Validity of the Behavioral Inattention Test (BIT):
Relationships With Functional Tasks

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Key Words: activities of daily living evaluation
- cerebrovascular accident
- visual neglect

Objectives. The Behavioral Inattention Test (BIT) is a standardized assessment for unilateral visual neglect. It comprises six conventional and nine behavioral subtests. The purpose of this study was to add to the validation of the behavioral subtests.

Method. Forty Israeli subjects with right cerebrovascular accident (CVA), from both day center and hospital settings, were evaluated on three measures: the BIT, performance tasks, and a checklist of activities of daily living (ADL).

Results. Seven of the nine BIT behavioral subtests differentiated significantly between subjects with visual neglect and those without neglect; six of the nine subtests correlated significantly with parallel performance tasks or ADL checklist items.

Conclusion. These results support the construct and predictive validity of most of the BIT behavioral subtests as functional measures of unilateral neglect; thus, the BIT is recommended for use by occupational therapists. Inclusion of a relative score for right and left omissions within the BIT is recommended.

The neglect syndrome, most often resulting from cerebrovascular accident (CVA) or from head trauma, is defined as the inability to orient or react to stimuli presented contralateral to the lesioned hemisphere (Heilman, Watson, & Valenstein, 1985). Neglect usually results from lesions of the nondominant hemisphere (in right-handed people, typically the right hemisphere). Therefore, neglect of the left side, resulting from right hemisphere lesions, is more common and severe than neglect of the right side, resulting from left hemisphere lesions (Ladavas, Perronio, & Umlita, 1990). Neglect is multidimensional. It can be present in the visual, tactile, auditory, or olfactory systems (Bellas, Novelly, Eskenazi, & Wasserstein, 1988; Heilman et al., 1985; Hugdahl, Wester, & Asbjornsen, 1991; Mesulam, 1985) and can be manifested in four spatial domains: internal representation of space, personal space, person-space, and extrapersonal space (Bisiach, Perani, Vallar, & Berti, 1986; Pizzamiglio et al., 1989).

Estimates of the incidence of neglect in persons who have had stroke vary from 12% to 90% (see Table 1), depending on a study's operational definition and selection criteria (Massironi, Antonucci, Pizzamiglio, Vitale, & Zoccolotti, 1988; Sunderland, Derick, & Hewer, 1987). Even if the lowest estimate is accepted, considering the prevalence of stroke, neglect is not uncommon.

Persons with neglect may be unable to communicate with persons situated on the neglected side, or to attend to one side of their body, the food on one side of their plate, obstacles on one side of their path, or letters or words on one side of a text (Herman, 1992). In light of these severe functional implications, it is not surprising that unilateral neglect is often a predictor of poor treatment outcome in stroke rehabilitation (Kinsella & Ford, 1985; Kotila, Niemi, & Laakonsen, 1986; Sunderland et al., 1987).

The significance of neglect in rehabilitation and its potential contribution to the understanding of normal brain function has led to a large body of research concerned with the underlying mechanisms of this deficit. It is widely accepted that neglect is an attentional deficit; however, theorists have emphasized different components of attention as being affected, such as orienting (Heilman et al., 1985; Kinsbourne, 1987); selective attention (Kaplan et al., 1991; Rapcsak, Verfaellie, Fleer, & Heilman, 1989); covert attention such as engagement, disengagement, and shifting attention (Posner, Walker, Friedrich, & Rafal, 1987); and automatic attention (Ridoch & Humphreys, 1983). Mark, Kooistra, and Heilman (1988) suggested that the different theories are compatible; Halligan and Marshall (1992) maintained that they are not. Currently there is no unified theoretical framework that can explain the diverse syndrome of neglect.

Traditional Assessments
The complexity of the neglect syndrome and the absence...
of a unifying theoretical framework has led to the use of a wide variety of tests, mostly paper-and-pencil ones, all claiming to assess the same syndrome. These include the following:

Cancellation tests are visual search tasks that examine the patient’s ability to locate and cancel target stimuli in the neglected hemispace. More omissions on the contralatral side than on the ipsilateral side are considered indicative of unilateral neglect. Commonly administered cancellation tests are line crossing (Albert, 1973), letter cancellation, (Egelko et al., 1989), star cancellation, number cancellation (Wade, Wood, & Langton-Hewer, 1988), and shape cancellation (Weintraub & Mesulam, 1987). These tasks may differ in characteristics that have been shown to influence the performance of patients with neglect, such as the stimulus content, the number of distracting stimuli, and the stimulus array (Caplan, 1985; Kaplan et al., 1991; Weintraub & Mesulam, 1988).

Line bisection tests require the person to estimate and mark the midpoint of lines. These tests vary in the number and position of the lines. Deviation toward the ipsilesional side is considered a manifestation of neglect (Schenkenberg, Bradford, & Ajax, 1980).

Copying and drawing tasks use various figures for copying, including a star, a cube (Oxbury, Campbell, & Oxbury, 1974), a Greek cross (Sunderland et al., 1987), the Rey complex figure (Lezak, 1983), and a flower (Hier, Mondlock, & Caplan, 1983; Kinsella & Ford, 1985) and figures for drawing, including a clock, a flower (Oxbury et al., 1974), a wagon wheel with spokes, and a human figure (Schenkenberg et al., 1980). Omissions or distortions of lateral features of the shapes or figures are typical manifestations of neglect in copying and drawing tasks.

Reading tests are examples of tests that are related to functional tasks. Patients with neglect may misread words or omit letters, words, or entire paragraphs. Battersby, Bender, Pollack, and Kahn (1956) developed a reading test, composed of 10 large printed phrases on cards that can detect a severe neglect-related reading deficit. The Indented Paragraph Test (Caplan, 1987), in which the left margins are indented to variable widths, has been useful in detecting mild to moderate neglect. However, because these tests do not simulate typical reading tasks (such as reading a newspaper or a book), therefore their value as functional assessments is questionable.

The Behavioral Inattention Test

The above assessments provide valuable diagnostic information, but most of them are not standardized and do not supply information about the implications of the neglect deficit for everyday life. The Behavioral Inattention Test (BIT) (Halligan, Cockburn, & Wilson, 1991; Wilson, Cockburn, & Halligan, 1987a, 1987b) was designed in response to this problem. The standardized BIT consists of six conventional subtests (similar to the cancellation, bisection, and copying measures) and nine behavioral subtests designed to identify a wide variety of visual neglect behaviors. The conventional subtests and their maximum scores are as follows: Line Crossing (40), Letter Cancellation (40), Star Cancellation (54), Figure and Shape Copying (4), Line Bisection (9), and Representational Drawing (5). The maximum total score is 146 points.

The behavioral subtests of the instrument all assess aspects of daily life: Picture Scanning with three pictures (plate of food, bathroom sink, and a room), Telephone Dialing, Menu Reading; Article Reading; Telling and Setting Time; Coin Sorting, Address and Sentence Copying, Map Navigation, and Card Sorting. Each subtest receives a maximum of 9 points, so the total maximum is 81. Scores can provide a functional profile of neglect and a meaningful guide for treatment.

The BIT is particularly relevant to occupational therapy because it is concerned with the functional consequences of cognitive deficits (Poole, Dunn, Schell, Tierman, & McKay Barnhart, 1991). Normative data and reliability and validity data were obtained from 50 subjects without brain damage (control subjects) and 80 patients with CVA: 54 with right brain damage (RBD) and 26 with left brain damage (LBD). Scores of the control subjects were used to establish cutoff points for the individual subtests and total scores. Interrater, parallel form, and test–retest reliability were all high (r = .99, .91, .99, respectively, p < .001). Validity

### Table 1

<table>
<thead>
<tr>
<th>Authors</th>
<th>Study Sample</th>
<th>Assessment</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caplan (1987)</td>
<td>66 H</td>
<td>Indented paragraph test</td>
<td>46.5</td>
</tr>
<tr>
<td>Denes, Semenza, Stoppa, &amp; Li (1982)</td>
<td>48 H</td>
<td>Copying (crosses)</td>
<td>53</td>
</tr>
<tr>
<td>Halligan, Cockburn, &amp; Wilson (1991)</td>
<td>54 H</td>
<td>BIT conventional tests</td>
<td>48</td>
</tr>
<tr>
<td>Kinsella &amp; Ford (1985)</td>
<td>31 H</td>
<td>Line cancellation</td>
<td>57</td>
</tr>
<tr>
<td>Kotila, Niemi, &amp; Laakonsen (1986)</td>
<td>66 SR</td>
<td>Copying (cross, cube)</td>
<td>35</td>
</tr>
<tr>
<td>Oxbury, Campbell, &amp; Oxbury (1974)</td>
<td>39 H</td>
<td>Copying (star, cube)</td>
<td>41</td>
</tr>
<tr>
<td>Schenkenberg, Bradford, &amp; Ajax (1980)</td>
<td>20 H</td>
<td>Drawing (flower, clock)</td>
<td>90</td>
</tr>
<tr>
<td>Shiel &amp; Wilson (1992)</td>
<td>27 H</td>
<td>Line cancellation</td>
<td>55</td>
</tr>
<tr>
<td>Smith, Akhtar, &amp; Gavanny (1985)</td>
<td>130 SR</td>
<td>Two pen test</td>
<td>12</td>
</tr>
<tr>
<td>Sunderland, Derck, &amp; Hewer (1987)</td>
<td>197 SR</td>
<td>Copying (cross)</td>
<td>15</td>
</tr>
</tbody>
</table>
| Greek cross (Sunderland et al., 1987), a wagon wheel with spokes, and a human figure (Schenkenberg et al., 1980). Omissions or distortions of lateral features of the shapes or figures are typical manifestations of neglect in copying and drawing tasks.

#### Reading tests

Examples of tests that are related to functional tasks. Patients with neglect may misread words or omit letters, words, or entire paragraphs. Battersby, Bender, Pollack, and Kahn (1956) developed a reading test, composed of 10 large printed phrases on cards that can detect a severe neglect-related reading deficit. The Indented Paragraph Test (Caplan, 1987), in which the left margins are indented to variable widths, has been useful in detecting mild to moderate neglect. However, because these tests do not simulate typical reading tasks (such as reading a newspaper or a book), therefore their value as functional assessments is questionable.

#### The Behavioral Inattention Test

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was established in two ways: first, by examining the relationship between the conventional and behavioral test scores ($r = .92, p < .001$), a measure of concurrent validity; second, by examining the relationship between the behavioral scores and therapists' observations of the patients' activities of daily living (ADL) ($r = .67, p < .001$), a beginning measure of predictive validity (Wilson et al., 1987a; Halligan et al., 1991). Cermak and Hauser (1989) in a critique of the BIT, suggested performing additional validity studies to determine whether the BIT indeed relates to actual functional performance, and suggested expansion of the normative data, as well as consideration of the influence of individual and demographic variables, such as age, gender, socioeconomic status, and educational level.

Shiel and Wilson (1992) found a strong association between neglect, as assessed by the BIT, and ADL as assessed by the Rivermead ADL Assessment and Frenchay Activities Index. Their study contributes to enhancing ecological validity of the BIT. Sunderland et al. (1987) stated that firmer conclusions regarding the link between unilateral visual neglect and ADL could be obtained only if measures of ADL are specifically related to neglect, that is, errors that are due to subjects not looking to one side. Whereas the ADL index used in Shiel and Wilson's study does not meet this criterion, the ADL checklist used in the original BIT study (Halligan et al., 1991) does relate to neglect. Still lacking in the validation of the BIT is a correlate of its behavioral subtests to parallel functional measures, such as use of telephone, scanning the environment, and reading a newspaper.

The purpose of the present study was to further examine the validity of the BIT behavioral subtests. Two questions were considered:

1. Do the behavioral subtests of the BIT discriminate between persons with right CVA who have neglect and persons with right CVA who do not have neglect? (a measure of construct validity)
2. For persons with neglect, is there a relationship between performance on the behavioral subtests of the BIT and (a) similar performance tasks or (b) performance on an ADL checklist? Can the test predict everyday performance? (a measure of predictive and criterion validity)

We hypothesized that the BIT behavioral subtests would discriminate significantly between the subjects with neglect and those without neglect, and that positive correlations would be found among performance on the BIT behavioral subtests, performance tasks, and ADL checklist within the subject group with neglect.

Method

Subjects

The study group was a sample of convenience consisting of 40 patients with right CVA (first event; right-hand dominance) from two treatment settings in Israel: a day rehabilitation center and a rehabilitation hospital. Criteria for exclusion from the study were previous CVAs, illiteracy, left-handedness, and severe visual impairments. All subjects had participated in an occupational therapy program (see Table 2). The main difference between the subjects from the two settings was in the average time since CVA onset (11 months for subjects from the day center, 3 months for subjects from the hospital), and a mean age of 68 years for subjects at the day center versus 60 years in the hospital. From each setting, there were 16 men and 4 women. Countries of birth were Israel (day center, $n = 3$; hospital, $n = 8$), Europe (day center, $n = 6$; hospital, $n = 6$), Asia (day center, $n = 6$; hospital, $n = 1$), and North Africa (day center, $n = 5$; hospital, $n = 5$). Social position, on a scale of 1 to V (1 = high, V = low) (Allen, 1985) was as follows: 1 (day center, $n = 2$; hospital, $n = 1$), II (day center, $n = 4$; hospital, $n = 7$), III (day center, $n = 7$; hospital, $n = 4$), IV (day center, $n = 9$; hospital, $n = 11$), and V (day center, $n = 2$; hospital, $n = 0$).

The presence of neglect was determined by cutoff scores on the BIT conventional subtests. A total score less than 129 (out of 146) is indicative of neglect. Twelve subjects (30%) were diagnosed with neglect (9 from the hospital and 3 from the day center). Similar percentages were found in previous studies that used the same neglect cut-off criterion (Shiel & Wilson, 1992; Wilson et al., 1987a).

Instruments

Translation of BIT A Hebrew translation of the BIT was used (Katz, Averbuch, & Itzkovich, 1991); the translation was approved and published by the BIT publisher, Thames Test Company. The Hebrew version closely follows the original BIT, with some minor adaptations of cultural items in menu reading, coin sorting, and wording for the address, sentence, and article.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Demographic Variables of Subjects From Day Center and Subjects From Hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
<td>Set*</td>
</tr>
<tr>
<td>Age</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Education</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Years in Israel</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Months since CVA onset</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

Note CV A = cerebrovascular accident.

*Set 1 = Day center ($n = 20$); Set 2 = Hospital ($n = 20$).
For this study, two scores were added to the original BIT scoring to provide additional information:

1. Left and right omission scores. The BIT score consists of the total number of omissions, without differentiating between sides.
2. Cuing score. The test manual instructs the examiner, when administering the Picture Scanning subtest, to ask the patient if he or she is finished, or if there is anything else he or she can name or point to on the pictures. The cueing score consisted of those items pointed to after the examiners' cue.

These two scores did not alter the original testing procedures and scoring system.

**Performance tasks.** Five performance tasks that were parallel to four BIT behavioral subtests were developed to examine the predictive and criterion validity of the BIT:

1. Using money from a purse
2. Finding a telephone number in a personal telephone book
3. Dialing a telephone number
4. Telling time on a real watch
5. Scanning objects in a room (see Table 3).

Scoring is ultimately categorical (pass/fail) for being able to perform the tasks correctly. However, it also includes numerical information, such as number of objects indicated while scanning a room and amount of correct numbers dialed or coins used, providing a more refined understanding of performance (see Appendix A).

**ADL checklist.** The ADL checklist developed for the study included eight activities of daily living commonly affected by neglect: dressing, shaving, combing, eating, mobility, social communication, reading, and writing (see Table 3). The checklist was based on that developed by Halligan et al. (1991), and on the Unilateral Inattention Functional Rating Scale by Toglia (1991). Each of the items is scored on a 3-point scale (1 = no, 2 = with guidance, 3 = yes) by the occupational therapist observing the person in daily activities. The therapists were guided to observe whether the subject performed on both sides of the face, body, plate, page, and so on, and to note the score on the checklist. Ten scores are given (reading and writing are scored twice for relating to both sides and not omitting or erring on one side), thus providing a profile and a total score ranging from 10 to 30 points (see Appendix B).

**Procedure**

The three measures were administered in the midmorning in a quiet room of the Occupational Therapy Department. The BIT and performance tasks were administered by the first author to all subjects. To control for practice effect, the BIT and the performance tasks were presented in alternate order. The total assessment time for both measures ranged between 30 and 60 min. The subjects' occupational therapists completed the ADL checklist on the same day, after the BIT and performance tasks were administered, without knowing the testing results.

**Data Analysis**

Data were analyzed with parametric and nonparametric statistical tests, depending on the size of the group and the measurement scales of the variables. The SAS software was used. The BIT scores for this sample did not meet criteria for normal distribution, so the inferential analysis was nonparametric.

Parametric statistics—means, standard deviations, and frequencies—were used to describe demographic variables (see Table 2), and subjects' performance on the BIT. A two-sample t test was used to compare demographic variables between settings (see Table 2).

Nonparametric statistics, the Wilcoxon rank-sum test, was used for group comparisons of performance on all BIT behavioral subtests and omission scores. Wilcoxon signed rank test for pairs' comparisons was used for left and right omission scores, and scores before and after cueing. Spearman rho correlation coefficients were used, defining the strength of the relationships between (a) BIT total scores (conventional and behavioral) and demographic variables and (b) BIT behavioral subtests and parallel functional measures (performance tasks and ADL checklist items), of the subjects with neglect (see Tables 4, 5, and 6).

**Results**

**Demographic Variables**

For the entire sample, no significant correlations were found between demographic variables (age, years of education, social position, country of birth, years in Israel, and setting).
time since CVA onset) and BIT conventional total score. However, significant correlations were found between the BIT behavioral total score and both years of education and social position \((r = .64, p < .0001)\). When reading and writing items (Menu and Article Reading; Address and Sentence Copying) were removed from analysis, the correlations were significant but lower \((r = .49, p < .001\) and \(r = .50, p < .0009\), respectively). A separate analysis for each of the two groups revealed that for the group with neglect, only social position correlated significantly with the behavioral score \((r = .58, p < .04\); additionally, the correlation coefficient was slightly lowered \((r = .55, p < .06)\) when reading and writing items were excluded. For the group without neglect, both years of education and social position correlated significantly with the behavioral score \((r = .58, p < .0005); r = .64, p < .0002)\), and both correlations were lowered by 0.2 when reading and writing items were removed from analysis.

**Hypotheses**

The prediction that the BIT behavioral subtests would differentiate significantly between the two groups was supported by results of the Wilcoxon rank-sum test (see Table 4). The total score and most of the behavioral subtests discriminated significantly between subject groups. Only two, Article Reading and Telling Time, showed the same direction of higher mean scores for the group without neglect, with mean scores of 8 out of a maximum of 9.

**Table 4**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Mean</th>
<th>SD</th>
<th>%≤Cutoff</th>
<th>Wilcoxon (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIT Behavioral Total</td>
<td>1</td>
<td>2</td>
<td>45.53</td>
<td>20.93</td>
<td>83</td>
<td>-3.9 (.0001)</td>
</tr>
<tr>
<td>Picture Scanning</td>
<td>1</td>
<td>2</td>
<td>2.08</td>
<td>2.07</td>
<td>92</td>
<td>-3.8 (.0001)</td>
</tr>
<tr>
<td>Telephone Dialing</td>
<td>1</td>
<td>2</td>
<td>6.67</td>
<td>2.93</td>
<td>50</td>
<td>-3.3 (.001)</td>
</tr>
<tr>
<td>Menu Reading</td>
<td>1</td>
<td>2</td>
<td>5.33</td>
<td>3.28</td>
<td>66</td>
<td>-3.8 (.0002)</td>
</tr>
<tr>
<td>Article Reading</td>
<td>1</td>
<td>2</td>
<td>6.33</td>
<td>3.84</td>
<td>58</td>
<td>-0.65 NS</td>
</tr>
<tr>
<td>Telling and Setting Time</td>
<td>1</td>
<td>2</td>
<td>7.67</td>
<td>2.61</td>
<td>41</td>
<td>-1.05 NS</td>
</tr>
<tr>
<td>Coin Sorting</td>
<td>1</td>
<td>2</td>
<td>8.36</td>
<td>1.50</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Address and Sentence Copying</td>
<td>1</td>
<td>2</td>
<td>4.00</td>
<td>3.95</td>
<td>67</td>
<td>-3.66 (.003)</td>
</tr>
<tr>
<td>Map Navigation</td>
<td>1</td>
<td>2</td>
<td>7.08</td>
<td>2.94</td>
<td>42</td>
<td>-3.09 (.002)</td>
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<tr>
<td>Card Sorting</td>
<td>1</td>
<td>2</td>
<td>7.56</td>
<td>3.65</td>
<td>75</td>
<td>-3.47 (.0005)</td>
</tr>
</tbody>
</table>

*Note: BIT = Behavioral Inattention Test.*

^1 Group 1 = Subjects with neglect \((n = 12)\). Group 2 = Subjects without neglect \((n = 28)\).

**Table 5**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Mean</th>
<th>SD</th>
<th>%≤Cutoff</th>
<th>Wilcoxon (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIT Picture Scanning</td>
<td>1</td>
<td>2</td>
<td>4.27</td>
<td>4.07</td>
<td>25</td>
<td>-4.95 (.0001)</td>
</tr>
<tr>
<td>BIT Telephone Dialing</td>
<td>1</td>
<td>2</td>
<td>5.17</td>
<td>2.62</td>
<td>20</td>
<td>-4.10 (.0001)</td>
</tr>
<tr>
<td>BIT Telling and Setting</td>
<td>1</td>
<td>2</td>
<td>3.86</td>
<td>2.87</td>
<td>16</td>
<td>-3.55 (.0004)</td>
</tr>
</tbody>
</table>

*Note: BIT = Behavioral Inattention Test.*

For all subjects, Telephone Dialing and Map Navigation were the easiest subtests, eliciting almost perfect scores. The most difficult item for both groups was Picture Scanning, which suggests that this task is the most sensitive to neglect (see Table 4 and Figure 1).

**Table 6**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Mean</th>
<th>SD</th>
<th>%≤Cutoff</th>
<th>Wilcoxon (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIT Conventional Total</td>
<td>1</td>
<td>2</td>
<td>23.66</td>
<td>19.04</td>
<td>84</td>
<td>-4.67 (.0001)</td>
</tr>
<tr>
<td>Right omissions</td>
<td>1</td>
<td>2</td>
<td>5.17</td>
<td>2.62</td>
<td>25</td>
<td>-4.10 (.0001)</td>
</tr>
<tr>
<td>Left omissions</td>
<td>1</td>
<td>2</td>
<td>12.25</td>
<td>9.91</td>
<td>50</td>
<td>-3.55 (.0004)</td>
</tr>
</tbody>
</table>

*Note: BIT = Behavioral Inattention Test.*

Wilcoxon signed rank test between BIT conventional subtests right and left omissions \(z = 0.5, p < .04\) for BIT behavioral subtests \(z = 0.30, p < .02\) in group with neglect.

^1 Group 1 = Subjects with neglect \((n = 12)\). Group 2 = Subjects without neglect \((n = 28)\).
The prediction that positive correlations would be found among the BIT behavioral subtests, the performance tasks, and the ADL checklist for subjects with neglect was generally supported by results of Spearman rho coefficients (see Table 5). Significant correlations above .60 were found between all nine BIT behavioral subtests and five compatible performance tasks. Among ADL items, writing had the highest correlation (r = .74) and reading correlated at .58 with Article Reading (it was not significant, probably because of the smaller subject group [n = 9]). Map Navigation and Picture Scanning (plate of food) showed the lowest correlations, suggesting that these subtests do not predict actual performance in eating and mobility. Findings revealed higher relationships with performance tasks and activities that directly parallel the BIT subtests than with global daily activities. Still, an overall correlation between total BIT behavioral and total ADL checklist items was significant (r = .77, P < .003).

Additional Scores

Omissions. All of the omission scores on the BIT differentiated significantly between subjects with and without neglect, as shown by Wilcoxon rank-sum test results (see Table 6). All z scores were significant at P < .0001. In addition, for the subjects with neglect, the mean number of items omitted on the left side of the BIT conventional and behavioral subtests were approximately double those omitted on the right (30 versus 15 BIt, conventional; 12 versus 5 BIT, behavioral). The Wilcoxon signed rank test results for pair comparisons indicated that these differences between the number of left and right omissions were significant (for BIT conventional, z = 26.5, P < .04; for BIT behavioral, z = 30, P < .02). For subjects without neglect, the number of omissions was small and not different between right and left (see Table 6).

Cuing scores. The number of items (out of 32) on the Picture Scanning subtest that subjects with neglect named or pointed to, before and after cuing, is presented in Table 7. For most subjects, cuing enabled them to attend to two to three more objects (whether they performed low, from 12 to 15, or higher, from 24 to 26). A comparison of these scores revealed a significant improvement in scores after cuing (Wilcoxon signed rank, z = 35, P < .001), verifying that the gap between scores before and after cuing was significantly different from 0. However, verbal cueing appeared to improve subjects’ scanning performance to a certain extent.

![Figure 1. BIT Behavioral Subtests: Comparison between group with neglect and group without neglect. PS = Picture Scanning, TD = Telephone Dialing, MR = Menu Reading, AR = Article Reading, TST = Telling and Setting Time, CS = Coin Sorting, ASC = Address and Sentence Copying, MN = Map Navigation, CAS = Card Sorting.](http://ajot.aota.org/11/29/2018 Terms of Use: http://AOTA.org/terms)
Discussion

When designing a test with functional tasks, such as the behavioral subtests of the BIT, it is difficult to isolate a singular factor, such as neglect, from the multiple factors that determine task performance. This situation is less problematic when designing more conventional tests (Webster et al., 1989). The absence of statistical significance on the correlations between the BIT conventional subtests and demographic variables, compared to the presence of significant correlations between the BIT behavioral subtests and years of education and social position, demonstrate this phenomenon. This finding of correlations with education and social position is weaker in subjects with neglect, which suggests that the attentional deficit is dominant, masking the effects of other variables in this group.

The finding that the majority of the behavioral subtests (seven out of nine) discriminated between subject groups supports the BIT’s construct validity. The inability of the Article Reading and Telling Time tests (see Table 4) to discriminate between subject groups on these subtests can be explained by several factors. On Telling Time, subjects with neglect achieved the highest average score and the lowest percentage below the cutoff score; these findings suggest that this test lacks sufficient sensitivity to detect neglect manifestations. Regarding Article Reading, the average score for subjects without neglect was second lowest and the percentage below cutoff was among the two highest, suggesting that an additional factor, such as years of education, might have influenced this group’s performance on this test.

Most of BIT’s subtests seem to have predictive validity for real-life situations. The lack of significant correlation between the two behavioral subtests, Picture Scanning 1 (plate of food) and Map Navigation, with parallel functional measures (see Table 5), suggests that they are not valid measures of eating and mobility and require more development. No conclusions can be drawn pertaining to the validity of the Card Sorting subtest, because this activity was compared to patients’ report of familiarity with card games, not to a parallel task (playing a card game).

The separation of right and left omissions in the BIT scoring relates to the issue of hemi-inattention, a lateralized deficit, versus a general nonlateralized inattentional deficit; this issue needs to be clarified. Wade et al. (1988) recommended the implementation of relative scoring, comparing left and right omissions on visual cancellation tasks. The distinction is not merely a technical matter, but has functional implications, as shown by Chen, Henderson, and Cermak’s study (1993). These authors implemented relative scoring criteria (comparing left and right omissions) on a visual cancellation test and found that patients with hemi-inattention showed less independence in ADL than did patients with nonlateralized inattention. Halligan et al. (1991), in their description of the BIT, stated that “a patient was considered to show neglect on any of the three visual search tasks if they made one or more omissions on the side contralateral to the damaged hemisphere over and above those made on the ipsilateral side” (p. 11). However, these authors did not implement this criterion in the test manual (Wilson et al., 1987a), because the final scores relate to the total number of omissions without distinction of hemispace. We have shown how the implementation of a relative scoring system dividing omission scores to right and left (see Table 6) could contribute to the accuracy of the BIT as a measure of unilateral neglect. Subjects showed twice as many omissions on the contralateral side (left) as on the ipsilateral side (right). Because of this finding, we suggest adding right and left omission scores to the test.

The beneficial effect of verbal cuing on the performance of subjects with neglect (see Table 7) is a finding similar to that found in studies by Riddoch and Humphreys (1983), Halligan and Marshall (1989), and Lin (1992). Because the BIT was intended to provide a basis for treatment planning, incorporation of the patient’s response to cuing into the scoring system may have potential value.

In addition, we suggest that the various subtests of the BIT could provide a framework for analyzing qualitative aspects of functional performance regarding other task characteristics as well. For example, a comparison of performance on the Menu Reading test with performance on the Article Reading test could provide useful information about the number and density of letters that a person can read effectively (the former has fewer and larger letters than the latter); a comparison between the structured format of the Letter Cancellation test and the randomly displayed format of the Star Cancellation test could reveal a deficit in systematic scanning. This additional information can have considerable value to therapists be-

Table 7
Raw Scores of Group With Neglect Before and After Cuing on the BIT Picture Scanning Subtest

<table>
<thead>
<tr>
<th>Subject Number</th>
<th>Before Cuing</th>
<th>After Cuing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>23</td>
<td>25</td>
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<tr>
<td>4</td>
<td>13</td>
<td>17</td>
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<td>5</td>
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<td>11</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>12</td>
<td>22</td>
<td>26</td>
</tr>
</tbody>
</table>

Note: BIT = Behavioral Inattention Test. Raw scores indicate the number of items the subject scanned out of 32. Wilcoxon signed rank test compares before and after cuing scores ($z = 5.3$, $p < .001$).

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cause it provides functional implications as well as diagnostic information.

Study Limitations

The study has two major limitations. First, no data for a healthy control group were collected. Because the BIT mean scores and standard deviations of our Israeli subjects were very similar to those of the British subjects in Halligan et al.'s study (1991), we used the cutoff scores obtained from the British normal sample. However, we recommend that normative data be collected for Israeli persons or, for that matter, for persons in any country. Second, the size of the subject group with neglect was small.

Conclusion

The findings of this study support the use of the BIT in Israel and further support construct and predictive validity of the BIT behavioral subtests as functional measures of unilateral neglect. Our findings also revealed several issues that require further investigation:

1. Some of the subtests did not discriminate between subjects with and without neglect, or did not correlate with parallel functional measures developed for this study.
2. Personal characteristics, such as years of education and profession (social position), need to be considered when interpreting performance on the BIT.
3. A clearer designation of the BIT test with respect to the distinction between general inattention and hemi-inattentional deficits of neglect, as well as scoring systems, needs to be addressed.

Continued development and research of the BIT can deepen our understanding of neglect and our ability to address this problem in rehabilitation. The BIT is recommended for use by occupational therapists because it has shown predictive validity for daily function. Inclusion of a relative score for right and left omissions within the BIT is recommended.

Appendix A

Performance Tasks

1. Money Use
Materials: Purse with 15 coins:
- 2 $5 coins; 2 $1 coins; 4 50-cent coins; 5 10-cent coins
Instructions: “You have to pay 8 ‘dollars’ and 20 ‘cents’ for groceries. Please take out the exact amount of money you need from the purse.”
Number of coins that were taken out: ___ $5 ___ $1 ___ 50 ___ 10
Scoring: 2 = Pass, 1 = Fail (if not exact)

2. Telephone Use
Materials: Personal telephone book and telephone
Instructions: “Please find the telephone number of Mr. Smith, and dial it using this telephone.” (If subject finds number, show him or her the page it is located on; if he or she still does not find it, then point it out.)
Scoring:
A. Finding the number: 3 = independent, 2 = with help (finding correct page), 1 = failed to find the number
B. Dialing: The number dialed: __ __ __ __ __ __ __
   Number of digits dialed correctly: 0 1 2 3 4 5 6
   2 = Pass (number correct), 1 = Fail (if not correct)

3. Telling Time
Materials: Subject’s wristwatch or clock placed opposite to him or her
Instructions: Ask “What time is it now?”
The time ____ Subject’s response ____
Scoring: 2 = Pass, 1 = Fail (if not within 5 min of real time)

4. Room Scanning
Materials: 18 objects spaced equally around the room
Instructions: “Please tell me every object you can see in this room.”
Write every object in the order reported:

Appendix B

Therapist Observation Checklist

Instructions: Circle the appropriate number according to your observation of the following activities:
Scoring: 1 = no, 2 = with guidance, 3 = yes

Does the patient
1. Dress both sides of his or her body? 1 2 3
2. Shave both sides of his face? 1 2 3
3. Comb both sides of his or her hair? 1 2 3
4. Eat and drink from both sides of his or her plate and tray? 1 2 3
5. Make allowances for body space on both sides during mobility (does not bump into objects or people)? 1 2 3
6. Communicate with people on both sides? 1 2 3
7. On reading
   (a) relate to both sides of the text? 1 2 3
   (b) not omit or err regarding letters or words to one side of a word or sentence? 1 2 3
8. On writing
   (a) relate to both sides of the page? 1 2 3
   (b) not omit letters or words to one side of a word or sentence? 1 2 3
Total ADL neglect score: sum ranging from 10–30

Note: ADL = activities of daily living. A total score is clinically irrelevant, but it can be used for research purposes to receive a global score.
Acknowledgments

We thank Professor Sharon Cermak, D. OTR, for encouragement and helpful comments, and the Occupational Therapy Departments at Tel Aviv University, Jerusalem, for enabling and participating in data collection. This article is based on a master’s thesis in partial fulfillment of requirements for the first author’s Master of Science degree in the School of Occupational Therapy at the Hebrew University, Jerusalem, Israel.

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