Executive Functioning, Awareness, and Participation in Daily Life After Mild Traumatic Brain Injury: A Preliminary Study

Asnat Bar-Haim Erez, Ettie Rothschild, Noomi Katz, Maya Tuchner, Adina Hartman-Maeir

KEY WORDS
• awareness
• brain injuries
• cognition
• self-concept

OBJECTIVE. We investigated the relationship of executive functioning and self-awareness to participation in daily life of people after mild traumatic brain injury (mTBI) referred to occupational therapy in the postacute phase.

METHOD. Thirteen participants who sustained mTBI (average time since injury = 4.7 months, mean age = 43.4 years) were evaluated with the Behavioral Assessment of the Dysexecutive Syndrome, the Dysexecutive Questionnaire, the Self-Awareness of Deficits Interview, and the Participation Index (PI) of the Mayo-Portland Adaptability Inventory.

RESULTS. Analysis revealed high frequencies of deficits in executive functions such as planning and shifting. However, self-awareness of the executive deficits was intact. A significant percentage (62%–85%) of participants experienced restrictions in everyday life activities, and PI scores were significantly correlated with measures of executive functioning.

CONCLUSIONS. After mTBI, people may be at significant risk for persistent executive deficits and restrictions in participation that warrant occupational therapy intervention.


Each year in the United States alone, more than 1 million people sustain a mild traumatic brain injury (mTBI). It is estimated that approximately 80% of all brain traumas are of mild severity (Kraus, McArthur, Silverman, & Jayaman, 1996). The most common cognitive problems encountered by patients who have sustained an mTBI are reduced speed of processing and problems with attention, memory, impaired verbal fluency, and executive functioning (Binder, 1997; Binder, Rohling, & Larrabee, 1997; Frencham, Fox, & Maybery, 2005; Mathias & Coats, 1999). These symptoms tend to be most evident in the acute stages after mTBI and often completely resolve after a few months, with 80% to 90% of patients making a favorable recovery (Binder, 1997).

However, a subgroup of patients (10% to 20%) who have sustained an mTBI continue to experience cognitive and neurological symptoms long after their injury (Binder, 1997; Ruff, Camenzuli, & Mueller, 1996). Binder et al. (1997) summarized results from 11 prospective postacute studies (>3 months postinjury) on the influence of mTBI on neuropsychological functioning. Overall, a small positive effect of mTBI was found, showing the potential risk for cognitive deficits in this population. In a more recent meta-analytic review, Frencham et al. (2005) addressed the effects of mTBI on cognitive findings for all stages postinjury. The analysis included data from 17 studies. A small positive effect of mTBI was found on cognitive performance in the areas of speed of processing, working memory, and executive function across all stages postinjury. Occupational therapy has a valuable role in the
rehabilitation of people with impairments in higher-level cognitive functions (Katz & Hartman-Maeir, 2005). Therefore, a need exists to examine the impact of the mTBI cognitive profile on participation in meaningful life roles.

Although many tests are available, the question arises as to which tests are sensitive enough to be used for monitoring of recovery in clients with such subtle deficits. Brooks, Fos, Greve, and Hammond (1999) recommended using tests that measure executive functioning and that are sufficiently cognitively demanding, such as the Behavioral Assessment of the Dysexecutive Syndrome (BADS; Wilson, Alderman, Burgess, Emslie, & Evans, 1996). Moreover, occupational therapy top-down assessment principles stress the need to use ecological measures of executive functioning that better capture the real-world functional consequences of executive impairment, such as the Executive Function Performance Test (Baum et al., 2008).

Current guidelines of occupational therapy practice (American Occupational Therapy Association, 2008) and of the World Health Organization (2001) for understanding the implications of health conditions stress the importance of adopting a wider perspective on outcomes, beyond the focus on impairment to disability and participation. Accordingly, to examine the broader outcomes of mTBI, we searched for studies reporting the implications of cognitive deficits on activity and participation levels. Several recent studies have highlighted the significant impact of higher-level cognitive functions on rehabilitation outcomes and participation in life roles in survivors of moderate to severe TBI. More specifically, executive deficits have been shown to correlate with limitations in instrumental activities of daily living (IADLs; Colantonio et al., 2004) and with poor employment outcomes (Ownsworth & McKenna, 2004). In addition, unawareness of the consequences of TBI has been shown to be associated with poor rehabilitation outcome and community integration (Shames, Treger, Ring, & Giaquinto, 2007; Sherer et al., 2003). A paucity of research exists regarding the consequences of mTBI in terms of higher-level cognitive functions (executive functioning and awareness) and their implications for participation in everyday life.

The purpose of this preliminary study was to investigate executive functioning, awareness, and participation in a sample with persisting problems in the postacute phase after mTBI. We hypothesized, in line with previous studies of people with more severe TBI, that (1) deficits would be found on measures of executive functioning and awareness, (2) restrictions in participation would be found in IADL and employment, and (3) significant relationships would be found between both executive functioning and awareness with participation.

Method

Participants

The participants were recruited from consecutive admissions (referred by the treating neurologist or family physician) to the outpatient rehabilitation department in a general hospital in southern Israel. We defined mTBI according to the criteria of the American Congress of Rehabilitation Medicine (“Definition of Mild Traumatic Brain Injury,” 1993) as follows: a Glasgow Coma Scale score (Teasdale, & Jennett, 1974) between 13 and 15, loss of consciousness not exceeding 30 min, and posttraumatic amnesia persisting <24 hr. The study exclusion criteria were previous history of head injury, dementia, neurological or psychiatric disorder, and alcohol or drug abuse. The study sample consisted of 13 participants (6 men, 7 women) between the ages of 25 and 64 (mean [M] = 43.4, standard deviation [SD] = 13.07). The mean time postinjury was 4.79 months (SD = 1.8), and the Glasgow Coma Scale range was between 13 and 15 (M = 14.53, SD = 0.66). The basic cognitive status evaluated by the COGNISTAT (Kiernan, Mueller, & Langston, 1995) showed mean scores within the normal range for orientation, comprehension, repetition, naming, construction, calculations, similarities, and judgment, yet mild impairment on the Attention and Memory subscales. The average years of education were 14.76 (SD = 3.19), and most of the participants (85%) were married and living with their spouses. The study was approved by the hospital’s Human Rights (Helsinki) committee, and all participants signed informed consent.

Measurements

Participation Index. The Participation Index (PI) from the Mayo–Portland Adaptability Inventory (Malec, 2004; Malec & Lezak, 2003) was designed to provide a brief outcome measure of rehabilitation targeting eight domains of social participation (initiation, social contact, leisure, self-care, residence, transportation, employment, and money management). Each participation domain is rated on a 4-point scale: 0 = within normal limits, 1 = mildly restricted in participation but not to a degree that interferes significantly with everyday functioning, 2 = moderately restricted in participation, and 3 = severely restricted in participation. The total index score ranges from 0 to 30, with higher scores reflecting greater restrictions in participation. Rasch analysis revealed strong internal consistency for the PI and a high correlation with the full Mayo–Portland Adaptability Inventory (r = .77). In addition, the PI showed a highly reliable effect for rater group (client, caregiver, therapist; rater reliability = .98) and minimal floor and ceiling effects (Malec, 2004; Malec.
et al., 2003; Malec & Lezak, 2003; Malec, Moessner, Kragness, & Lezak, 2000).

**BADS.** This instrument consists of six subtests: Rule Shift Cards, Action Program, Key Search, Zoo Map, Temporal Judgment, and Modified Six Elements. The profile scores of each subtest range from 0 to 4, and the total profile score ranges from 0 to 24. Interrater reliability was found to be high (ranging between .88 and 1.00), and construct validity was supported, showing significant differences between groups with brain injury and healthy controls (Wilson et al., 1996; Wilson, Evans, Emslie, Alderman, & Burgess, 1998). The BADS and most of its subtests correlate significantly with the standard executive tests, indicating that it possesses adequate concurrent validity. In addition, the BADS’s ecological validity is superior to standard executive tests in terms of predicting competency in role functioning (Norris & Tate, 2000). In this study, we used three subtests from the BADS: Rule Shift Cards, the Zoo Map, and the Modified Six Elements.

**Dysexecutive Questionnaire.** The Dysexecutive Questionnaire (DEX) comes with the BADS battery but can be used separately as well (Wilson et al., 1996), and it is considered to be a sensitive and ecologically valid measure of dysexecutive symptoms among patients with different types of neurological disorder (Burgess, Alderman, Evans, Emslie, & Wilson, 1998; Wilson et al., 1996, 1998). The DEX is a 20-item questionnaire constructed to reflect the range of problems encountered in the dysexecutive syndrome, covering four areas: (1) emotional–personality changes, (2) motivational changes, (3) behavioral changes, and (4) cognitive changes. Items are scored using a 5-point Likert scale ranging from 0 (never) to 4 (very often). Higher scores reflect greater dysexecutive characteristics. The DEX has two identical versions, one to be completed by the client (self-rated version) and the other to be completed by a close relative or caregiver (informant rater version) who is well acquainted with the patient. An overall score is calculated by totaling the 20 individual items, with a maximum score of 80. The internal consistency reliability of this scale was adequate (α = .74), and a recent study demonstrated the DEX’s construct validity in acquired TBI (Larson, Perlstein, Demery, & Stigge-Kaufman, 2006). In a study of people with mTBI, people with moderate to severe TBI, and control participants, Larson et al. (2006) found significant group effects on the DEX self- and informant report, demonstrating higher DEX scores with higher injury severity. In the present study, clients and their relatives completed the DEX.

**Self-Awareness of Deficits Interview.** The Self-Awareness of Deficits Interview (SADI; Fleming, Strong, & Ashton, 1996) is a semistructured interview that assesses clients’ self-awareness in three areas: (1) self-awareness of deficits (i.e., the individual’s knowledge of the physical, cognitive, and behavioral changes after brain injury); (2) self-awareness of functional implications of deficits; and (3) ability to set realistic goals. The interviewer asks several questions related to each of these areas to establish the client’s level of self-awareness. The responses are scored on a 4-point scale according to detailed definitions, with 0 indicating accurate self-awareness and 3 indicating severe disorder of self-awareness. We obtained total SADI scores by summing the three subscales to provide a range of possible scores from 0 to 9, with higher scores reflecting greater disorder of self-awareness (Fleming et al., 1996). Research investigating the SADI’s psychometric properties has found that the measure has sound interrater reliability (r = .82; Fleming et al., 1996) and good test–retest reliability, with an intraclass correlation coefficient of .94 in a TBI group (Simmond & Fleming, 2003). In this study, we used the total SADI score and three subscales scores to examine overall level of awareness.

**Procedure**

The tests and questionnaires were conducted by an experienced occupational therapist and collected in one meeting in a quiet room in the rehabilitation department. The evaluation lasted 1.5 hr. First, an interview was conducted to gather the personal information and administer the questionnaires of awareness, DEX, and the PI. Second, the COGNISTAT and the BADS were conducted. The DEX was given to a relative after the patient was evaluated.

**Data Analysis**

We performed statistical analyses using SPSS version 12.0 software (SPSS, Inc, Chicago). Descriptive statistics were used to describe the cognitive and functional profile. We performed t-test comparisons with Israeli normative sample data on the BADS subtests, used Mann–Whitney nonparametric statistics to compare self- and informant reports on the DEX, and used Spearman rho correlation analysis to examine the relationships between the PI and the BADS subtests and DEX total scores.

**Results**

**Executive Functioning**

The results of the executive functioning according to the three BADS subtests are presented in Table 1. A comparison between mean scores of the participants with those of the Israeli normative sample (Dvir et al., 2003) on the BADS for ages 18–65 revealed significant differences on all three subtests (p < .05). The analysis of the frequency distribution
Table 1. Executive Functions According to Three Behavioral Assessment of the Dysexecutive Syndrome (BADS) Subtests: Comparison With Normative Data

<table>
<thead>
<tr>
<th>BDS Subtests</th>
<th>mTBIa (n = 13; M [SD])</th>
<th>Israeli Normative Dataa (n = 93; M [SD])</th>
<th>T (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule Shift Cards</td>
<td>−2.605 (.023)</td>
<td>3.47 (0.9)</td>
<td>2.38 (1.50)</td>
</tr>
<tr>
<td>Zoo Map</td>
<td>−2.545 (.026)</td>
<td>2.54 (1.14)</td>
<td>1.76 (1.09)</td>
</tr>
<tr>
<td>Six Elements</td>
<td>−2.206 (.048)</td>
<td>3.46 (0.42)</td>
<td>2.53 (1.50)</td>
</tr>
</tbody>
</table>

Note. N = 13. mTBI = mild traumatic brain injury; M = mean; SD = standard deviation.

The score range in the mTBI group on all subtests was 0–4.

The results, the scores were dichotomized (0–1 = no restriction in participation, 2–4 = restriction in participation). A considerable percentage of the sample reported restrictions in participation in the domains of initiation (84.6%), leisure (76.9%), and employment (61.5%). Conversely, low rates of restriction were found in transportation (23.1%).

Table 2. Mean Scores on Each Item of the Dysexecutive Questionnaire (DEX) and Total Score: Self- and Relative Report

<table>
<thead>
<tr>
<th>Item</th>
<th>DEX Self-Report M (SD)</th>
<th>DEX Relative Report M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I have problems in understanding what other people mean unless they keep things simple and straightforward.</td>
<td>1.23 (1.16)</td>
<td>0.92 (1.25)</td>
</tr>
<tr>
<td>2. I act without thinking, doing the first thing that comes to mind.</td>
<td>1.15 (1.21)</td>
<td>1.46 (1.39)</td>
</tr>
<tr>
<td>3. I sometimes talk about events or details that never actually happened but I believe did happen.</td>
<td>0.00 (0.00)</td>
<td>0.46 (0.96)</td>
</tr>
<tr>
<td>4. I have difficulty thinking ahead or planning for the future.</td>
<td>2.38 (1.44)</td>
<td>1.92 (1.38)</td>
</tr>
<tr>
<td>5. I sometimes get overexcited about things and can be a bit over the top at these times.</td>
<td>2.15 (1.34)</td>
<td>2.69 (1.03)</td>
</tr>
<tr>
<td>6. I get events mixed up with each other and get confused about the correct order of events.</td>
<td>0.15 (0.37)</td>
<td>1.15 (1.46)</td>
</tr>
<tr>
<td>7. I have difficulty realizing the extent of my problems and am unrealistic about the future.</td>
<td>0.30 (0.75)</td>
<td>0.15 (0.55)</td>
</tr>
<tr>
<td>8. I seem lethargic and unenthusiastic about things.</td>
<td>1.53 (1.56)</td>
<td>2.15 (1.46)</td>
</tr>
<tr>
<td>9. I do or say embarrassing things when in company of others.</td>
<td>0.38 (0.76)</td>
<td>0.46 (0.77)</td>
</tr>
<tr>
<td>10. I really want to do something one minute but couldn’t care less about it the next.</td>
<td>0.38 (0.76)</td>
<td>1.07 (1.32)</td>
</tr>
<tr>
<td>11. I have difficulty showing emotion.</td>
<td>1.15 (1.34)</td>
<td>1.76 (1.58)</td>
</tr>
<tr>
<td>12. I lose my temper at the slightest thing.</td>
<td>1.53 (1.39)</td>
<td>2.15 (1.34)</td>
</tr>
<tr>
<td>13. I seem unconcerned about how I should behave in certain situations.</td>
<td>0.38 (0.76)</td>
<td>1.00 (1.47)</td>
</tr>
<tr>
<td>14. I find it hard to stop repeating saying or doing things once started.</td>
<td>0.46 (0.96)</td>
<td>0.91 (1.31)</td>
</tr>
<tr>
<td>15. I tend to be very restless, and I can’t sit still for any length of time.</td>
<td>1.23 (1.48)</td>
<td>1.30 (1.25)</td>
</tr>
<tr>
<td>16. I find it difficult to stop doing something even if I know I shouldn’t.</td>
<td>0.30 (1.10)</td>
<td>0.84 (1.14)</td>
</tr>
<tr>
<td>17. I will say one thing but will do something different.</td>
<td>0.53 (1.19)</td>
<td>1.15 (1.40)</td>
</tr>
<tr>
<td>18. I find it difficult to keep my mind on something and am easily distracted.</td>
<td>2.00 (1.58)</td>
<td>2.46 (1.12)</td>
</tr>
<tr>
<td>19. I have trouble making decisions or deciding what I want to do.</td>
<td>2.30 (1.43)</td>
<td>2.61 (1.19)</td>
</tr>
<tr>
<td>20. I am unaware of, or unconcerned about, how others feel about my behavior.</td>
<td>0.46 (0.77)</td>
<td>0.76 (1.23)</td>
</tr>
</tbody>
</table>

Note. N = 13. M = mean; SD = standard deviation.

The results for the PI are presented in Table 3. To simplify the results, the scores were dichotomized (0–1 = no restriction in participation, 2–4 = restriction in participation). A considerable percentage of the sample reported restrictions in participation in the domains of initiation (84.6%), leisure (76.9%), and employment (61.5%). Conversely, low rates of restriction were found in transportation (23.1%).
Table 3. Participation Profile According to the Participation Index

<table>
<thead>
<tr>
<th>Restriction in Participation</th>
<th>M (SD)</th>
<th>Range (0–4)</th>
<th>Domain of Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>84.6 (11)</td>
<td>1.69 (1.10)</td>
<td>0–3</td>
<td>Initiation</td>
</tr>
<tr>
<td>46.2 (6)</td>
<td>1.12 (1.51)</td>
<td>0–4</td>
<td>Social contacts</td>
</tr>
<tr>
<td>76.9 (10)</td>
<td>2.23 (1.64)</td>
<td>0–4</td>
<td>Leisure</td>
</tr>
<tr>
<td>46.2 (6)</td>
<td>0.69 (0.94)</td>
<td>0–3</td>
<td>Self-care</td>
</tr>
<tr>
<td>76.9 (10)</td>
<td>2.07 (1.60)</td>
<td>0–4</td>
<td>Residence</td>
</tr>
<tr>
<td>23.1 (3)</td>
<td>0.23 (0.43)</td>
<td>0–1</td>
<td>Transportation</td>
</tr>
<tr>
<td>61.5 (8)</td>
<td>0.92 (1.03)</td>
<td>0–3</td>
<td>Employment</td>
</tr>
<tr>
<td>46.2 (6)</td>
<td>1.00 (1.29)</td>
<td>0–4</td>
<td>Money management</td>
</tr>
<tr>
<td>10.00 (7.10)</td>
<td>3–23</td>
<td>Total Participation Index x Score (possible range = 0–30)</td>
<td></td>
</tr>
</tbody>
</table>

Note. N = 13. M = mean; SD = standard deviation.

Relationships Between Executive Functioning Measures and the PI

We found no significant correlations between the three BADS subtests and the total PI score. However, we found significant moderate correlations between the PI money management domain and all three BADS subtests—Rule Shift Cards (r = -.600, p < .05), Zoo Map (r = -.603, p < .05), and Six Elements (r = -.638, p < .01)—and between the PI employment domain and the Zoo Map (r = -.619, p < .05). Concerning the DEX, we found a significant high correlation between the self-report DEX total score and the PI total score (r = .707, p < .01) and a significant moderate correlation between the relative report DEX total score and the PI total score (r = .598, p < .03).

Discussion

The purpose of this preliminary study was to investigate executive functioning, awareness, and participation in a sample of people with persisting cognitive complaints in the postacute phase after mTBI. Our first hypothesis—that deficits would be found on measures of executive functioning and awareness—was confirmed for executive functions but not for awareness.

Concerning executive functions, large percentages of the participants demonstrated impairments in shifting, planning, and strategy use on the BADS subtests, and mean scores were significantly lower than a sample of healthy Israelis of comparable ages. In addition, according to both DEX self- and informant report, frequent difficulties were reported in emotional regulation, attention, and decision making. Taken together, these findings demonstrate the presence of cognitive and emotional aspects of the dysexecutive syndrome in a sample referred for rehabilitation services after mTBI. These findings are in line with those of other studies demonstrating executive deficits in mTBI (Frencham et al., 2005). Concerning the measures of executive functioning used in this study, the BADS subtests and the DEX, which are recommended measures for evaluating dysexecutive syndrome, were shown to be sensitive measures in this sample. Previous studies have supported the use of the BADS and DEX with people after acquired brain injury (ABI; Norris & Tate, 2000; Wilson et al., 1998); however, these studies did not specifically examine their utility in mild brain injuries.

Our hypothesis predicting the presence of deficits in awareness was not confirmed. According to the awareness interview, all participants were aware of their deficits and functional implications and were able to set realistic goals for the future, except for 1 participant who was mildly unaware of his deficits and their implications. In addition, when comparing DEX self- and relative reports, we found an opposite trend, in which the participants with mTBI reported significantly more frequent dysexecutive behaviors than did their relatives. These results of intact awareness are not consistent with unawareness findings in people with moderate and severe TBI (Port, Willmott, & Charlton, 2002; Sherer et al., 1998, 2003). These preliminary findings of intact awareness in people with mTBI, coupled with previous findings documenting unawareness in people with more severe TBI, appear to support Prigatano’s (1999) hypothesis regarding a significant relationship between injury severity and unawareness in ABI. Moreover, from a clinical perspective, because intact awareness is a positive predictor of rehabilitation outcome (Fischer, Gauggel, & Trexler, 2004; Sherer et al., 1998), the finding that our sample members were aware of their deficits may suggest a potential for positive treatment outcome. Further investigation of awareness dimensions in mTBI, in larger and more representative samples, is clearly warranted to confirm these results.

Our second hypothesis, concerning restrictions in participation in everyday activities, was supported. According to the PI, a considerable percentage of the sample reported restrictions in participation in the domains of initiation, leisure, residence, and employment, highlighting the widespread problems that these people faced in their daily lives. To our knowledge, no prior studies have been conducted on participation in people with mTBI, and further research is required to examine the possible negative impact of mild injury on the daily lives of these people during the postacute phase and in the long term.

Our final hypothesis, that a significant relationship would be found between executive functions and participation, was largely supported. We found significant correlations between the BADS subtests and several participation domains (employment and money management), as well as between the total DEX (self- and informant report) and the
total PI scores. These findings are consistent with the literature on the significant relationship between executive functions, employment outcome (Ownsworth & McKenna, 2004), and IADLs (Colantonio et al., 2004) in people with ABI. The lack of significant correlation between the BADS subtests and the other domains of participation (e.g., leisure, transportation, residence) may be because of the less cognitively demanding nature of these areas of functioning. The strong and significant relationship between the DEX and the total PI may be related to the nature of the DEX assessment, which is designed to reflect executive problems in everyday life.

In summary, this preliminary study demonstrated the persistence of executive function deficits and participation restrictions in daily activities in a group of people several months after sustaining an mTBI. Furthermore, we found a significant relationship between these outcomes. The implications of these results, from a theoretical and clinical perspective, suggest that the consequences of mTBI may not be so mild— that is, that some people may be at risk for significant restrictions in their life roles and that occupational therapy intervention (screening and treatment) may be warranted. The importance of providing intervention supports Ruff's (2005, p. 16) conclusion that it is time to focus on intervention for the “miserable minority” of patients who have persisting symptoms. To identify deficit areas to be targeted in treatment, the test battery used in this study (BADS subtests, DEX, and PI) was shown to have clinical utility and ecological validity.

Limitations and Future Research

The study is limited primarily in sample size and in the omission of measures of depression or emotional state, which have been shown to be significantly related to cognition and participation after mild to moderate head injury (Chamelian & Feinstein, 2006; Rapoport, McCullagh, Shammi, & Feinstein, 2005). We recommend that future studies include larger samples of people with mTBI, as well as measures of emotional functioning. ▲

References


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