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Self-Management Intervention for Attention and Executive Functions Using Equine-Assisted Occupational Therapy Among Children Aged 6–14 Diagnosed with Attention Deficit/Hyperactivity Disorder

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Abstract

Background: Attention deficit/hyperactivity disorder (ADHD), characterized by inattention, hyperactivity, and impulsivity, is currently one of the most common diagnoses given to children. Children with ADHD have a unique cognitive profile that involves difficulties in executive functions (EFs) and in the self-management system of the brain, and are at higher risk for educational failure, social and emotional difficulties, and high risk behavior.

Objectives: The purpose of this study was to examine the effectiveness of self-management intervention for attention and executive functions using equine-assisted occupational therapy (*STABLE-OT*) for school-aged children with ADHD.

Design: A pre–post design was used in the intervention.

Setting/location: The study was conducted at two riding school stables is Israel.

Subjects: Twenty-five 6–14-year-old children (3 girls, 22 boys, age: 7.8–12.3 years, $M = 9.41 \pm 1.75$) diagnosed with ADHD participated in a therapeutic equestrian riding intervention.

Intervention: The intervention included structured 45-min sessions for 12 weeks, while integrating child- and family-centered strategy acquisition and immediate feedback principles.

Outcome measures: Their EF and occupational performance were evaluated pre- and post-intervention, using *The Behavior Rating Inventory of Executive Function (BRIEF)* and the *Canadian Occupational Performance Measure (COPM)*.

Results: Results showed a significant improvement in EF, as reflected by statistically significant decreases in the Global Executive Composite (*GEC;* $t = 2.801$; $p = 0.01$), metacognitive index ($t = 3.873$; $p = 0.001$), working memory ($t = 2.476$; $p = 0.021$), monitor ($t = 2.359$; $p = 0.027$), and initiation ($t = 3.204$; $p = 0.004$) subscales of the BRIEF questionnaire. A statistically ($p < 0.001$) and clinically significant improvement was also found in the COPM performance and satisfaction scales.

Conclusions: This study provides key preliminary evidence supporting the effectiveness of an individual equine-assisted OT intervention for children with ADHD. It constitutes an initial step toward clinical implementation of such therapeutic approaches, and is expected to spark further research in this area.

Keywords: equine-assisted activities and therapies, ADHD, cognitive approach, occupational therapy, executive functions, functional goals

Introduction

Attention deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder that is characterized by the presence of symptoms of inattention, hyperactivity, and impulsivity.[1]

ADHD is currently one of the most common pediatric diagnoses. Approximately 6.4 million children aged 4–17 years across the United States were diagnosed with ADHD in 2014, with boys having 2–9-fold greater prevalence than girls.[2] ADHD is characterized by a developmental impairment of executive functions (EFs): high-level

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cognitive self-management processes, often associated with the frontal lobes of the brain. EFs allow individuals to regulate their behavior, thoughts, and emotions, and thereby enable self-control, goal-directed behavior, response inhibition, working memory (WM), and set shifting.[3] These are core skills that are critical for cognitive, social, and psychologic development; success in school and in life; and mental and physical health.[4] Therefore, ADHD is often further associated with impairment of psychosocial functioning beyond the core symptoms.[5] Evidence suggests that children with ADHD are characterized by a pattern of chronic difficulties in executing a wide variety of daily tasks.[6] It can lead to significant difficulties in education, social performance, and personal relationships,[7] as well as deficient academic functioning and behavioral regulation,[8] which result in low self-esteem and reduced quality of life.

There are a number of different treatments for ADHD. The most common is stimulant medication (methylphenidate and amphetamine), which has been shown to reduce symptoms.[6] The current recommendation by American academy of pediatrics as the most effective intervention is a combination of pharmacologic and behavioral interventions.[9] A number of nonpharmacologic cognitive-behavioral interventions that focus on personal functional goals have been applied successfully on children with ADHD.[10–12] Other approaches focus on cognitive training of a single or multiple domains of EF, such as WM, inhibition, or cognitive flexibility. As these approaches are led by neuroplasticity principles, they are based on intensive repetitive training and immediate feedback.[8,13]

One increasingly popular practice is equine-assisted activities and therapies (EAATs). EAAT is a term used to describe several interventions with horses, including hippotherapy (HOPT) and therapeutic riding (TR). ''TR is performed with the purpose of contributing positively to the cognitive, physical, emotional and social well-being of individuals with special needs, while learning riding skills and caring for a horse.''[14] HOPT refers to how ''occupational therapy (OT), physical therapy and speech-language pathology professionals use evidence-based practice and clinical reasoning in the purposeful manipulation of equine movement as a therapy tool to engage sensory, neuromotor and cognitive systems to promote functional outcomes.''[15] This research was performed by a licensed occupational therapist utilizing both the horse's movements and caring for it during the intervention, and will be referred as equine-assisted OT.

In recent years, preliminary evidence demonstrates that various interventions incorporating horses may improve functional skills; physical disabilities; and behavioral, emotional, and social behaviors,[16,17] in addition to sensory processing[18] and mental health conditions.[19] For example, TR has been shown to improve behavioral regulation among children with autism spectrum disorder,[16,20] children at risk and those enrolled in special education.[21] The researchers hypothesized that the emotional aspect of the relationship with the horse and reinforcement of positive actions during riding sessions were the main mechanism for the improvement.[20,22]

Only a few studies have thus far examined the efficacy of EAATs among children with ADHD.[23] A pilot study with five ADHD participants aged 10–11 years found that TR had a positive effect on several domains of social role behavior, quality of life, and motor performance,[24] whereas another study found improvement in quality of life and interpersonal relationships.[23,25] Improvement in anxiety, depression, attention, and learning disorder was found after a 4-week intervention among 10 children aged 10–12 years with ADHD. However, of the studies that examined EAATs among children with ADHD, most have included small samples and few group sessions,[24,25] or referred to ADHD comorbidity with other diagnoses.[23,24,26] Moreover, none of the studies described have been provided by a licensed health care professional.

Given the high prevalence of ADHD and the potential therapeutic advantage of EAATs, much more evidence is needed. This study aims to expand previous research by evaluating the effectiveness of equine-assisted OT on EFs and daily functions of children aged 6–14 years diagnosed with ADHD, as provided by a licensed occupational therapist: self-management intervention for attention and executive functions using equine-assisted occupational therapy (STABLE-OT). The intervention incorporated principles of the cognitive orientation to daily occupation performance (CO-OP) approach[27]: a client-centered performance-based problem-solving approach that enables skill acquisition through a process of strategy use and guided discovery, and also emphasizes generalization of the acquired skills. CO-OP is grounded in learning theory and combines a cognitive approach with motor training theories. CO-OP is centered around the child learning the global problem-solving strategy of ''goal-plan-do-check,'' and then, through guidance, applying this strategy to come up with their own unique solutions to achieve their chosen goals.

The CO-OP approach was used with positive results in a pilot OT intervention study of a 12-week intervention for children aged 7–12 years diagnosed with ADHD in a clinical setting.[28] This study introduces equine-assisted OT, with the aim to provide evidence-based treatment for improving EFs and daily functional goals among children with ADHD.

Methods

Study design

Pre- and postintervention design without control group.

Regulatory

Ethical approval was received from the Faculty of Medicine of the Hebrew University of Jerusalem.

Participants

Participants were screened for eligibility from among those who were referred by their pediatrician for EAATs. Eligible participants were approached, their parents signed a consent form, and they provided their oral assent.

Twenty-six school-aged children with ADHD (4 girls, 22 boys, aged 7.8 years–12.3, $M = 9.44 \pm 1.75$) were enrolled in two stables in Israel. Twenty-five participants (22 boys and 3 girls 7.8–12.3 years, $M = 9.41 \pm 1.75$) completed 12 weeks of the intervention program. One participant completed the

intervention but refused to complete postassessments and, therefore, was excluded from data analysis.

Inclusion criteria: (1) ADHD (ICD code F90.0) diagnosis by a licensed pediatrician or neurologist, according to DSM-V; (2) age 6–14 years; (3) nonmedicated or takes medication regularly for at least 2 months prior the intervention (i.e., no changes in medication in the preceding 2 months); (4) executive dysfunction in daily life, as determined by a *t*-score[3] 65 on at least one subscale of the parent version of the Behavior Rating Inventory of Executive Function (BRIEF)[29]; (5) medical permission to ride a horse; (6) ability to verbally define and set functional goals; and (7) recommendation for EAATs from an occupational therapist, physical therapist, or a psychologist.

Exclusion criteria: (1) primary psychiatric diagnosis or (2) intellectual disability or other neurologic conditions as primary diagnosis.

Materials and Methods

Measures

Demographic questionnaire. Demographic features of the child and parents, including age, marital status, number of children, education, and income, were collected at baseline. Income was reported as average/above average/below average according to the parents' own perceptions. It also included the child's diagnosis, medical treatment, and activity preferences.

The Behavior Rating Inventory of Executive Function Hebrew version. The Behavior Rating Inventory of Executive Function[29] Hebrew version[30] was administered pre- and postintervention. This is an 86-item standardized rating scale filled by a parent with respect to their diagnosed child, designed to reflect the neuropsychologic constructs of EF in everyday situations for children aged 5–18 years. It comprises eight scales, a Global Executive Composite (GEC), and two indexes: The behavioral regulation index (BRI) includes the inhibit, shift, and emotional control scales, whereas the metacognitive index (MI) includes the initiate, WM, plan-organize, organization of materials, and monitor scales. This instrument takes $\sim$15 min to administer. Raw scores are converted to *t*-scores, with ≥65 considered clinically impaired.

The BRIEF has been found to be valid for identification, description, and measurement of EF among children with ADHD.[31] Internal consistency, test–retest reliability ($r = 0.72$–0.84 for parent version for 3 weeks), and discriminant validity have been established for children with ADHD, as well as convergent and concurrent validity.[10,29,32]

Canadian Occupational Performance Measure. Canadian Occupational Performance Measure (COPM)[33] was administered pre- and postintervention, as goals were set with child and parents, whereas the parents rated the satisfaction and performance scales. This is a standardized subject-centered semistructured 15-min interview conducted by an occupational therapist. It is designed to detect self-perceived change in occupational performance problems over time in children over the age of 5 years. It refers to the subject's roles and expectations and can be used as a measurement for treatment outcomes and objectives before and after an intervention. It also enables goal setting with the client, according to their preferences. An improvement in COPM score of ≥2 is considered to be clinically significant. The COPM is well validated, reliable (test–retest reliability = 0.80 for performance scale for 1–2 weeks), and standardized. It was used as an outcome measure for participants with ADHD in several studies.[10,34]

Procedure

The study was conducted between August 2016 and August 2018, in ''Malkiya'' stable northern Israel and ''Amir'' stable in Jerusalem. It was provided by a licensed occupational therapist and a certified advanced TR instructor for the past 7 years (Author A.H.). Assessments were performed at baseline and postintervention. Baseline assessments included setting two to three goals and assessment of occupational performance and satisfaction using the COPM, in conversation with the children and their parents. The majority of the functional goals set were related to education (e.g., doing homework independently and preparing backpack for school) and self-care (e.g., performing morning routine on time, organizing cloths for school, and getting dressed). Other goals were related to leisure and socializing (e.g., engaging in a soccer game with friends in the afternoon).

In addition, the parents provided demographic information and completed the BRIEF questionnaires. Postintervention assessment included review of the goals performance and satisfaction using the COPM and refilling of the BRIEF.

The riding intervention included 12 weekly sessions of 45 min. Each treatment session had a defined structure. The first 10 min included setting the riding objectives for the session and warm-up exercises on the horse. The following 25 min duration was dedicated to acquisition and practice of skills such as walking, halting, and using reins and riding strategy, according to each riders' abilities. Enabling principles were used to help teach basic riding skills, according to each rider's goals. These include, for example, the use of extrinsic reinforcements, direct teaching techniques, visuals to supplement task knowledge, making choices obvious through modeling, prompting using physical cues, chaining to learn a sequence of skills, and fading to work toward independence.[35] The last 10 min were used to cool down and summarize the session, including a ''planning phase'' regarding the functional goal and how to implement it during the next week, as the COPM goals were not directly trained during the sessions themselves. Parents were present and involved during all sessions. Functional goals refer to the child's everyday function at the home/school/social context. Due to technical issues, baseline and postassessments were performed by the same occupational therapist who provided the intervention.

The *STABLE-OT* intervention was inspired by principles of strategy acquisition, guided discovery, and transfer.[36,37] Both specific and global strategies were taught while learning new riding and equestrian skills, such as strategies for inhibition (the ability to stop), planning and organizing, and more. All strategies were subject centered and adjusted to each participant, according to his/her individual goals. The strategies were acquired using guided discovery, with emphasis placed on their generalization to

other environments. The main cognitive executive global strategy that was used in the intervention was goal-plan-do-check. The participants were asked to verbalize what he/she wanted to do (goal), how they were going to do it (plan), and then performed the activity (do). They then learned to review and assess their performance (check). An example of a 12-week intervention process is described in Table 1.

Statistical analysis

Descriptive statistics were obtained on the demographic, social, and educational pretest characteristics of participants. Quantitative data were analyzed using SPSS 21.0. Normal distribution was confirmed using the Kolmogorov–Smirnov test. Paired sampled *t*-tests were used to test the differences between pre- and postintervention outcome measures, using within-subject effects of time (baseline, post). *p*-Value <0.05 was considered statistically significant in all comparisons. Effect size values were computed using the Cohen's *d* statistic, determined as follows: 0.2 (small), 0.5 (medium), and 0.8 (large).[38] Given the exploratory nature of the study, multiple testing corrections were not performed in the statistical analyses.

Results

Demographic characteristics of the sample ($n=25$) are presented in Table 2, indicating that the participants come from diverse backgrounds.

Regarding EFs, as shown in Figure 1, preintervention the sample had higher scores in all subscales and indexes than the BRIEF normative sample (*t*-score ≥50). Moreover, the sample reached the BRIEF ADHD clinical cutoff score (*t*-score ≥65) on the BRIEF WM subscale ($M=65.76$) and the GEC ($M=65.80$). It is noteworthy that all subscales, indexes, and composites, except for emotional control, showed trends consistent with improvement, such that at the end of the intervention the sample no longer fulfills the clinical criteria for significant executive dysfunction in any subscale. Remarkably, significant improvement with small to medium effect sizes were found between the pre- and postintervention scores in three out of the eight subscales of the BRIEF: Initiate [$t(24)=3.204$; $p=0.004$; $d=0.49$]; WM [$t(24)=2.476$; $p=0.021$; $d=0.32$] and Monitor [$t(24)=2.359$; $p=0.027$; $d=0.35$]. A significant difference was also found in the MI [$t(24)=3.873$; $p=0.001$; $d=0.43$] and in the total GEC score [$t(24)=2.801$; $p=0.01$; $d=0.37$].

Regarding occupational performance and satisfaction, altogether, children and parents identified 67 functional

Table 1. An Example of 12 Weeks Intervention Sessions

Number of sessions and aim	*Session structure*
1. Acquaintance with the rider and parents	Baseline assessment and goal setting using the COPM. Introducing the stable environment and the horse.
2. Acquaintance between rider and horse First riding session	Discuss the child's functional goals for intervention and prioritizing. Teach the global goal-plan-do-check strategy by basic riding skills: halt, walk, and trot. Goal: *The horse will start walking.* Plan: *Sit up straight, hands on the saddle, ask the horse to walk by saying ''walk on'' and press with the part of your legs between the knee and ankle.* Do: *Perform the plan.* Check: *Did the horse start to walk? If not, review the plan and doing.* Summary of session: *Review the use of the global strategy with the functional goals.*
3. Basic riding skills acquisition, beginning to work on functional goals.	Warm-up: *Choose the first functional goal*. Example *(10-year-old girl)*: *Preparing a school backpack with all the required equipment independently.* Goal: *Arrange the horse tack before the session and verify that all tack is present to mount and ride the horse.* Plan: *Use a checklist (through guided discovery).* Do: *Perform the plan.* Check: *Whether we have all the necessary tack?* Summary of session: *Set a plan to achieve the functional goal.* Example: *Preparing a list of all the needed equipment for school backpack.*
4–11. Advanced riding skills (according to the child's proficiency). Goals-directed intervention	Warm-up: *Review last week's goal achievements.* Goal: *Arrange the horse tack before and after the session and verify that all tack is present to mount and ride the horse and return the horse to its stall.* Plan: *Use a short pictorial checklist before and after riding.* Do: *Perform the plan.* Check: *After riding, verify that all tack has been removed.* Summary of session: *If the plan did not work, use a guided discovery to set an alternative plan*. Example: *Just preparing the list did not work. The list was too long and hard to follow. Alternative plan: Prepare a shorter and pictorial list of items.* Once achieved, the next goal can be worked on.
12. Intervention summary	Summary session, saying goodbye to the horse and staff. Postintervention assessments

COPM, Canadian Occupational Performance Measure.

Table 2. Demographic Characteristics of Subjects

	Mean (SD)	*Range*
Age (years)	9.41 (±1.75)	7.8–12.3
Gender	3 girls, 22 boys	
	Frequency	*%*
Residency ($n=20$)		
Rural	9	36
Urban	11	44
Children who take pharmacologic treatment*	14	56

*Ritalin™, Focalin™, Concerta®, Attent®, Vyvanse™.

goals using the COPM. Overall, clinical improvement (≥2 points) in performance was reported regarding 47 (70%) of the functional goals and 22 (30%) reported clinical improvement in satisfaction. In addition, the paired sampled *t*-test analysis showed a statistically significant improvement in occupational performance and satisfaction postintervention. Performance increased significantly from $M=3.40$ (SD = 1.58) to $M=5.80$ (SD = 1.36) [$t(24=-10.01$, $p<0.001$, $d=2.0$]; satisfaction also increased significantly from $M=3.77$ (SD = 1.41) to $M=6.05$ (SD = 1.21) [$t(24)=-9.86$, $p<0.001$, $d=1.98$] on a 1–10 rating scale.

Discussion

The findings of this preliminary study support the efficacy of *STABLE-OT* among school-aged children (6–14 years old) diagnosed with ADHD.

Ultimately, this was a pilot study, which was intended to provide preliminary proof of concept and a first assessment of general trends. Its positive results now support a more comprehensive investigation using larger and/or more specific population samples for more robust conclusions.

The assessments were chosen to reflect EF and occupational performance in the natural daily life environment of the participants. Specifically, improvement of EFs was reported by the parents and demonstrated by a significant improvement in the Initiate, WM and Monitor subscales, as well as the MI and GEC indexes of the BRIEF questionnaire. Occupational performance and satisfaction enhancement was supported by both clinical and statistical improvement in occupational goals, according to the COPM.

The results are in line with other studies that utilized nonpharmacologic treatment and strategies to set occupational goals during treatment using the BRIEF as an outcome measure, which have shown different improvement rates in the various BRIEF subscales.[10,39] A possible explanation for the nonsignificant improvement in the inhibit, shift, and emotional control BRIEF subscales may be the duration of the intervention. Most participants achieved basic riding skills and became independent riders only toward the end of the intervention. Basic riding skills are acquired while the horse is mostly led by the therapist. One can hypothesize that a longer intervention, when the horse is led mainly by the rider, independently, might encourage the use of behavioral regulation skills.

In addition, an improvement in the occupational performance, as rated by parents and children using the COPM, was found in various goals in different life areas, including school performance, self-care, and leisure. In the current intervention protocol, the functional goals were discussed but untrained directly during the sessions. The participants were taught a global problem-solving strategy that can be used at home when the therapist is not present and, therefore, it might support the improvement achieved in the functional goals.[28,40] The results are in line with previous studies that also reported improvement in occupational-based intervention among children with ADHD in trained and untrained goals.[28,41]

The improvement in EF may have occurred at least partially due to a number of mechanisms. The participants acquired a global strategy (goal-plan-do-check), which they were able to use in their everyday lives. Riding the horse and caring for it may have provided an ideal learning environment for acquiring this cognitive strategy. First, horses are motivating and promoting full attention and engagement in a learning situation. It was found that the animal–human

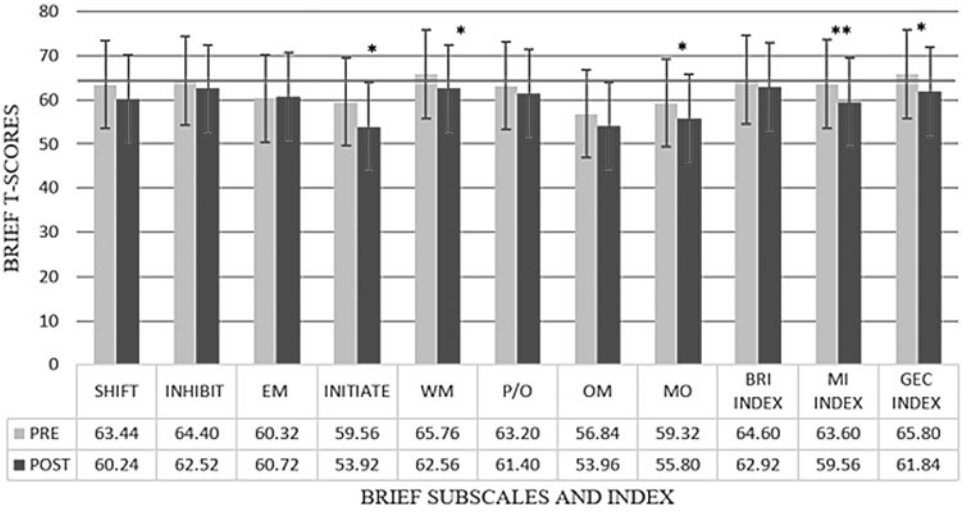

FIG. 1. Pre- and post-intervention results according to the BRIEF scale. *$p<0.01$ **$p<0.05$; higher score indicates higher impairment. Vertical line indicates cutoff score (*T*-score ≥65). BRIEF, The Behavior Rating Inventory of Executive Function; BRI, behavior regulation index; EM, emotional control; GEC, global executive composite; MI, metacognitive index; MO, monitor; OM, organization of materials; P/O, plan/organize; WM, working memory.

emotional relationship promotes changes in the children's function and evokes attachment behavior.[42] The connection with an animal provides a sense of confidence, helps decrease anxiety, and is perceived by the participant as a social relationship.[43] Second, the sensory stimulation of both the ground and mounted activities can help modulate physiologic arousal levels, also improving attention and engagement in the activity. Finally, the immediate feedback that the rider receives from the horse enables physical and mental self-regulation.[25] It provides differential reinforcement for successful execution of a task, enhancing learning for the ''check'' part of the cognitive strategy. The suggested graded protocol also allows individual adaptation according to the rider's abilities.[42]

Study limitations

The first limitation of this study is the absence of a control group. A control group is essential in determining that the results of the study and the effect of the intervention were due to the effect of the intervention and not due to other factors, such as participating in an extracurricular activity, interaction and guidance by the instructor, or riding the horse irrespective of the structured training and goal setting. Future studies should aim to compare STABLE-OT riding with a control/other intervention groups.

Another limitation relates to the small sample size, with a broad age range of children (6–14 years), which complicates the ability to interpret the results, as it does not take into consideration the significant development of EF during these years.[44] Undoubtedly, a larger sample size would allow to stratify the participants into groups according to age, or other manifestations of ADHD, which could give a more comprehensive understanding of the benefits to specific population subsets. It will also enable evaluation of the intervention among girls, whereas here, with only three girls being analyzed, it is little more than anecdotal with respect to girls.

In addition, reports from teachers and the subjects themselves would present a wider perception of change and validate the results further. Another limitation relates to the use of the COPM, as some studies[45,46] have shown an administration effect as the goals can improve without any other intervention. Assessment from various perspectives (i.e., teachers) and the use of more assessment tools can help validate the improvement due to the intervention. Finally, due to technical issues, the assessments and intervention were performed by the same occupational therapist, which might have caused bias regarding the results. Future studies should have different assessors.

Clinical significance

The results of this preliminary study support a positive effect of equine-assisted OT and promote this kind of intervention as an evidenced-based nonpharmacologic treatment for ADHD. It addresses an important need for more effective interventions.[9,10] This study further provides a protocol and timeline for occupational therapists, which can be applied for children with ADHD in the professional field and be implemented as a complementary intervention. The study also presents an alternative OT intervention, providing new therapeutic tools, although more research is needed.

Conclusions

This preliminary study indicates that STABLE-OT might be an effective intervention for EF, occupational performance, and satisfaction improvement, along with personal functional goals among school-aged children (6–14 years old) with ADHD. A key innovation of this study is the combination of strategy acquisition and the horse to address the child's needs in everyday life. The authors demonstrated that the current therapeutic protocol, which combined occupational-based principles, might enable generalization of therapeutic achievements into the natural environment of the patients, applying gains in the occupational goals outside the therapeutic setting.

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