Use of the Dynamic Interactional Model in Self-Care and Motor Intervention After Traumatic Brain Injury: Explanatory Case Studies

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KEY WORDS
- adolescent
- brain injuries
- cognitive therapy
- consciousness
- mobility limitation
- self-care

PURPOSE. The highest proportion of traumatic brain injuries (TBIs) occurs among adolescents. This study examines the effectiveness of a therapeutic protocol for rehabilitation of adolescents with TBI. This protocol is based on Toglia's (1998, 2005) Dynamic Interactional Model and Expanded Awareness Model (Toglia & Kirk, 2000).

METHOD. Explanatory case studies presenting 2 adolescents (ages 16–17) with mild to moderate TBI are combined with qualitative and quantitative data assessing self-care, mobility, and graphomotor abilities as well as deficit awareness in these domains. Outcome measures include the FIM™, the Canadian Occupational Performance Measure, the Computerized Penmanship Object Evaluation Tool, and the Awareness of Mobility Deficits Questionnaire. Graphic data analysis compared outcome measures before, during, and after intervention.

RESULTS. The Dynamic Interactional Model was effective in improving self-care, mobility, and graphomotor abilities and identified awareness of deficits in these domains.

CONCLUSION. These research findings contribute to our theoretical knowledge in rehabilitation and promote adopting this approach for rehabilitation of adolescents with TBI.

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One professional practice area in occupational therapy is rehabilitation after traumatic brain injury (TBI). TBI can occur in an instant but is a life-changing experience involving a lengthy journey from rehabilitation to recovery. It has been estimated that TBI affects >10 million people annually worldwide, leading to either mortality or hospitalization (Hyder, Wunderlich, Puvanachandre, Gururaj, & Kobusingye, 2007). According to the World Health Organization (2001), TBI will surpass many diseases as a major cause of death and disability by the year 2020.

Recently, interest in the relationship between cognitive deficits and occupational performance has grown. This interest can be seen in the increasing number of therapeutic models in which cognitive function is considered to be a major skill that influences occupational performance (Averbuch & Katz, 1998). Cognitive–perceptual difficulties, such as those that result in TBI, can significantly affect a person's ability to perform everyday tasks, fulfill usual roles, and maintain personal and social relationships. Independent self-care significantly influences participation in many activities at home and school and in the community (Bedell & Dumas, 2004). The aim of occupational therapy intervention for people with cognitive–perceptual dysfunction is to decrease activity limitation and enhance participation in everyday activities (Toglia, 2003).

A review of literature by Limond and Leeke (2005) recommended that because there is no evidence for a single effective intervention for people with TBI, rehabilitative

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models be developed for this population to improve cognitive and metacognitive functions through everyday tasks and standardized treatment procedures. One approach developed for the rehabilitation of adults with TBI is the Dynamic Interactional Model of cognition (Toglia, 1992, 1998, 2005). Josman (2005) has suggested that this model can be further adapted for use with children and adolescents; principles of the approach have been successfully applied in treating handwriting difficulties. The model focuses on clients' occupational performance in the context of meaningful daily tasks while facilitating awareness of deficits. Such awareness is of great importance for generalizing treatment outcomes to real-life situations after discharge (Beardmore, Tate, & Liddle, 1999; Hoofien, Gilboa, Vakil, & Barak, 2004; Port, Willmott, & Charlton, 2002; Toglia, 2003).

Toglia's (1992, 1998, 2005) Dynamic Interactional Model provides an extensive framework for the simultaneous use of diverse treatment approaches according to the client's needs. Because cognitive deficits influence different occupational performances and roles, Toglia (2005) suggested that therapy should include multitask activities in a variety of contexts and functional domains, both within and outside the clinic, including self-care activities. The overall goal of this multicontextual treatment is to help the client gain more control over symptoms by efficiently and independently using strategies for information processing.

To emphasize self-awareness training, Toglia and Kirk (2000) developed a comprehensive model of awareness that includes two interrelated concepts: self-knowledge and online awareness. *Self-knowledge* refers to the understanding of one's strengths and limitations; *online awareness* refers to metacognitive skills such as the ability to accurately judge task demands, anticipate the likelihood of problems, and regulate and evaluate performance within the context of an activity. Online awareness changes within an activity, whereas self-knowledge is stable and changes slowly with experience.

In this research, we examine the effectiveness of an intervention protocol that combines the principles of the multicontextual treatment approach (Toglia, 2005) and the recommendations for rehabilitation of Toglia and Kirk (2000). Specifically, the aims of the study were to determine whether the participants' self-awareness improved over the period of intervention and whether the participants experienced enhanced daily function in self-care, mobility, and graphomotor abilities.

Method

The research was an explanatory case study with 2 participants that used a combination of qualitative descriptions and quantitative measurements. This methodology offers a means of describing phenomena and provides insight into the uniqueness of cases. Yin (2003, pp. 3–7) defined *explanatory case study* as a method that provides answers to how and why questions offer insight into unique events. This type of comprehensive understanding can be achieved through a process known as *thick description,* which involves an in-depth description of the entity being evaluated. In this research, it includes measures before, during, and after intervention (Law et al., 1998) and thick descriptions of the process and outcomes.

Participants

The sample consisted of 2 adolescents (ages 16–17) who were diagnosed with mild to moderate TBI, with a score >12 on the Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974), who sustained injury <2 months earlier. The participants were selected from two different rehabilitation centers in Israel (Loewenstein Rehabilitation Center in Raanana, Israel, and Rambam Health Care Campus in Haifa, Israel). The exclusion criteria screened out participants who were diagnosed with attention deficit hyperactivity disorder, learning disabilities, or previous TBI.

Case Report 1. David was a 16-year-old boy who lived in the countryside and was involved in a road accident while driving a small tractor. After the accident, he was admitted to the intensive care unit (ICU) unconscious and was placed on life support equipment. He experienced mild right hemiparesis; a spleen hemorrhage; and various fractures, including ones to the C-7 vertebra, the right hip, the right kneecap, and the right dominant arm. On admission to the ICU, his score on the GCS was 6–7. A brain computed tomography (CT) scan revealed subdural and subarachnoid hemorrhages. David regained consciousness after 4 days and was transferred to the neurosurgical ward. Two weeks later, he was referred to rehabilitation. Overall, he received 32 occupational therapy treatment sessions with five 1-hr sessions per week.

Case Report 2. Sara was a 17-year-old girl who lived in a northern Israeli city. She was admitted to the ICU after being involved in a car accident and was placed on life support equipment for 3 days. As a result of the accident, Sara sustained a brain injury. The CT head scan showed a left frontal injury, a subarachnoid hemorrhage, and multiple fractures in the naso-orbital complex. After halting the use of medication, she regained consciousness. Sara was able to move all four limbs, but her speech was difficult to understand, and she refused to open her eyes. In addition, a foot drop was observed in her right leg, and she had sustained a sensory neural injury in her left leg that caused high sensitivity, stinging, and pain. At the time of her discharge from

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the ICU, she scored 14–15 on the GCS. Rehabilitation treatment began 10 days later and included 40 occupational therapy treatment sessions over the course of 8 weeks, with sessions lasting 30 min to 1 hr per day, 5 days a week. Also included in rehabilitation were hydrotherapy treatment, physical therapy, and meetings with a psychologist.

Instruments

The GCS (Teasdale & Jennett, 1974) is a standardized system used to assess the degree of brain impairment and to identify the seriousness of injury in relation to outcome. The test provides a score in the range of 3–15, and patients with scores of 3–8 are usually considered to be in a coma. The total score is the sum of scores in three categories: eye opening response, verbal response, and motor response.

The Children's Orientation and Amnesia Test (Ewing-Cobbs, Levin, Fletcher, Miner, & Eisenberg, 1990) was designed to identify disorientation and amnesiac states, and we used it in this study to evaluate cognitive level and duration of posttraumatic amnesia after TBI. It is a short quantitative test consisting of 16 items that measure three areas: (1) general orientation to place and personal details (e.g., parents' names, school name, date of birth), (2) orientation to time (year, month, hour), and (3) immediate recall of short-term and long-term memory (e.g., recall a set of numbers, a famous personality, the name of the examiner). The range of scores of correct answers is between 0 and 124; the memory score is between 0 and 43 and calculated separately.

The FIM™ (Granger, Hamilton, Linacre, Heinemann, & Wright, 1993) is a measure of the severity of disability and functional state. It is an 18-item ordinal scale used for assessing progress during inpatient rehabilitation. The scores range from 1 to 7, with a score of 7 categorized as *complete independence* and a score of 1 categorized as *total assist* (performs <25% of a given task). Scores <6 require another person for supervision or assistance. The test measures independent performance in self-care, sphincter control, transfers, locomotion, communication, and social cognition. By adding the points for each item, the possible total score representing the level of independence ranges from 18 (lowest) to 126 (highest).

The Awareness of Mobility Deficits Questionnaire (see Appendix) was developed for this study. The questionnaire consists of three multiple-choice questions regarding the extent of independence in the mobility domain: "Do you have difficulties getting from place to place on your own?" "How did you get to the treatment room today?" and "How much help did you need to get to the treatment room today?" The therapist observes the patient and answers the same questions in relation to the way the patient arrived to the therapy session and the extent of help needed. The score for the level of awareness of deficits is calculated by comparing the therapist's and patient's answers and evaluating the gap between the two evaluations.

The Computerized Penmanship Object Evaluation Tool (ComPET, previously referred to as *POET;* Rosenblum, Weiss, & Parush, 2003) is a computerized system used to assess graphomotor and writing abilities. The ComPET is an online validated and standardized handwriting evaluation that provides objective temporal, spatial, and pressure measures of the handwriting process. The system is not language dependent and includes two main parts: data collection and data analysis. Participants in this study were requested to perform two tasks: (1) to write their first and last name, which is an automatic and familiar task, and (2) to copy 27 shapes, grouped into nine sequential tasks (3 shapes per task), which is an unfamiliar task. All of the writing and drawing tasks were performed on A4-size lined paper affixed to the surface of a WACOM Intuos III (407 × 417 mm × 36.3 mm) x–y digitizing tablet using a wireless electronic pen with a pressure-sensitive tip (Model UP-401; WACOM Co. Ltd., Japan). A digitizing tablet is an electronic surface that records the x and y coordinates when an electronic pen comes into contact with its surface or within 5 mm of its surface.

The handwriting–drawing process outcome measures used were the number of written strokes, total performance time, in-air time (i.e., the time during writing or drawing in which the pen is not in contact with the writing surface), on-paper time, writing speed, and writing pressure applied to the paper (in nonscaled units from 0 to 1,024). The ComPET temporal outcome measures (total time, on-paper time, in-air time) are presented in seconds, the speed is presented in millimeters per minute, and the pressure is presented in nonscaled units from 0 to 1,024 (for further details, see Rosenblum et al., 2003).

The Canadian Occupational Performance Measure (COPM; Law et al., 1994) is an individualized outcome measure designed to detect changes in self-perception of occupational performance over time.

Procedure

Both Institutional Review Board committees at Loewenstein Rehabilitation Center in Raanana and Rambam Health Care Campus in Haifa, Israel, approved the research. Parents also signed informed consent. The GCS and the Children's Orientation and Amnesia Test were administered before the intervention. The FIM, ComPET, and the Awareness of Mobility Deficits Questionnaire were administered both before and after the intervention. The Awareness of Mobility Deficits Questionnaire was also administered once a week

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during the intervention. At the Loewenstein Rehabilitation Center, all assessments were administered by a staff occupational therapist. At the Rambam Health Care Campus, assessments were administered by Sharon Zlotnik. Both data collectors had full knowledge of the research questions.

The intervention was delivered by Sharon Zlotnik using a therapeutic protocol based on Toglia's (1998, 2005) Dynamic Interactional Model together with Toglia and Kirk's (2000) Expanded Awareness Model. The protocol was divided into four or five sections or phases according to level of difficulty. Every phase included the same information-processing strategy, and the task characteristics were systematically changed (Toglia & Kirk, 2000). This systematic advancing from one level of ability to the next was aimed at facilitating the generalization of abilities to real-life functioning outside the clinical environment.

Data Analysis

We analyzed the quantitative data by visual analysis of the graphic data and comparison of the results of the outcome measures before, during, and after intervention. We report the qualitative data as case studies.

Results

The following case reports describe the application of the Dynamic Interactional Model to two adolescents with TBI.

Case Report 1

On his admission to rehabilitation, David had to use a wheelchair because his leg was still in a cast. The cast from his right arm had already been removed, and the fracture was reported to be healed. David needed help in mobility and transfers to and from the wheelchair. He also experienced other motor difficulties, such as pouring a drink into a cup. David expected to improve enough in mobility to walk independently and even play soccer. He also expected to improve the function of his right arm and the quality of his graphomotor abilities to reach his before-injury performance level. Although he did not mention difficulties in self-care activities, he did require help getting dressed, tying his shoes, bathing, and toileting. He was hoping to go home within a month, and he emphasized the word *walk.* David claimed to have no "problem with his brain" and was willing to do whatever was necessary to fully recover. The goals of treatment were based on David's anticipated improvement in self-care skills, mobility skills, graphomotor skills, and awareness of mobility deficits.

Qualitative Results. On the Awareness of Deficits in Mobility Questionnaire, both David and the therapist indicated that he had difficulty getting from place to place. David claimed to have come to the therapy room by himself without any help, whereas the therapist reported that he was brought to the room by a caregiver, indicating the need for high-level assistance.

Self-care training intervention was directed toward achieving independence. David did not want to practice self-care activities because he predicted that he would regain full independence in his mobility without the need for external help in this domain. At this initial stage, awareness training was promoted by asking David direct questions to facilitate awareness of his deficits and motivate self-practice.

Mobility training intervention was aimed at achieving greater independence because David needed full assistance with transfers to and from the wheelchair. David was trained to move the wheelchair by himself and to use help only for opening and closing doors. In the initial stage, awareness training was focused on providing direct feedback about his performance. As the intervention progressed, awareness training was directed toward facilitating his ability to identify situations in which he could function independently and determine the amount of help he required in different situations.

For example, once he was able to use crutches, he no longer needed help opening doors. However, he walked slowly with crutches at first and still required assistance to carry his belongings. As David's ability to walk with crutches improved, he could walk for longer distances, take shorter breaks, and increase stair use instead of elevator use. At this stage, he was encouraged to carry his belongings himself while walking with crutches. In the final stage of the intervention, David no longer needed crutches and could walk independently. He was then asked to predict the situations in which he could function independently and those in which he still had difficulties. For example, his ability to predict his success in response to the question "Will you be able to meet me downstairs and carry your belongings?" was an indicator of his own awareness of his deficits and his competence in choosing activities suitable to his skill level.

Another goal of mobility training intervention was aimed at safe functioning. For example, when sitting down in a chair David initially stood with his back to the chair and dropped into it in one movement without looking behind him. Facilitating safety awareness when sitting down involved cuing him to use support by holding onto the arms of the chair or by leaning on a table to sit down.

Graphomotor training intervention was directed toward achieving improved motor control and muscle strength, combined with awareness training. Because David was healing from an arm fracture, the qualitative evaluation of his handwriting, compared with his preinjury ability, revealed that it was difficult for him to write fluently. David reported

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that his right hand felt weaker and that he needed to put more effort into writing, leading to his initial tendency to avoid graphomotor tasks. The graphomotor training began with activities to strengthen his right dominant arm and fine motor skills. As in the motor and self-care domains, the awareness training followed a progressive course of self-evaluation beginning with receiving feedback about performance from the therapist. The demands for more accuracy and fine motor control were gradually and systematically increased until by the end of the intervention, David initiated writing assignments and showed improvement in his kinetic control.

The intervention ended after 5 weeks, and several days later David was released from the hospital. One month after his discharge, a follow-up phone conversation was held with his mother. She reported that 2 weeks after David had returned home, he began receiving occupational and physical therapy in the community. His mother noted that "David wanted to be even better than he had been prior to the accident" and that "his motivation was greater than ever." David did not return to play soccer as he had hoped, but he was enrolled in a gym for extra exercise. As for the self-care domain, he once again became totally independent.

Quantitative Results. A comparison of outcomes in the mobility and self-care domains, as measured by the FIM assessment, is presented in Figure 1. As the figure shows, David regained independence in both self-care (90%) and mobility (233%) by the end of treatment. The treatment of David's mobility deficits was based on five phases that gradually enabled him to gain more independence and improve his abilities from requiring maximal assistance for transfers and getting from place to place to modified independent walking and climbing stairs. Likewise, the improvement in self-care abilities was gradual, beginning with maximal assistance and reaching complete independence.

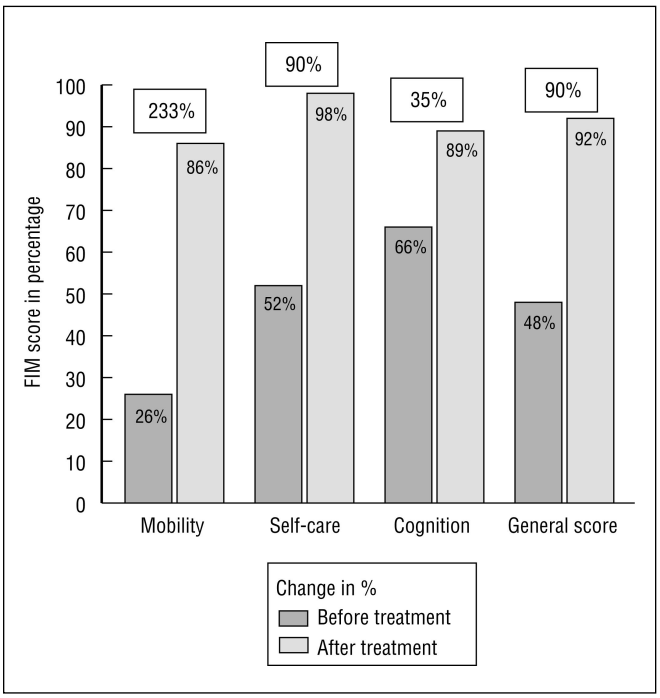

Figure 1. FIM results for Participant 1.

We compared outcomes of awareness of mobility deficits by measuring the gaps between the therapist's report and David's responses to three specific self-efficacy questions regarding the extent of his mobility independence (see Appendix). We found that the gap between the two evaluations of David's deficits existed only before intervention. These results indicate that by the end of treatment, David had a more accurate awareness of his own deficits and a greater recognition of the amount of help he needed. Facilitating this awareness required that David be trained to be less dependent on others and to perform motor activities without assistance.

A comparison of outcomes in the graphomotor domain is presented in Table 1. David's graphomotor abilities were assessed using the ComPET on two writing tasks: (1) writing his own name and (2) copying 27 shapes grouped into nine tasks (3 shapes in each task). ComPET's pre- and postintervention outcomes were compared for the number of strokes, total performance time, on-paper time, in-air time, speed, and pressure.

As shown in Table 1, we found consistent improvement regarding the ComPET measurements of speed, performance time, and pressure (in-air time, total time, on-paper time). The total change reflected processes at the mechanical level and at the cognitive and awareness levels. An increase in pressure indicated an improvement in general muscle tone. An increase in performance time and a decrease in speed may have reflected reduced impulsivity, awareness of the need to slow down and check, and the availability of more time for planning and organization.

Case Report 2

On her admission to rehabilitation, Sara reported that she did not remember the accident, but she was aware of time and place, herself, and the reason for her hospitalization. Since the accident, she described being very troubled by leg pain and losing sleep as a result of pain. Pain relievers did not help her, and she tried to alleviate the pain by running cold water on her leg. Her moods were heavily affected by the intensity of pain; the activities that were limited by pain included studying, self-care, mobility, and leisure activities. She was motivated to progress, and her primary priority was to manage her pain, overcome her limited mobility, and enhance her self-care capabilities. The treatment goals were based on Sara's anticipated improvement in self-care skills,

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Table 1. Change in Handwriting Measures of Name Writing Task and Averages of All Nine Copying Shape Tasks

Participant 1			
Gap in Percentile	After the Intervention	Before the Intervention	Handwriting Process Measure
			1. Name-writing task
10	11	10	Number of strokes
63	6.17	3.79	Total time (s)
39	2.98	2.14	On-paper time (s)
91	3.19	1.670	In-air time (s)
–42	25.04	43.20	Speed (mm/min)
–25	466.23	625.24	Pressure (nonscaled units from 0 to 1,024)
			2. Copying shapes task (averages of the nine tasks)
5	10.37	9.875	Number of strokes
73	57.51	33.32	Total performance time (s)
102	34.85	17.24	On-paper time (s)
41	22.66	16.07	In-air time (s)
–58	20.72	48.80	Speed (mm/min)
21	897.28	739.77	Pressure (nonscaled units from 0 to 1,024)

mobility skills, graphomotor skills, and awareness of mobility deficits.

Qualitative Results. On the Awareness of Deficits in Mobility Questionnaire, both Sara and the therapist indicated that she had difficulty getting from place to place. They both reported that she came to the therapy room by leaning on an adult. Sara perceived that she needed a high level of assistance, whereas the therapist reported that her assisted walking indicated the need for little help.

Intervention regarding self-care training was directed toward achieving improved independence. Sara quickly accomplished functional independence in self-care. In the intervention's first phase, she required help with dressing and supervision while bathing, but after a short period of time she began to function independently. To her satisfaction, there was no need to continue practicing self-care activities for the duration of intervention because she was generally independent in self-care. However, there was still some time dedicated to grooming activities, such as polishing her nails, which Sara chose to practice as part of treatment sessions. Accordingly, she was required to evaluate her performance and identify activities that she still needed to practice, such as stably holding a nail polish brush to color her nails.

Mobility training intervention was directed toward achieving improved mobility, independent walking for a longer distance, and the ability to climb stairs. First, Sara was unable to bear weight on her foot because of neuropathic pain, which was interrupting her sleep and causing her to feel exhausted. The pain in Sara's leg thus became her primary priority for treatment. She was treated in the hospital's pain clinic but reported no relief. Additional treatment for pain included fitting a splint to her leg at night and an external elastic strap to support the ankle. As a result, Sara reported sleeping better at night. Other strategies included the use of a guided imagery technique to achieve a state of rest and relaxation, together with self-efficacy training. Still, Sara reported only momentary relief from pain.

The modality that provided the most relief was the EYETOY computer program, which is part of Sony PlayStation®. This program simulates a virtual environment by projecting the image of the player on the screen so that the player can see her- or himself move according to a rhythm in sports-oriented games and while hitting moving targets onscreen. These games probably provided distraction from pain and involved putting graduated weight on the legs for training, walking, and finally even dancing, all combined with awareness training.

At first, awareness training consisted of concrete feedback from the therapist about the motor activities in which Sara was able to participate for longer periods of time. Using the Awareness of Deficits in Mobility Questionnaire (see Appendix), Sara was asked several times during the course of rehabilitation to evaluate her level of independence in mobility while practicing familiar tasks. At the beginning, her awareness of deficits was only partial and did not match the therapist's report. However, this ability improved over time, and the repeated measurements allowed more sensitivity to fluctuations in Sara's self-efficacy regarding her ability to walk and the amount of help needed in relation to the pain she was experiencing.

In the final stage of the intervention, Sara was asked to complete the COPM to assess her satisfaction with her functioning. She noted that she would like to go dancing again and was consequently given the opportunity to use the treatment sessions to practice dancing. She chose to learn how to dance salsa, and before leaving the hospital, Sara planned and prepared a party in which she danced salsa and performed a small show for her family, friends, and therapists from the ward.

At the end of treatment, Sara was aware of the remaining deficits in her mobility, although she continued to evaluate her performance as slightly above her actual ability. Although she had accomplished her goal of dancing, some deficits were still observed in her walking. However, she was able to walk independently at a faster pace and for longer distances with a walking strap supporting her ankle and without a need for supervision.

Graphomotor training intervention was directed toward achieving improved writing and graphomotor abilities, combined with awareness training. The treatment focused on

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strengthening the underlying mechanism of writing together with functional practice. At the beginning of treatment, Sara was asked to evaluate the outcome of her writing in comparison to the past in terms of readability and output of effort. She reported that her handwriting was similar to her previous writing, but that now her hand was shaking. Because her shakiness was ascribed to muscle weakness, awareness training was aimed at facilitating Sara's knowledge of the sensorimotor exercises that would help her overcome her graphomotor deficits; she was encouraged to continue practicing on her own outside of therapy sessions.

Quantitative Results. A comparison of outcomes in the mobility and self-care domains, as measured by the FIM assessment, is presented in Figure 2. As can be seen in the figure, Sara's greatest improvement was in the mobility domain (79% change). Outcomes of awareness of mobility deficits were compared by measuring the gaps between the therapist's report and Sara's responses (see Table 2) to the Awareness of Mobility Deficits Questionnaire (see Appendix). In most cases, the two evaluations were evenly matched. The greatest gap in evaluating the amount of help needed was evident in the measurement before treatment: Sara claimed that she needed substantial assistance, whereas the therapist reported that only minimal assistance was necessary.

A comparison of outcomes in the graphomotor domain is presented in Table 3. Sara's graphomotor abilities were assessed using the ComPET on two writing tasks: (1) writing her own name and (2) copying 27 shapes grouped into nine tasks (3 shapes in each task). ComPET's pre- and postintervention outcomes were compared for the number of written strokes, total performance time, in-air time, on-paper time, speed, and pressure.

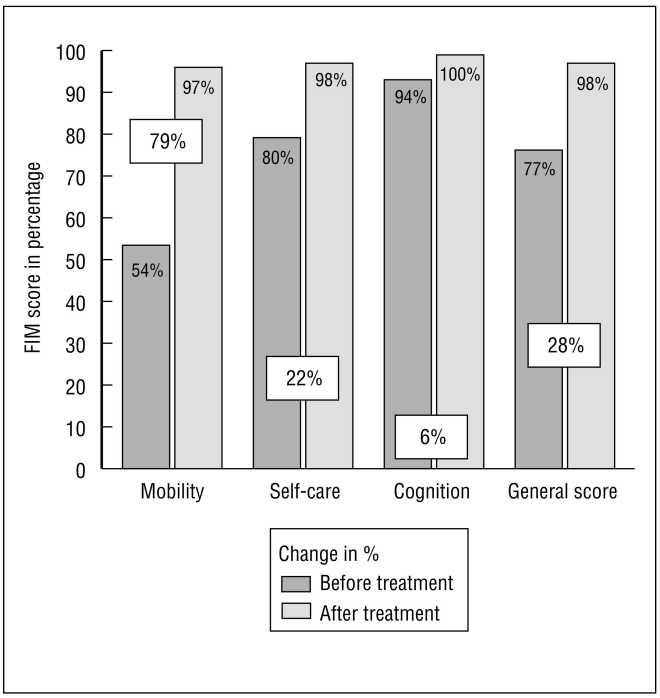

Figure 2. FIM results for Participant 2.

The improvement in Sara's graphomotor skills is evident in Table 3. Findings show a constant trend of change. Although the number of strokes she wrote differs slightly, after the intervention it took her less time to complete the tasks, and she was able to apply more pressure on the writing surface while maintaining a steady writing speed.

Discussion

This research protocol was designed and used as a basis for building an intervention program that matches the special needs of adolescents in their rehabilitation after TBI. We found use of the principles from the Dynamic Interactional Model (Toglia, 2005), combined with those of the Extended Awareness Model (Toglia & Kirk, 2002), to be effective for improvement of the major measures tested in this research. The study's first objective was to determine whether the participants' self-awareness improved over the period of intervention. The research findings regarding awareness of mobility deficits showed that both participants improved from partial awareness before the intervention to full awareness by the end of intervention. The study's second objective was to determine whether the participants improved their mobility, self-care, and graphomotor functioning over the period of intervention. The 2 participants showed improvement in their level of independence and regained full functioning on intervention completion.

These findings are similar to previous research showing that even when a head injury was severe, many patients regained an independent level of functioning in both mobility and self-care (Boyer & Edwards, 1991). Independent self-care significantly influences participation in many activities, as demonstrated by another study that followed 60 children and youth with head injuries 6 months after discharge from rehabilitation (Bedell & Dumas, 2004). Bedell

Table 2. Participant 2: Comparison of Awareness of Mobility Deficits

Question	Before	Week 1	Week 2	Week 3	Week 4	Week 5	After
				Therapist Evaluation			
1	Yes	No	No	Yes	Yes	No	No
2	3	5	5	1	3	5	6
3	3	4	4	1	3	4	4
				Participant 2 Evaluation			
1	Yes	No	Yes	Yes	Yes	No	No
2	2	5	6	1	3	6	6
3	1	4	4	1	2	4	4

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Table 3. Change in Handwriting Measures of Name Writing Task and Averages of All Nine Copying Shape Tasks

Participant 2			
Gap in Percentile	After the Intervention	Before the Intervention	Handwriting Process Measures
			1. Name-writing task
13	9	8	Number of strokes
–37	3.58	5.68	Total time (s)
–23	2.20	2.85	On-paper time (s)
–51	1.38	2.83	In-air time (s)
0	31.34	31.24	Speed (mm/min)
46	549.46	375.32	Pressure (nonscaled units from 0 to 1,024)
			2. Copying shapes task (averages of the nine tasks)
–17	5	6	Number of strokes
–63	5.91	16.11	Total time (s)
–71	3.24	11.31	On-paper time (s)
–60	2.67	6.64	In-air time (s)
164	107.56	40.81	Speed (mm/min)
67	539.67	322.42	Pressure (nonscaled units from 0 to 1,024)

and Dumas found that the higher the level of independent functioning at the time of rehabilitation discharge, the higher the level of participation at home and school and in the community.

After treatment, both participants improved their awareness of deficits in mobility and graphomotor abilities. Research findings in the graphomotor domain showed changes in all of the tested variables. The change in applied pressure may reflect an increase in awareness or an improvement in muscle tone for both participants. Although the changes indicate a decreased speed for 1 participant and an increased speed for the other, the changes both demonstrate improvement relative to the preintervention cognitive state and reflect the different treatment goals of each participant. These findings are congruent with previous research indicating a connection between cognitive components such as planning and attention to the writing process (Montgomery, 2004; Oliver & Kellogg, 2002). Moreover, previous research has shown that graphomotor activities, made up of elements at the cognitive level (planning and content) and the mechanical level (motor skills) can be easily affected by head injury (Cornin, 2001; Hotz, Helm-Estabrooks, & Nelson, 2001).

Limitations of the Study

The use of explanatory case study methodology allowed us to compare the qualitative data with the quantitative outcome measurements and examine the results in light of changes in performance within the context of events that were beyond the scope of the study, such as the possible influence of pain. One main limitation was that the research was conducted in two separate rehabilitation settings under different conditions. In one setting, treatment was provided by Sharon Zlotnik, and the evaluation was conducted by another occupational therapist. Although this separation of treatment from evaluation provided greater objectivity, it could not be practically carried out at both rehabilitation centers. In the second setting, it was not possible to enlist an external tester for all assessments, and therefore the treatment and evaluation were carried out primarily by Zlotnik.

Research findings indicate that both participants experienced improvement in desired functional areas (self-care, mobility, graphomotor skills) after intervention; however, given the nature of this nonrandomized and uncontrolled case study, no definitive conclusion regarding intervention efficacy can be fully drawn.

Future Research

We found the use of principles from Toglia's (1998) Dynamic Interactional Model, in combination with Toglia and Kirk's (2000) Extended Awareness Model to be suitable for rehabilitating hospitalized adolescents after traumatic brain injury. Toglia's (1998) model of cognitive rehabilitation incorporates treatment for impaired self-awareness within a multicontextual treatment approach. This model's unique focus is its incorporation of strategies to improve self-awareness not only in cognitive rehabilitation, but also in the individual's sense of mastery and control during occupational performance. The matching of individual participant needs to self-selected individual goals, both before and during treatment, characterizes the flexibility of the Dynamic Interactional Model and strengthens its usefulness in treating a variety of populations. The current study is one of the few that has examined the effectiveness of any intervention for the treatment of adolescents in TBI rehabilitation; therefore, extensive research is needed in the future to examine the approach's suitability specifically for the treatment of this population.

The validity of this treatment approach may be further enhanced through replication of an almost identical protocol in future case studies with this population. To enhance the internal validity of research measuring effectiveness, a group comparison design could be used in which clients in one group receive the dynamic interactional treatment and clients in a control group receive a different cognitive intervention. A longitudinal research design could be also be used to examine treatment effects over time and in the context of both social and school participation. ▲

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Appendix. Awareness of Mobility Deficits Questionnaire

Questions	Before	Week 1	Week 2	Week 3	Week 4	Week 5	After
1. Do you have difficulties getting from place to place on your own?							
A. Yes	A.	A.	A.	A.	A.	A.	A.
B. No	B.	B.	B.	B.	B.	B.	B.
2. How did you get to the treatment room today?							
1. I was brought by wheelchair.	1	1	1	1	1	1	1
2. I came by myself on a wheelchair.	2	2	2	2	2	2	2
3. I walked leaning on an adult.	3	3	3	3	3	3	3
4. I walked slowly with a walker.	4	4	4	4	4	4	4
5. I walked slowly with supervision.	5	5	5	5	5	5	5
6. I walked independently as appropriate to my age.	6	6	6	6	6	6	6
3. How much help did you need to get to the treatment room today? (from an adult, walker, or wheelchair).							
1. I needed a lot of help.	1	1	1	1	1	1	1
2. I needed moderate help.	2	2	2	2	2	2	2
3. I needed a little help.	3	3	3	3	3	3	3
4. I did not need help.	4	4	4	4	4	4	4

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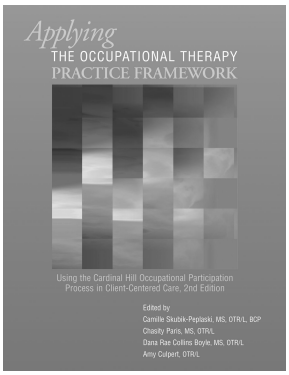

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