A Pilot Study of Computerized Cognitive Training in Adults with Attention-Deficit/Hyperactivity Disorder: Change in Executive Functions and Quality of Life Following 3 Months of Training Using the AttenGo™ Program

Adi Stern, Yehuda Pollack, Avi Yakir, Adina Maeir

Key words: Adult attention-deficit/hyperactivity disorder, executive functions, cognitive training, occupational performance, quality of life

Abstract

Objective: Executive function (EF) deficits in adults with ADHD have been shown to have a negative impact on everyday functioning and quality of life (QOL). Very few cognitive training studies have targeted EF deficits in individuals with ADHD. Although positive effects have been demonstrated on training tasks, neuropsychological and ADHD symptomatology measures, additional evidence is needed to confirm these findings as well as to examine the effects on EFs, everyday functioning and QOL. Thus, the goal of this pilot study was to further examine the effect of computerized cognitive training for adults with ADHD on measures of ADHD symptomatology, EFs, occupational performance and QOL. **Method:** Adults with ADHD (N=14) trained on the AttenGo™, an on-line computerized cognitive program. **Results:** Before and

Adi Stern, MSc, OT, School of Occupational Therapy, Faculty of Medicine, Hadassah and Hebrew University of Jerusalem, Jerusalem, Israel. Department of Adult Psychiatry, Hadassah University Medical Center Ein Kerem, Jerusalem. adischleyer@hotmail.com

Yehuda Pollak, PhD, The Neuropediatric Unit, Shaare Zedek Medical Center, Jerusalem. Department of Psychology, Hadassah and Hebrew University of Jerusalem, Jerusalem. msyehu@huji.ac.il

Avraham Yakir, M.D., Psychiatrist, NATIV - Multidisciplinary Adult ADHD Center, Medical Director, Jerusalem, Tel-Aviv, ISRAEL. avi.yakir@nativ-adhd.co.il

Adina Maeir, PhD, OT, School of Occupational Therapy, Faculty of Medicine, Hadassah and Hebrew University of Jerusalem, Jerusalem, Israel. adinamaeir@gmail.com

after comparison demonstrated significant, moderate to large effects of the training on all outcome measures except the COPM. **Conclusion:** The findings provide preliminary supporting evidence for computerized cognitive training in adults with ADHD and warrant further controlled studies to examine its potential impact on functional outcomes.

Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is a chronic mental health disorder of childhood characterized by inattention, impulsiveness and hyperactivity (Diagnostic and Diagnostic and Statistical Manual of Mental Disorders, 4th edition [DSM-IV]; APA, 1994). Long-term controlled follow-up studies have shown that the disorder persists in a sizeable number of adults who were diagnosed as having ADHD in childhood, and the estimated prevalence of adult ADHD is approximately 4% of adults worldwide (Wilens, Faraone, & Biederman, 2004). ADHD is now increasingly recognized as a developmental impairment of executive functions (Brown, 2008). The term executive function (EF) refers to a wide range of higher cognitive processes that enable goal-directed behavior and play a critical role for all individuals as they manage multiple tasks of daily life. EFs include response inhibition, initiation, implementing strategies for performance, shifting, intrusion control, working memory and control of complex cognitive or motor responses (Brown, 2008; Castellanos, Sonuga-Barke, Milham, & Tannock, 2006; Lezak, Howieson, Loring, Hannay, & Fischer, 2004; Nigg et al., 2005; Roth & Saykin, 2004). Converging evidence points to prominent disturbances in a wide range of EFs in children and adults with ADHD that impedes the quality of their daily lives (Biederman et al., 2006, 2007; Nigg et al., 2005; Roth & Saykin, 2004).

The functional and occupational implications of living with ADHD are becoming more evident as the research on adult ADHD increases. These implications include impairments in academic, occupational, social, and emotional domains of functioning (Solanto, Marks, Mitchell, Wasserstein, & Kofman, 2008). In addition, adults with ADHD have been shown to be at greater risk for lower socioeconomic status, fewer years of education, lower academic achievements, lower rates of professional employment, more frequent job changes, more work difficulties, increased rates of antisocial behavior and arrests, driving violations, relationship difficulties manifested in interpersonal conflicts and higher rate of spousal separation and divorce (Adler et al., 2008; Barkley, 2002; Barkley, Murphy, & Fisher, 2008; Brod, Johnston,

Able, & Swindle, 2006; Solanto et al., 2008; Wilens et al., 2004). Therefore, it is not surprising that adults with ADHD demonstrate serious impediments in their quality of life (Barkley, 2002; Barkley et al., 2008; Wilens et al., 2004). These broad and pervasive functional implications of ADHD have been shown to be uniquely affected by the cognitive executive symptoms of ADHD. Thus, deficits in executive functioning have been found to have a negative impact on the functional outcomes of adults with ADHD beyond that conferred by the diagnosis of ADHD alone (Biederman et al., 2006; Solanto et al., 2008). Taken together, these findings suggest that a treatment focus on the cognitive executive symptoms of ADHD may be a positive avenue for improving the daily functioning and quality of life of adults with ADHD.

Pharmacological treatment by psychostimulants, and currently also by nonstimulants, is the most common treatment for ADHD (Castle, Aubert, Verbrugge, Khalid, & Epstein, 2007; Dodson, 2005; Peterson, McDonagh, & Fu, 2008; Solanto et al., 2008; Spencer, Biederman, & Wilens, 2004; Wilens et al., 2004). Overall rates of efficacy of stimulant drugs in adults in controlled studies are somewhat lower than they are with children, ranging between 25% and 78%, with the higher rates reported in studies employing higher doses (Spencer et al., 2004). Despite the substantiated evidence of pharmacological treatment for ADHD, a considerable number of adults with ADHD do not utilize this treatment due to several causes: a) a lack of interest in using pharmacological treatment due to a variety of reasons (e.g. fear of side effects, negative believes about medication use); b) drug side effects (Dodson, 2005; Wilens et al., 2004); and c) a lack of responsiveness to drug treatment (Solanto et al., 2008). In addition, many patients who respond well to drug treatment do not achieve full remission of the symptoms (O'Connell, Bellgrove, Dockree, & Robertson, 2006; Solanto et al., 2008). For these reasons drug treatment alone may not be sufficient to remediate the deficits associated with ADHD, and it is important to develop additional treatment methods that could target the core neuropsychological deficits of ADHD (O'Connell et al., 2006; Solanto et al., 2008). Thus, the pharmacotherapy of ADHD is the first but not last step toward the acquisition of the skills needed for complete and autonomous adult functioning. Currently, there is a growing recognition that treatment options for adult ADHD should include additional cognitive and behavioral interventions that take into consideration the comprehensive implications of the disorder, its functional outcomes and overall quality of life (Adler et al., 2008; Brod et al., 2006; Dodson, 2005; Solanto et al., 2008).

The focus of this study is on a cognitive training program for adults with ADHD. The goal of cognitive intervention in individuals with ADHD is to remediate deficiencies in cognitive processes. Cognitive programs include direct training of cognitive skills, such as working memory, inhibition or switching of attention, by repeated and graded exposure to cognitive stimuli (Toplak, Connors, Shuster, Knezevic, & Parks, 2008). Very few of the cognitive intervention studies have targeted EF deficits in children and adults with ADHD (Green et al., 2012; Karatekin, 2006; Klingberg et al., 2005; Klingberg, Forssberg, & Westerberg, 2002; O'Connell et al., 2006; Rapport et al., 1996; Shalev, Tsal, & Mevorach, 2007; White & Shah, 2006). Most of the participants in these studies included children that were diagnosed with ADHD (Green et al., 2012; Klingberg et al., 2002, 2005; O'Connell et al., 2006; Rapport et al., 1996; Shalev et al., 2007). The participants in the study of Karatekin (2006) were adolescents with ADHD, whereas in the study of White and Shah (2006) the participants were adults with ADHD. The attention-executive functions that were targeted in the studies were inhibitory control (Karatekin, 2006), sustained attention (O'Connell et al., 2006; Rapport et al., 1996; Shalev et al., 2007), selective attention, orienting of attention, executive attention (Shalev et al., 2007), reflectivity (Rapport et al., 1996), attention-switching ability (White & Shah, 2006) and working memory (Green et al., 2012; Klingberg et al., 2002, 2005). Computerized training was used only in the studies of Green and colleagues (2012), Klingberg and colleagues (2002; 2005) and Shalev and colleagues (2007).

Positive effects of the cognitive training have been consistently demonstrated on training tasks, novel near tasks and neuropsychological measures in all studies. However, additional evidence is needed to confirm these initial findings, especially concerning adults with ADHD. Moreover, current models in cognitive rehabilitation of adults with neurological involvement stress that cognitive skills may not transfer from training tasks to everyday life (Toglia, 2005). Therefore, in order examine the "real world" ecological impact of intervention, it is necessary to include outcome measures of everyday functioning, real-life settings and quality of life. Except for the study of Shalev and colleagues (2007) in which pre- and post-training measures of academic performance for children were used, no studies have been found that examined the outcome of cognitive training on everyday life in ADHD.

Therefore, the objective of this pilot study was to further examine the effect of computerized cognitive training for adults with ADHD. Specifically, we

wanted to examine the effect of the training on executive functioning in daily life, on occupational performance and on quality of life. The study hypotheses were that a significant main effect of time (pre-post training) will be found in: a) neuropsychological measures of executive functions (IntegNeuro test battery); b) measures of ADHD symptomatology (Adult ADHD Self-Report Scale [ASRS-v1.1] Symptom Checklist; Wender Utah Rating Scale [WURS]; c) executive functioning in daily life (Behavior Rating Inventory of Executive Function - Adult Version [BRIEF-A]); d) occupational performance (Canadian Occupational Performance Measure [COPM]); and e) ADHD-related quality of life (Adult ADHD Quality-of-Life Scale [AAQoL]).

Methods

Participants

Participants for the study were recruited through an advertisement placed in a local newspaper and on a website detailing information about attention disorders and treatment options (www.krz.co.il). The conditions of the study were presented and participants were asked to contact the researcher for more information. Inclusion criteria included: Adults (age18-60); sufficient reading skills to complete questionnaires; and a diagnosis of ADHD (any subtype) by a qualified medical professional (psychiatrist or neurologist), scores above the cutoff on ADHD screening questionnaires (Wender Utah Rating Scale [WURS] score above 36; at least four out of six symptoms in part A of the Adult ADHD Self-Report Scale [ASRS-v1.1] Symptom Checklist; Brown Attention-Deficit Disorder (ADD) Rating Scale for Adults [BADDS] score above 45), verification of the diagnosis by a structured DSM-IV criteria based interview; signed informed consent to participate in the research; without change in pharmacological treatment in the last 3 months; and without other new treatment for ADHD in the last 3 months. Exclusion criteria were: acute neurological or psychiatric (Axis I) disorders; current substance abuse; and color blindness (due to program's demands).

Twenty-four adults with ADHD (16 men, 8 women) were enrolled in the study, after receiving an explanation through the phone and providing initial oral consent. One subject did not meet inclusion criteria for ADHD (scores below cutoffs on ADHD questionnaires); therefore the study sample included 23 participants who were evaluated at the onset of the training. From the study sample, 14 participants (61%; 10 men, 4 women) completed the computerized

training period and provided pre- and post-test measures. These participants had a mean age of 33.50 years (SD = 9.272, range 22-58) and a mean years of education of 15.36 (SD = 3.296, range 11-22). Five (35.7%) were married and nine (64.3%) were single. Ten (71%) of them received medication for ADHD.

Measures

Neuropsychological measure:

IntegNeuro test battery (Brain Resource Company, Ltd)

A neuropsychological test battery consisted of 12 tasks that cover five cognitive domains: sensori-motor-spatial, verbal and nonverbal memory, language, attention and vigilance and executive function/planning. It is administered on a computer using a touch-screen interface and voice recording, and takes approximately 50 minutes to complete (Clark et al., 2006). All instructions are provided via headphones, and each test is preceded by a thorough explanation, visual examples of performance, and a practice trial. The battery has demonstrated validity, reliability and established norms from 6 to over 80 years (Paul, Brickman, et al., 2006; Paul, Haque, et al., 2005; Paul, Lawrence, et al., 2005; Williams et al., 2005).

Measures for ADHD diagnosis:

Wender Utah Rating Scale (WURS; Ward, Wender, & Reimherr, 1993). The WURS is a 25-item self-report questionnaire for the retrospective assessment of childhood ADHD symptoms in which higher scores indicate greater symptoms. The original scale consists of 61 items assessing symptoms of childhood ADHD, with 25 of these items used to differentiate ADHD adults from a nonpatient comparison group. The WURS has been shown to have good internal consistency and temporal reliability (Stein et al., 1995) and was validated in a study by Ward and colleagues (1993).

Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist (World Health Organization, 2003) is an instrument consisting of the EIGHTEEN DSM-IV-TR criteria. Six of the eighteen questions were found to be the most predictive of symptoms consistent with ADHD. These six questions are the basis for the ASRS v1.1 Screener and represent Part A of the Symptom Checklist. Part B of the Symptom Checklist contains the remaining TWELVE questions. The checklist takes about five minutes to complete and can provide information that is critical to supplement the diagnostic process.

Brown Attention-Deficit Disorder (ADD) Rating Scale for Adults (BADDS; Brown, 1996). The BADDS is a 40-item self-report inventory. This

scale is based on a series of symptom descriptors reported by high school and college students with nonhyperactive ADD and is often used with highly functioning adults. The BADDS assesses five dimensions of symptoms that include organizing work, sustaining attention and concentration, sustaining alertness and effort, managing frustration and other emotions, and using working memory. The internal consistency of the BADDS is high (Cronbach's coefficient α= .96).

Ecological measures of everyday functioning and quality of life:
Behavior Rating Inventory of Executive Function - Adult Version (BRIEF-A; Roth, Isquith, & Gioia, 2005). A standardized self-report measure that captures adults' own views regarding their executive functions in their everyday environments. It is designed for adults between the ages of 18 and 90 years with a minimum fifth-grade reading level, including those with a wide variety of developmental disorders and systemic, neurological, and psychiatric illnesses. The BRIEF-A is composed of 75 items within nine clinical scales that measure different aspects of executive functioning. The clinical scales form two broader indexes: the Behavioral Regulation Index (BRI) and the Metacognition Index (MI), as well as an overall summary score, the Global Executive Composite (GEC). The raw scores are transformed into T-scores (age dependent and relative to normative groups). T-score above 65 in one of the scales, indexes or the GEC identify an impairment. The BRIEF-A has moderate to high internal consistency (α=.73-.98), high test-retest stability (r=.82-.94), moderate interrater agreement (r=.44-.68) and was found to significantly differentiate between adults with and without ADHD (Rotenberg-Shpigelman, Rapaport, Stern, & Hartman-Maeir, 2008).

Canadian Occupational Performance Measure (COPM; Law et al., 2005). The COPM is an individualized, client-centered measure designed for use by occupational therapists to detect change in a client's self-perception of occupational performance over time. It is designed as an outcome measure, with a semi-structured interview format and structured scoring method. Change scores between assessment and reassessment using the COPM are the most meaningful scores derived from this assessment. The COPM is a standardized instrument, and has good reliability and validity. Clinical utility, examined through a number of different studies, supports the use of the COPM with a wide variety of clients in many different settings.

Adult ADHD Quality-of-Life Scale (AAQoL; Brod, Perwien, Adler, Spencer, & Johnston, 2005). The AAQoL was designed to assess health-related

quality of life (HRQL) during the prior 2 weeks. It consists of 29 questions using a 5-point Likert scale for frequency of occurrence. Four subscale scores are derived: productivity, life outlook, relationships, and psychological health. Total and subscale scores are computed and higher scores indicate better assessment of quality of life. The AAQoL has good internal consistency reliability, good construct and discriminate validity (Brod et al., 2006; Matza, Johnston, Faries, Malley, & Brod, 2007) and is highly responsive to change (Matza et al., 2007).

Design

This pilot study was designed as an experimental pre-and post-training of one group of adults with ADHD.

Procedure

The study was approved by the institutional review board ethics committee.

Subjects who responded to the newspaper or internet advertisement of the study and had a diagnosis of ADHD that was made by a qualified medical professional, received a brief telephone explanation regarding the conditions of the study (assessment time, training time). If oral consent was given, they were invited to an assessment meeting. The pre-training assessment refers to the current functioning at the time of entry to the study, and not to past functioning or to the period preceding the diagnosis of ADHD.

Assessment meeting (about 4 hours long): The subjects were asked to fill out ADHD screening questionnaires (WURS, ASRS, BADDS). If the scores on the questionnaires were above the cutoff levels, a face-to-face structured DSM-IV criteria-based clinical interview was administrated by a psychiatrist for the confirmation of ADHD symptoms and evaluation of exclusion criteria (acute Axis I disorders and substance abuse). Subjects that were found suitable for the study received a complete description of the study and were asked to provide a written informed consent. The subjects were then asked to complete additional questionnaires (demographic questionnaire, BRIEF-A, AAQoL). Next, the IntegNeuro test battery was administrated as well as the semi-structured interview and structured scoring of the COPM. In the semi-structured interview the subjects were asked to identify up to five areas of difficulty in occupational performance that were, in their opinion, due to their disorder. For each of these problems, subjects scored their current level of performance and their satisfaction with that performance on scales of 1 (unable to perform, not satisfied) to 10 (able to perform, extremely satisfied). Scores were totaled for

both performance and satisfaction and averaged over the number of problem areas. At the end of the meeting the subjects received instructions in the use of the computerized program AttenGo^{TM} and a personal username and password. In addition, an explanation about the training conditions was provided, namely that the training will be 12 weeks long, 3-5 times a week for at least 20 minutes and that they should have at least 6 hours of sleep the night before. The participants were informed that weekly personal follow-up phone calls would be made, which would include feedback regarding the training parameters (time, length, and performance) retrieved from the computer program.

Training by the AttenGo^{TM} program

The training was conducted with the computerized AttenGoTM program developed at the ACE (Advanced Cognitive Enhancement) clinic in Toronto, Canada. AttenGo^{TM} is an adaptive cognitive online training system designed for ages 6 and up. The program utilizes neutral universal stimuli (e.g. circles and squares) and is tailored to the individual, based on age and baseline performance on the training tasks. The training is hierarchic, is continuously adjusted to individual performance and delivers feedback. It focuses on executive cognitive skills such as working memory, inhibition, shifting and dividing attention and persistence. All training is conducted online and performance parameters are automatically recorded and stored. Computerized assessments are executed before the training and every 21 days throughout the training. The participants used the Hebrew version of the program.

A weekly follow-up phone call was made by the researcher to all subjects.

Final Assessment - after 3 months (about 3 hours long): The subjects were asked to complete the ASRS, BADDS, BRIEF-A and AAQoL questionnaires, the IntegNeuro test battery was administered and a reassessment through the COPM, in which the subjects reviewed their identified problems and rated their performance and satisfaction. The participants received a license to continue using the program for a period of another 9 months.

Statistical analysis

Statistical analysis was computed with the statistical software package SPSS - 15.0 version. Descriptive statistics were performed in order to describe the sample characteristics and the cognitive and functioning variables. The nonparametric, Wilcoxon Signed Rank test was computed to analyze pre-post differences (α=.05). Hedges' g was calculated to measure effect size.

Results

Fourteen adults with ADHD completed the training program, whereas nine subjects discontinued their training. The subjects reported the reasons that they dropped out as follows: technical computer difficulties (3 subjects), life events (birth of a child, change of job - 2 subjects), and difficulty persisting with practice regimen (4 subjects). There were no significant differences ($p > .10$) between the 'completers' and the 'drop outs' on demographic variables (age, gender, years of education), nor on any of the study measures (IntegNeuro test battery, ASRS, BADDS, BRIEF-A, COPM, AAQoL). In addition there were no significant differences in any of the study measures, between the subjects who were taking/not taking (10/4) medication for ADHD ($p > .10$). The subjects that completed the training program trained on the AttenGo^{TM} software program 3-5 times a week for approximately 20 minutes each time. The mean total training time for the group was 11:40 hours (SD=6:15).

Change in neuropsychological assessment (IntegNeuro test battery)

Analysis of the change on the IntegNeuro test battery revealed significant improvements in several measures of executive function and attention ('switching of attention', 'maze' and 'sustained attention'), effect sizes were small to moderate, while the improvements that were found on the other measures of the IntegNeuro test battery did not reach statistical significance (see Table 1 - page E89).

Table 1
Comparison of the IntegNeuro Test Battery Scores Before and After Training.

IntegNeuro test battery	Time 1 Before practice Mean (SD)	Time 2 After practice Mean (SD)	Z (p)	Hedges' g
Digit Span				
Recall span (forwards)	6.46 (1.71)	6.46 (1.56)	-.159 (.437)	0
Recall span (backwards)	4.85 (2.04)	5.54 (1.81)	-1.195 (.116)	.34
Sustained Attention (CPT)				
Reaction time (ms)	457.92 (111.323)	409.42 (124.56)	-1.490 (.068)	.39
False alarms*	1.42 (2.07)	.33 (.49)	-1.725 (.042)	.69
False misses	1.08 (1.56)	.58 (.90)	-.938 (.174)	.37
Switching of Attention				
Completion time (digits) (s)*	21.54 (7.73)	18.17 (3.91)	-1.958 (.025)	.52
Completion time (digits+letters) (s)	45.76 (13.99)	40.29 (12.47)	-1.503 (.067)	.39
Choice Reaction Time				
Reaction time (ms)	828.10 (352.38)	704.40 (188.07)	-1.478 (.070)	.41
Time Estimation				
Accuracy (s)	-.03 (.27)	-.02 (.26)	-.105 (.458)	.04
Maze				
Completion time (s)	223.31 (82.10)	191.62 (77.28)	-1.54 (.062)	.38
Total errors*	43.77 (22.79)	30.77 (19.36)	-2.029 (.022)	.68
Number of overruns*	19.00 (15.06)	13.92 (12.87)	-1.771 (.039)	.34

*Significant group difference.

Change in ADHD symptomatology (ASRS; BADDS)
Significant improvements were found on measures of ADHD symptomatology (ASRS; BADDS). A reduction was found in the reported severity of symptoms after the training for all subjects, except for one subject who reported increased severity of symptoms (8% increase on the BADDS). The effect size for the ASRS was large and was moderate for the BADDS (see Table 2).

Table 2
Comparison of the ASRS and BADDS Scores Before and After Training.

	Time 1 - Before practice			**Time 2 - After practice**				
	Min	Max	Mean (SD)	Min	Max	Mean (SD)	Z (p)	Hedges' g
ASRS*	45	79	62.42 (9.69)	46	70	53.58 (6.72)	-2.831 (.003)	1.03
BADDS*	51	111	82.83 (20.09)	42	113	71.25 (23.04)	-2.279 (.012)	.52

Note. ASRS = Adult ADHD Self-Report Symptom Checklist; BADDS = Brown Attention-Deficit Disorder (ADD) Rating Scale for Adults.
*Significant group difference.

Change in executive functioning scores in daily life (BRIEF-A)
Significant improvements were found on the BRIEF-A global score, indices, and 7/9 scales after training (see Table 3). Effect sizes were moderate to large (Hedges' g=.32-1.09) with the largest size effects on the 'inhibit' scale and 'BRI' index. The frequencies of the individual BRIEF GEC profiles (see Figure 1) revealed that after training the scores improved (decreased) for 13 of the subjects while one score remained the same (range of the change 0 - [-22], M=-9.00, SD=6.67). In addition, prior to the training, the GEC scores of 12 subjects were in the impaired range (T-score ≥ 65), whereas after the training the scores of five of these subjects were within the normal range (T-score < 65).

Table 3
Comparison of the BRIEF-A T-Scores Before and After Training.

	Time 1 - Before practice			Time 2 - After practice				
BRIEF-A (T-scores)	Min	Max	Mean (SD)	Min	Max	Mean (SD)	Z (p)	Hedges' g
Inhibit*	48	74	61.50 (8.46)	41	65	53.29 (5.90)	-3.06 (.001)	1.09
Shift	51	91	61.71 (10.09)	47	74	58.71 (8.30)	-1.33 (.092)	.32
Emotional Control*	53	84	64.71 (10.42)	43	77	58.14 (10.88)	-3.08 (.001)	.60
Self-Monitor*	42	72	54.21 (9.35)	37	63	46.50 (8.29)	-3.19 (.001)	.85
BRI*	51	72	63.64 (7.40)	47	68	55.71 (6.72)	-3.30 (.001)	1.09
Initiate*	53	87	68.71 (13.54)	43	81	61.21 (13.84)	-2.95 (.002)	.53
Working Memory	63	95	77.79 (9.47)	56	92	72.79 (11.45)	-1.65 (.050)	.46
Plan/Organize*	57	94	72.57 (11.39)	41	80	63.00 (12.79)	-3.05 (.001)	.77
Task Monitor*	60	88	74.14 (9.15)	52	83	66.29 (9.14)	-2.55 (.006)	.83
Organization of Materials*	41	83	64.86 (12.93)	37	83	58.21 (14.58)	-2.37 (.009)	.47
MI*	58	92	74.79 (10.84)	47	82	66.21 (12.05)	-2.95 (.002)	.73
GEC*	57	86	71.71 (8.35)	47	74	62.71 (8.97)	-3.19 (.001)	1.01

Note. BRIEF-A = Behavior Rating Inventory of Executive Function - Adult Version; BRI = Behavioral Regulation Index; MI = Metacognition Index, GEC = Global Executive Composite.

*Significant group difference.

Figure 1
Global Executive Composite (GEC) T-scores of the Behavioral Rating Inventory of Executive Function - Adult Version (BRIEF-A) before and after training for each subject.

Change in occupational performance (COPM)
The COPM was administrated to seven subjects. It was administrated in order to evaluate the change in their daily functioning. The initial and reassessment scores of the performance and satisfaction were compared and evaluated for change (Law et al., 2005). An improvement of one average point was found in level of performance (M=.94, SD=2.07) and on satisfaction (M=1.03, SD=2.28). This improvement was not significant (see Table 4).

Table 4
Comparison of the COPM Scores Before and After Training.

	Time 1 - Before practice			**Time 2 - After practice**			
COPM	Min	Max	Mean (SD)	Min	Max	Mean (SD)	Z (p)
Performance	1.00	5.75	3.54 (2.01)	2.00	7.38	4.48 (1.97)	-1.05 (.293)
Satisfaction	1.00	5.40	2.95 (2.01)	1.00	7.88	3.97 (2.46)	-1.18 (.237)

Note. COPM = Canadian Occupational Performance Measure.

In the evaluation of level of performance, a clinically significant improvement (increase of 2 points or more) was found among three subjects, a small improvement was found in one subject, a decline in rating was found in one subject and the scores of two subjects remained the same. In the evaluation of their satisfaction with that performance, an improvement was found among six subjects (clinically significant for three subjects) and a decline was found in one subject.

The COPM semi-structured interviews revealed that adults with ADHD experience very significant functional difficulties, poorly evaluate their functional performance and correspondingly, their satisfaction from their performance is low. The main difficulties in occupational performance that were mentioned are: procrastination of work, study or household tasks; difficulties in temporal and spatial organization of instrumental activities of daily living (ADL) and work (being late, meeting deadlines and time estimation); difficulty in concentrating for long periods of time; daydreaming during conversations, lectures, meetings and academic tasks; and impulsivity, especially in social settings (interrupting other people during conversation, difficulty in social regulation).

Change in quality of life (AAQoL)

Significant improvements were also found in the measure of quality of life (AAQoL) - in the total score and in all four subscales. The total score for 13 of the subjects improved (increased) after the training, while one score remained the same (range of the change .00-28.97, M=11.15, SD=8.69). Pre-post comparisons were significant at $p \leq .01$, and effect sizes were all large (Hedges' g = .66- 1.15) (see Table 5).

Table 5
Comparison of the AAQoL Scores Before and After Training.

	Time 1 - Before practice			Time 2 - After practice				
AAQoL	Min	Max	Mean (SD)	Min	Max	Mean (SD)	Z (p)	Hedges' g
Total Score*	40.69	73.79	54.43 (9.79)	45.52	78.62	65.58 (9.37)	-3.233 (.001)	1.13
Life productivity*	30.91	83.64	50.52 (14.41)	38.18	85.45	63.12 (13.50)	-2.858 (.002)	.88
Psychological health*	30.00	70.00	55.00 (10.76)	40.00	86.67	69.05 (12.97)	-3.207 (.001)	1.15
Life outlook*	28.57	74.29	54.29 (11.81)	48.57	74.29	62.10 (8.88)	-2.576 (.010)	.73
Relationships*	48.00	88.00	62.57 (12.31)	44.00	96.00	71.71 (14.67)	-2.408 (.008)	.66

Note. AAQoL = Adult ADHD Quality of Life Questionnaire.
*Significant group difference.

Discussion

The findings of the current study provide preliminary evidence supporting computerized cognitive training for adults with ADHD. Participants in the study demonstrated significant positive changes in ADHD symptomatology, as well as in measures of executive functioning and quality of life. However, no significant change was found in the measure of occupational performance. The current study adds to the body of evidence regarding the efficacy of cognitive treatment for individuals with ADHD. The positive effects that were found on computerized tasks and neuropsychological measures are in line with previous cognitive training studies in children and adults with ADHD (Dowsett & Livesey, 2000; Karatekin, 2006; Klingberg et al., 2002, 2005; O'Connell et al., 2006; Rapport et al., 1996; Shalev et al., 2007; White & Shah, 2006). However, the unique contribution of the current study lies in the additional real-world outcomes with established clinical significance, with the exception of the results on the COPM.

We found EF improvements in objective cognitive testing (IntegNeuro test battery) as well as in subjective report of executive functioning in daily life

(BRIEF-A). It is noteworthy that the largest effects were found on the 'Inhibit' scale and the 'BRI' index (Hedges' g = 1.09). This finding may have particular clinical value and future potential for individuals with ADHD, since hierarchical models of EF and ADHD conceptualize inhibition at the base of the hierarchy, which further influences the other EFs (e.g. working memory and behavioral regulation) (Barkley, 1997; Barkley et al., 2008). In addition to the change in cognitive measures, we also found very large pre-post effects in the quality of life and ADHD symptomatology outcomes measure. In adults, ADHD symptoms are associated with impairment in multiple domains that are considered to be key aspects of health-related quality of life and a subjective perception of the impact of health status (Matza et al., 2007), which are important aspects to be measured in adult ADHD.

Concerning the results of the COPM, they shed light on the unique occupational issues that these clients face in their daily life. However, the results pertaining to the change scores were not statistically significant. The lack of statistical and clinical change for the majority of subjects warrants the attention of occupational therapists. We suggest that when occupational issues are not at the center of intervention and are not directly addressed, they do not necessarily improve spontaneously. This issue of transfer of training has been discussed at length in the cognitive rehabilitation literature (Katz, 2011; Toglia, 2005) and the current results, although limited to a small number of subjects, are in line with this body of evidence. Further studies are needed that will focus on the transfer of training to individualized occupational goals.

There is a need to question the mechanism of change underlying the positive findings on the measures delineated above, excluding the COPM, which may be attributed to several possible processes: (1) remediation of executive functions core abilities (e.g. inhibition, shifting, planning); (2) metacognitive effect, whereby the experience in cognitive training tasks enhanced awareness to cognitive difficulties, which enabled the development and use of compensatory strategies (e.g. anecdotal reports of participants revealed that they began to notice their impulsivity in social situations and attempted to consciously control their behavior); (3) the invested motivational resources (time, effort) in the cognitive training led to positive expectations that were perceived in the participant's subjective outcome reports; and finally, (4) a combined effect of improved cognitive ability, awareness and strategy utilization, motivation and positive expectations. The current study methodology cannot test the contribution of the above processes or the interactions among them. Further research, controlling for motivational

processes (placebo training), exploring awareness and strategy use, and examining the relationship between the degree of improvement in cognitive and functional measures, is required to shed light on the underlying mechanisms of cognitive training benefits.

It is noteworthy that the effects of cognitive training found in this study are comparable to the effects that were found in pharmacological treatment studies of ADHD. The effect sizes of the training in this study for ADHD symptoms, executive functioning and quality of life were all moderate to large (between 0.32-1.15). In comparison, stimulants medications have been shown to have a large effect size, and the second-line medications (nonstimulant) as a group have been shown to have a moderate one, in reducing ADHD symptoms (Dodson, 2005; Michelson, Adler, & Spencer, 2003). This comparison is encouraging, suggesting a possible second-order treatment option for individuals who may not be able to benefit from pharmacological treatment (Dodson, 2005; Wilens et al., 2004). On the other hand, considering that a large percent of the sample (71%) were also treated with medication, the findings may also suggest a combined benefit of cognitive training and medication, as has been shown by Rostain and Ramsay (2006). The therapeutic effects of stimulant medication are known to enhance concentration and reduce hyperactivity (Stevenson, Whitmont, Bornholt, Livesey, & Stevenson, 2002). Therefore, one could hypothesize that pharmacological treatment may improve the attention of individuals, thereby furthering their ability to benefit from a higher level executive cognitive training program. However, Stevenson and colleagues (2002) found that non-medicated adult participants with ADHD responded to a cognitive remediation program as well as medicated participants. Therefore, further studies on cognitive training in larger samples that control for medication use, could determine the unique or cumulative contribution of cognitive and pharmacological treatments.

Besides the inherent weaknesses of an open-label design, our study has some additional limitations. Concerning the current study sample, the rigorous criteria utilized for ADHD verified that the sample represents individuals with a valid diagnosis of ADHD. However, the subtype of the disorder was not taking into consideration in the process of analyzing the findings. It is important to examine whether there is a difference in the results of the training among the subtypes of the diagnosis. In addition, the sampling was based on response to a newspaper and internet advertisement, which may have biased the sample in terms of representing educated adults that are aware of their diagnoses and are actively seeking information and treatment options for their ADHD. Furthermore, the training required the recruitment of motivational

resources in order to persist and complete the 12 week computerized training period. Therefore, the final sample (61% of the initial sample) was probably characterized by high motivation. Thus, the findings of the current study may not be generalized to the ADHD adult population at large, and may be limited to a subgroup of adults with high motivation for improvement.

In summary, as ADHD in adults becomes increasingly recognized, it is important to find more effective treatments in addition to the use of pharmacological treatment. While this study is only preliminary, the findings suggest that computerized cognitive training may assist adults with ADHD in improving their executive functioning and their quality of life. However, it seems that this intervention alone is not enough when addressing occupational issues. There should be a direct consideration of occupational performance goals by occupational therapists. A combined intervention of cognitive training and work on functional goals will probably lead to better results in daily living. Further studies are needed, with a representative sampling and placebo control group, including metacognitive measures and follow up assessments, in order to verify these initial findings, their stability over time, as well as examine their underlying mechanisms.

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Abstracts from Hebrew

The Courage to Treat

Key words: Courage, common sense, therapeutic dialogue, empathy, authenticity, evidence-based practice, clinical experience

This article is derived from a lecture I presented upon receiving the Prize for Excellence at the 19th Professional Convention of Occupational Therapists in Israel. The treatment of a sick person is an invasive act that is both professional and humane in nature. It is based on both acquired and proven knowledge, as well as accrued clinical experience. When intruding upon a patient's life during treatment in order to bring about beneficial results, we must rely on these two sources of knowledge. Knowledge based on clinical findings attains validity through an empiric process of research. However, knowledge based on clinical experience, by its very nature, cannot be validated empirically and depends on the therapist's intuition, analogies common sense and courage. Courage, among other things, refers to the ability recognize one's own limitations as a therapist during treatment, and to stand ready to change and expand them when necessary. This courage relates to the therapist's ability to accept his/her strengths and weaknesses, as well as those of his/her patient and at the same time, to recognize that empathy cannot be total. Furthermore, it is necessary to realize that a certain ambiguity is a necessary part of the treating process.

Aviva Fried, MSc, OT, Senior lecturer, Department of Occupational Therapy, School of Health professions, Tel-Aviv University. afried@post.tau.ac.il

Activities with Plants for Children with Developmental and Intellectual Disability and Limited Mobility- A Case Study

Key words: Developmental and intellectual disability, mobility limitations, occupational therapists, activities with plants, plants as play accessories

Occupational therapy is linked to treatment methods relating to nature, such as therapeutic gardening, which have been applied in a variety of therapeutic settings and with different populations. This kind of treatment modality was found to be successful in improving abilities, such as body strength, movement,

memory, social skills, and emotional affect. The intervention program presented in this article was inspired by "nature as therapy" activities and principles of activity through play that lie at the foundation of the occupational therapy profession. It is composed of activities in which plants represent a playful game 'accessory' for children. The program was run over the course of one school year, for a class of children with developmental and intellectual disability and mobility. These children are usually not exposed to the world outside of their homes and classrooms, to experience nature and plant life. Thus through this program, groups of children led by an occupational therapist and the kindergarten staff, experienced multisensory participation and interpersonal interaction through the use of selected plants. At the end of the year the children's expressions regarding their preferences and desires were observed, both with respect to the sensory domain (touch, taste and smell of certain plants) and interpersonal interactions (reaching out a hand, request from a grown up, passing leaves between children). This was a pilot program developed as a first step in the development of a nature experience program for the entire center.

Vered Sharon Yairi, BOT, MA in Special Education, Ministry of Education, Haifa. veredyairi@walla.co.il
Margalit Cohen, BOT, Ministry of Education, Haifa.
margalit.291@gmail.com

P-5 Glove: Computer Game as a Tool for Measuring Upper Limb Reaching Movement

Key words: P5 glove remote control technology, kinematics of reaching movement, upper limb, mean reaching velocity, stroke

Introduction: The P5-glove, originally developed as part of a commercial computer game system, was examined as a tool to be used for the kinematic assessment of reaching movements of the upper limb. Upon validation, the glove could be used in the clinic to examine and measure hand function in space, as well as to establish the efficacy of rehabilitative intervention. Previously, the measurement of hand reaching velocity has only been possible through the use of simple devices, such as an accelerometer, or by methods which cannot supply immediate results, such the use of three-dimensional systems for movement analysis (i.e., 3-D cameras, etc.). The purpose of this study was to investigate the validity and reliability of the P5-glove for monitoring reaching movements.

Methods: The validation process incorporated the use of the glove in a research population including 10 healthy participants (± 69 years). The study was performed in four stages, as follows: 1) examining the validity of the P5-glove measurements by converting the raw values from the glove assembly into metric units and comparing these to measurements made using a gold standard; 2) validating the data provided by the Matlab software, adapted specifically for this study; 3) measuring the reaching movements of both hands of the healthy participants on three linear axes; and 4) establishing the test-retest reliability of forward reaching measurements in healthy individuals. **Results:** The results indicated that the values of forward reaching velocity for both hands, as recorded using the P5 glove, are valid and reliable. The mean reaching velocity was determined to be 42.2 cm \ sec for the right hand and 41.7 cm \ sec for the left hand. **Conclusions:** The use of the glove is a realistic means for effectively measuring forward reaching movements in the clinic.

Avia Guttman, PhD, BPT, Department of Physical Therapy, Faculty of Social Welfare and Health Sciences, University of Haifa. guttman@macam.ac.il
Arie Burstin, BPT, Beit Rivka Geriatric Rehabilitation Center, Petach Tikva.
Riki Brown, BPT, MSc, Beit Rivka Geriatric Rehabilitation Center, Petach Tikva.
Shay Bril, M.D, Beit Rivka Geriatric Rehabilitation Center, Petach Tikva.
Ruth Dickstein, Prof. BPT, Department of Physical Therapy, Faculty of Social Welfare and Health Sciences, University of Haifa.

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