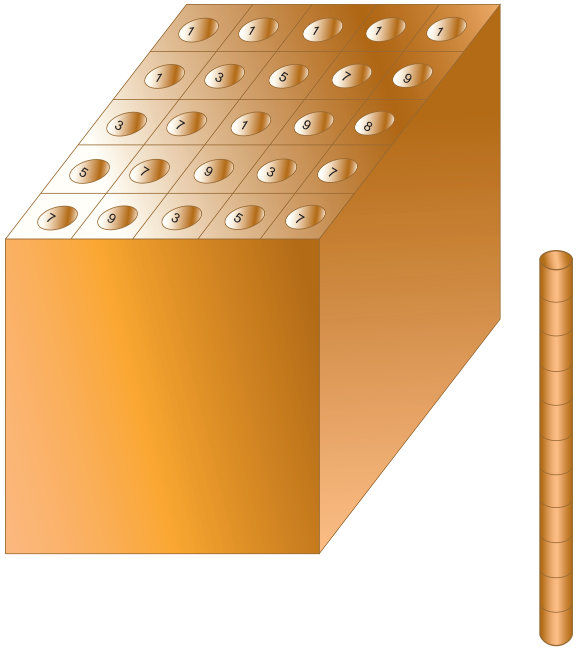

FIGURE 17.1 The Seria-Think Instrument (5 × 5 version).

In order to solve the problems, children have to apply a four-step strategy (P → M → C → S): (1) *Predict* the height of the cylinder above the surface level of the block, (2) *Measure* correctly the depth of the hole, (3) *Compute* the required length of cylinder (i.e., by adding depth to the predicted height), and (4) *Select* the correct cylinder (some are longer than the measuring rod). The task requires comparing the results not only within each hole but also between holes. It is important to emphasize here that for most holes there is no way of knowing their depth without using the measuring rod.

In teaching how to solve the problems, the mediator emphasizes the PMCS four-step strategy. The child is mediated strategies of planning behavior (e.g., preparing the solution outside the holes before inserting the cylinders), restraint of impulsivity in data gathering, need for precision (e.g., measuring the depth of the hole and the length of cylinder), and comparative behavior (e.g., comparing the depth of the hole to the required height). When the Seria-Think Instrument is used as a test, the child's responses are recorded according to three criteria: performance (correctness of solution) and two process-oriented measures, which are number of insertions and number of measurements (relatively few insertions and more measurements indicate reflective behavior).

A derived score of number of insertions by number of measurements is also available. This score may reveal qualitative aspects about the child's patterns of dealing with the problems. For example, a child who measures only rarely and makes many unnecessary insertions is considered to be impulsive compared to a child who makes frequent measurements but fewer insertions; the latter child is considered to be more reflective. Validity and reliability of the Seria-Think Instrument is reported in the literature (e.g., Tzuriel, 2000).

THE CURRENT STUDY

For the current study, the concepts and strategies of the Seria-Think Instrument were elaborated to create a novel, short cognitive education program designed to modify the self-regulation and planning abilities of children with ADHD and consequently their math skills. The STP is composed of a set of seven structured lessons (45 minutes each) aimed at teaching children self-regulation and planning behavior in the math domain.

During the intervention, the mediator introduces to the student the components of the instrument, the types of problems, and specific problem-solving strategies. Throughout the lessons, the child is encouraged to use systematic exploratory behavior, inhibit tendencies for impulsivity, develop need for accuracy in measuring depth of holes and length of cylinders, and plan the solution before acting. Feelings of competence are enhanced by rewarding the child for successful solution and by interpreting successful performance, even partial. In the current study, we used a shortened version of the program composed of only three 50-minute lessons. Unfortunately, we had to shorten the program because of restrictions imposed by the Ministry of Education, which, against our views, thought that taking the children out of their class for cognitive intervention would cause loss of learning in subject matter. During the first lesson, the students were familiarized with the instrument's characteristics and the measurement procedure. During the second lesson, the students learned the task demands (creating rows of equal, increasing, and decreasing heights above the block surface level) and had to solve six problems in the first two rows using the specific strategies of *prediction*, *measurements*, *computation*, and *selection*. During the third lesson, students applied the strategies learned in the first and second lessons to rows with mixed order of depths. The students solved on the average between five and seven problems.

The objective of the current study was to examine the effects of the STP on planning, self-regulation, and math achievement among third grade children with ADHD. The main hypothesis was that the experimental group would show greater pre- to post-test improvement on planning, self-regulation, and math achievement than the control group.

METHOD

Participants

A group of 87 third grade students diagnosed with ADHD participated in the study. The students came from 27 inclusive classrooms randomly selected from 11 schools in the central part of Israel. All students met the *DSM-IV-TR* criteria for ADHD. The students were randomly assigned into experimental ($n = 44$) and control ($n = 43$) groups. All participants received the usual programming in school, but the experimental children received the intervention in addition to the usual programming. The mean age of children in the experimental (M = 9.07 years, SD = .34) and control (M = 9.04 years, SD = .41) groups was similar: $t(85) = .70$, *ns*. The percent of boys (77.3% vs. 86.0%) and girls (22.7% vs. 14.0%) in the experimental and control groups was also similar: $\chi^2 = .24$, *ns*. The percent of children on medication (72.7%) and without medication (27.3%) in the experimental group was similar to the percent of children on medication (53.5%) and without medication (46.5%) in the control group: $\chi^2 = .30$, *ns*. Parents' consent for their children participating in the study was obtained before the start of data gathering.

Measures

Complex Figure Test. The Complex Figure Test (CFT; Rey, 1956) consists of a reproduction of a complex geometric figure with 18 internal and external details. The CFT was administered three times: before intervention (T1) and after intervention (T2 and T3). The administration of the CFT *after* the intervention was carried out using a DA procedure so that a teaching phase was introduced between T2 and T3. The DA procedure used in the current study after the intervention was composed of five phases: (a) reproducing the figure directly from the stimulus model (Copy I), (b) reproducing the figure from memory (Memory I), (c) teaching how to draw the figure, (d) post-teaching reproduction of the figure from the stimulus model (Copy II), and (e) post-teaching reproduction of the figure from memory (Memory II). During the teaching phase, the child is mediated to produce the figure using efficient strategies of gathering information, planning the stages of performance (from whole to parts, directionality), using a systematic and analytic approach, and using precision in performance (proportions, details, line quality). Comparison of Copy and Memory performances in T1 and T2 provides information about improvement due to the intervention program. Comparison of Copy and Memory performances in T2 and T3 provides an indication of the child's *cognitive modifiability* as a result of the intervention. In other words, the DA at the end of the intervention (change in performance from T2 to T3) provides information regarding how children benefit from MLE given within the DA procedure.

The scoring system provided quantitative and qualitative evaluation of the subject's performance. Each of the 18 parts of the drawing was scored one point for accuracy (e.g., part correctly drawn and proportioned) and one point for correct location to a combined Accuracy + Location Copy and Accuracy + Location Memory score. The maximum score for each is 36 (18 × 2). The qualitative score was based on the level of organization of the figure as evaluated by the examiner on a rating scale from 0 (lowest) to 6 (highest) resulting in Organization Copy and Organization Memory scores. Level of organization is based on the order of drawing (from main features to details) and level of cohesion of the figure. The level of organization was rated by two trained examiners who reached a high level of agreement (Cronbach alpha = .89). Cronbach alpha reliabilities reported by Tzuriel (2001) on a combined score of Accuracy + Location for pre- and post-teaching scores were .89 and .92, respectively.

Matching Familiar Figures Test (*MFFT*). The MFFT (Kagan, 1965) is used to measure the bipolar trait of reflection-impulsivity. The original children's version of the MFFT contains 2 practice and 12 experimental items. Each item consists of a standard picture of a common object and six variants, one identical to the standard and five slightly different in one detail each. The student is asked to choose the variant that matches the standard, with five incorrect choices allowed per problem. Two measures are recorded: performance (accuracy) and reaction time between presentation of the item and the response. Children with short reaction time and poor performance accuracy are considered to be impulsive, whereas children with longer reaction time and better performance accuracy are considered reflective. Kagan and Kogan (1970) reported that the correlation between MFFT and another cognitive test for reflective-impulsive dimension was higher for reaction time measurement ($r = .87$) and lower for performance ($r = .64$). The reliability of repeated tests after one year ranges from $r = 62.$ to $r = .52$ (Kagan & Kogan, 1970). López and López (1998) reported Cronbach alpha reliabilities of .73 for errors and .92 for latency in a sample of 1,200 Spanish students using the short MFT20 version developed by Cairns and Cammock (1978).

Confirmatory factor analysis demonstrated a two-factor solution for the relationship between reflection-impulsivity as measured by the MFFT and various measures of executive functions, and supports the notion that the two are differing but associated constructs (Filippetti & Richaud de Minzi, 2012).

Strategic Planning Math Exam (*SPME;* Tzuriel & Trabelsi, 2010). The SPME is based on the design of the *Novel Task for Examining Strategic Planning* (Kofman, Gidley-Larson, & Mostofsky, 2008) adapted for math problems. Originally, Kofman et al. (2008) used decision-making tasks in which the participants were asked to decide whether a series of figures were similar or different. Some of the tasks were framed, and subjects were instructed that the correct solution of each framed task was given a score of 4 rather than a score of 1 given to unframed tasks. We adapted this procedure to math problems of addition and subtraction (range of 0–21). The math problems were constructed on the basis of the math curriculum of the Israeli Ministry of Education and were aimed at measuring basic knowledge and achievement in math. We designed the SPME so that a third of the problems were framed (18/54) and students were instructed that correct performance on each framed exercise was given a score of 4 rather than a score of 1 given to unframed problems. The math exam included 54 exercises divided in a matrix of 3 columns × 3 rows. Each column is divided into 3 parts (addition, subtraction, and mixed), and each row is divided into 3 parts based on the level of complexity (2 numbers, 3 numbers, and 3 numbers with 1 unknown) (see Appendix 17.1). The SPME was administered in 15 minutes; every 5 minutes, students were instructed to change the color of pencil they used. This procedure allowed us to assess the planning of the solution process, much like the procedure used in the dynamic assessment administration procedure of the Complex Figure Test (Rey, 1956; Feuerstein et al., 2002). The SPME produces two scores:

a. Planning-dependent math score. Each framed problem is scored 4 ($18 \times 4 = 72$), and each of the unframed problems is scored 1 ($36 \times 1 = 36$) to a maximum total score of 108.

b. Math score. Each correct solution of the 2 number problems (upper row) gets a score of 1, each correct solution of the 3 number problems (middle row) gets a score of 2, and each correct solution of the 2 number problems with 1 unknown (bottom row) gets a score of 3. The total score is 108 ($18 + 36 + 54$ for top, middle, and bottom rows, respectively).

Cronbach alpha coefficients for math scores pre- and post-intervention test were .93 and .91, respectively.

Procedure

All participants were administered the tests before and after the intervention in the following order: Complex Figure Test, MFFT, and Math Exam. The experimental group received the STP for three lessons over 2 weeks, whereas the control group received a substitute program that included practice of math problems.

RESULTS

Complex Figure Test

The means and standard deviations of the CFT in Times 1 to 3 are presented in Table 17.1. The experimental group showed higher performance on all scores than the control group in Time 3; the scores in Times 1 and 2 were similar in both groups. A series of three MANOVA's of Treatment by Time (2×3) were carried out on each of the CFT variables. The findings revealed significant Treatment by Time interactions only on Organization Copy, $F_{(2,84)} = 5.97$, $p < .01$, $\eta^2 = .12$; and on Organization Memory scores, $F_{(2,84)} = 12.67$, $p < .01$, $\eta^2 = .23$. The interactions are portrayed in Figures 17.2 and 17.3. As can be seen in Figures 17.2 and 17.3, the experimental group showed higher performance than the control group only in Time 3. Between-groups *t*-tests for each time revealed significant group differences only in Time 3 for Organization-Copy, $t_{(85)} = 3.85$, $p < .001$; and for Organization-Memory, $t_{(85)} = 5.07$, $p < .001$.

It should be noted that although no significant Treatment × Time interactions were found for Accuracy + Location Copy and Memory scores, we nevertheless analyzed the differences between the experimental and control groups in each time. The findings showed that the experimental group received higher scores than the control group only in Time 3; Accuracy + Location Copy, $t_{(85)} = 2.18$, $p < .05$; Accuracy + Location Memory, $t_{(85)} = 2.28$, $p < .05$.

Matching Familiar Figures Test

The means and standard deviations of the MFFT reaction time and performance accuracy scores are shown in Table 17.2. Two repeated-measure ANOVAs of Treatment by Time (2×2) were carried out—one for reaction time and one for performance accuracy. The results revealed a significant interaction only for reaction time, $F_{(1,85)} = 18.66$,

TABLE 17.1 Means and Standard Deviations of the Complex Figure Test Scores by Treatment by Time

		Time		
Group		**I**	**II**	**III**
ACCURACY + LOCATION COPY				
Experimental	M	21.89	23.45	31.50
	SD	7.42	7.42	5.40
Control	M	21.74	21.95	28.67
	SD	8.54	7.73	6.62
ACCURACY + LOCATION MEMORY				
Experimental	M	12.61	15.52	31.50
	SD	7.18	8.87	5.51
Control	M	11.28	13.23	28.67
	SD	8.33	8.17	6.62
ORGANIZATION COPY				
Experimental	M	.97	1.58	5.04
	SD	1.14	1.36	1.13
Control	M	1.10	1.41	3.82
	SD	1.44	1.42	1.73
ORGANIZATION MEMORY				
Experimental	M	.48	1.14	4.90
	SD	.76	1.21	1.14
Control	M	.53	.91	3.35
	SD	1.10	1.21	1.65

$p < .001$, $\eta^2 = .13$. Simple main effects showed that the experimental group scored higher than the control group on reaction time only on post-intervention, $t_{(85)} = 3.67$, $p < .001$, assessment.

Strategic Planning Math Exam

The means and standard deviations of the SPME scores are presented in Table 17.3. The differences between the experimental and

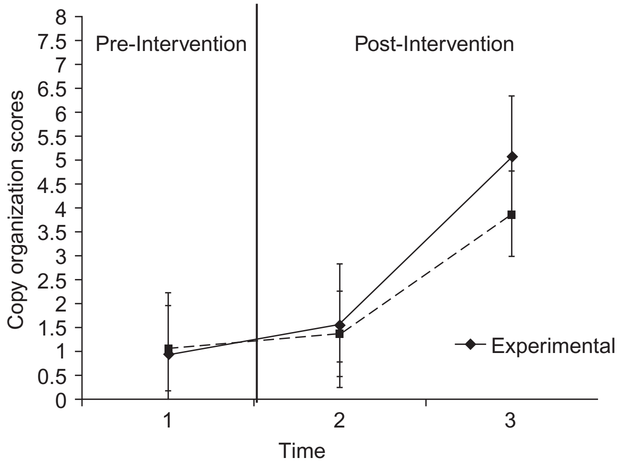

FIGURE 17.2 Organization-copy scores of the complex figure test by treatment by time.

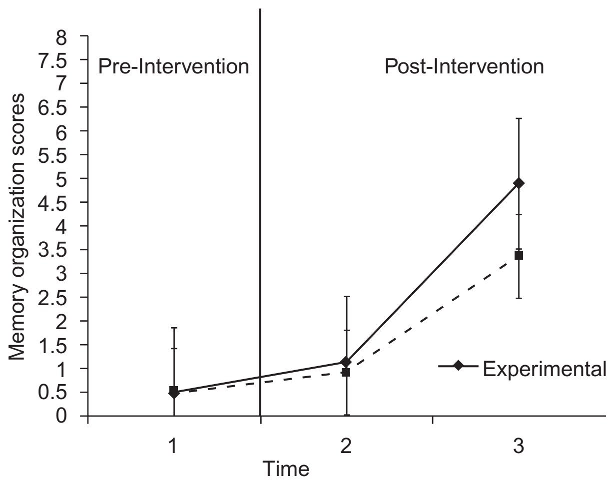

FIGURE 17.3 Organization-memory scores of the complex figure test by treatment by time.

control groups were analyzed by two-way repeated-measure ANOVAs of Treatment by Time (2×2) for planning-dependent math score and math score. The results showed significant Time by Treatment interaction for planning-dependent math score, $F_{(1,85)} = 6.52$, $p < .05$, $\eta^2 = .07$;

TABLE 17.2 Means and Standard Deviations of MFFT Reaction Time and Performance Accuracy Scores by Treatment by Time

Treatment		Time	
		Pre-Intervention	**Post-Intervention**
REACTION TIME			
Experimental	M	13.01	19.24
	SD	6.60	11.04
Control	M	12.60	12.00
	SD	6.31	6.75
PERFORMANCE			
Experimental	M	6.00	7.80
	SD	1.94	2.40
Control	M	5.05	6.12
	SD	2.20	2.71

TABLE 17.3 Means and Standard Deviations of Planning-Dependent Math Score and Math Scores by Treatment by Time

Treatment		Time	
		Pre-Intervention	**Post-Intervention**
PLANNING-DEPENDENT MATH			
Experimental	M	62.45	73.11
	SD	27.30	31.15
Control	M	53.26	54.72
	SD	22.72	32.29
MATH			
Experimental	M	55.24	67.15
	SD	30.02	32.34
Control	M	46.17	46.14
	SD	28.44	34.10

and for math score, $F_{(1,85)} = 7.60$, $p < .01$, $\eta^2 = .10$. Simple effect analysis showed significant group differences only on post-intervention scores, $t_{(85)} = 3.08$, $p < .01$; for planning-dependent math score; and $t_{(85)} = 2.78$, $p < .01$, for math score.

DISCUSSION

The objectives of the present study were to examine the effectiveness of the Seria-Think Program (STP) in improving the executive functions of planning and self-regulation as well as improvement of math performance among children diagnosed with ADHD. The improvement in planning and self-regulation may reflect a near-transfer effect, whereas the improvement in math may reflect a far-transfer effect. The findings showed clearly that the STP was efficient in improving children's planning as evidenced in the Complex Figure Test Organization Copy and Memory scores at Time 3. Adequate organization of the CFT requires systematic planning of a sequence of activities and accurate analysis of visuo-spatial order of components. Accurate verbalization of both the figure components and sequence of activities is also considered as an important factor facilitating adequate performance. It should be emphasized that the superiority of the experimental group over the control group on Organization scores of Copy and Memory (see Figures 17.2 and 17.3) was evident in Time 3, after the teaching phase of the DA procedure. It is impressive that the experimental group improved from an average score of below 1 on T1 to an average score of about 5 in both Organization Copy and Organization Memory on T3. These findings indicate that the intervention effects revealed themselves only in the DA procedure. More specifically, very often experimental and control groups show no treatment effects when standardized tests are used. However, when a DA procedure is applied, the experimental group shows much higher pre- to post-teaching change in performance than the control group. The findings of the current study support previous research concerning the effects of cognitive intervention on *cognitive modifiability* or *learning how to learn* skills (Tzuriel, 2011b; Tzuriel & Alfassi, 1994; Tzuriel, Kaniel, Kanner, & Haywood, 1999). One of the major claims in these studies is that if the declared objective of the intervention program is teaching children "learning how to learn" and to benefit from mediation, then the criterion outcome measure should be assessed by DA. The findings of the current study clearly indicate that children participated in the STP learned how to process seriational math-related tasks. It is expected that later these children would benefit from teaching given within the DA procedure and show a higher level of accessibility to mediation than children in the control group. This is exactly what was found in the DA measures of the CFT!

The findings are especially impressive in view of the fact that the STP, originally designed for seven sessions, was applied for only three sessions. This shortened version was forced by the Ministry of Education, which was concerned about loss of class time. The findings show that, nevertheless, children gained from the STP short version not only in terms of executive functions but also in math content as will be discussed later.

The MFFT results show significantly higher pre- to post-intervention increase in reaction time for the experimental group compared to the control group, which showed a slight decrease (see Table 17.2). These findings should be interpreted in the context of the task requirements and the meaning of reaction time for successful performance. A higher reaction time in the context of the MFFT means an inhibition of response that allows the child to activate executive functions. Barkley (2003, 2012) has asserted that executive functions allow for the developmental shift from external controls and cues to internal mental representations and self-control of individuals' behavior. In explaining executive functions in relation to ADHD, Barkley (1997a, b) posited that the core deficit is that of behavioral inhibition. Behavioral inhibition refers to three interrelated processes: (a) inhibiting the initial pre-potent response to an event; (b) stopping an ongoing response or response pattern, thereby permitting a delay in the decision to respond; and (c) protecting this period of delay and the self-directed responses that occur within it from disruption by competing events and responses (Barkley, 1997a; Barkley & Fischer, 2011). The central executive in Barkley's model is that of time awareness, including the ability of the individual to use hindsight and foresight in the problem-solving process (Lee, Riccio & Hynd, 2004). It seems that the STP, in its present short format, helped the experimental group to be more aware of the time factor of the MFFT tasks but did not help in improving the accuracy of the performance. One should expect a higher improvement of the experimental group over the control group with application of the full STP program.

Both planning-dependent math and math performance scores should be considered as far transfer measures. We assumed that the STP's focus on the executive functions of self-regulation and planning would lead to better performance. The results revealed that children in the experimental group achieved higher pre- to post-intervention improvement on both planning-dependent math and math scores than the control group, thus showing higher far-transfer effects. These findings indicate that the experimental group benefited from mediation within the program more than children in the control group.

These findings support previous research findings regarding enhancement of executive functions and academic content of children with ADHD (Goldstein & Naglieri, 2008; Lee, Riccio & Hynd, 2004) and learning disabilities (Iseman & Naglieri, 2011). The importance of applying cognitive education programs focused on specific executive functions with children with ADHD seems to be a very promising approach to grapple with a disorder that affects so many children. The findings are in line with the PASS theory (Das et al. 1996; Das et al. 1994) which emphasizes the role of Planning as an executive function responsible for controlling and organizing behavior, selecting and constructing strategies, and monitoring performance.

In conclusion, it seems that even a relatively brief intervention focused intensively on executive functions combined with basic math skills can modify children's executive functions (inhibition of impulsivity and planning), cognitive style (e.g., reflectivity), and academic math performance. Should the program be applied in its full length, one would expect a much stronger impact. We believe STP is effective in improving children's cognitive functions partly because of its game-like and engaging characteristics. The implications of this study are in orienting teachers and psychologists to the importance of training executive functions within the curriculum, especially of children with special needs. There is still a need for further research to examine the effectiveness of the full version of the STP in various academic domains, different ages, and different training strategies.

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APPENDIX 17.1: STRATEGIC PLANNING MATH EXAM (SPME)

15 + 3 =	19 − 7 =	14 + 3 =
9 + 3 =	13 − 8 =	15 − 9 =
9 + 7 =	19 − 19 =	16 + 2 =
7 + 12 =	14 − 7 =	19 − 8 =
8 + 9 =	12 − 9 =	9 + 10 =
8 + 11 =	18 − 6 =	19 − 11 =
16 + 2 + 1 =	19 − 2 − 5 =	19 + 1 − 7 =
6 + 9 + 4 =	19 − 9 − 7 =	13 − 12 + 11 =
17 + 0 + 2 =	15 − 2 − 4 =	14 + 6 − 9 =
4 + 12 + 3 =	9 − 6 − 1 =	12 − 5 + 12 =
9 + 3 + 7 =	11 − 3 − 4 =	16 + 3 − 9 =
2 + 11 + 6 =	18 − 8 − 5 =	18 − 2 + 3 =
2 + 3 + ___ = 17	17 − 8 − ___ = 6	19 + 0 − ___ = 3
15 + ___ = 19	12 − ___ − 3 = 2	4 − ___ + 12 = 15
___ + 13 + 1 = 19	___ − 4 − 1 = 12	9 + 6 − ___ = 10
9 + 0 + ___ = 13	10 − ___ − 1 = 7	10 − ___ + 3 = 9
___ + 8 + ___ = 18	19 − ___ − 10 = 7	2 + ___ − 1 = 12
1 + ___ + 14 = 17	16 − 8 − ___ = 3	19 − 8 + ___ = 19
Score:	Score:	Score:

Math Score: Planning Dependent Score: