Is SIB or BNP Better Than MMSE in Discriminating the Cognitive Performance of Severely Impaired Elderly Patients?

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The sensitivity of the Mini Mental State Evaluation (MMSE) in severely impaired patients is reduced by a floor effect and limited score range. The Severe Impairment Battery (SIB) and Preliminary Neuropsychological Battery (BNP) may be valid alternatives. We studied a group of 37 severely compromised elderly inpatients to investigate the usefulness of these two test batteries as alternatives to the MMSE. Both proved reliable, but only the SIB had a wider distribution of results with respect to the MMSE in the lower score range. The BNP, that might be thought easier to perform being a simple verification task, could actually not be completed by the most compromised patients. The SIB seems better able than the MMSE to provide cognitive profile in the three diagnostic categories into which patients were subdivided (Psychogeriatric, Psychorganic, Mentally Retarded). We conclude that it may be useful to test patients with the SIB when they yield a MMSE score lower than 10–12 points. © 1999 National Academy of Neuropsychology. Published by Elsevier Science Ltd

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The cognitive evaluation of severely impaired patients in a long-term care institution is crucial for the planning of rehabilitation efforts. A sound cognitive assessment may help (a) to improve communication with the patient, thus avoiding unnecessary frustration due to interventions that are not adequate to the patient’s residual abilities; (b) to assess

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the efficacy of pharmacological treatment; and (c) to program a rational organization of rehabilitation and caregiver’s activity.

However, it is not always possible to choose an appropriate assessment tool. This is particularly the case with the assessment of severely impaired patients, where the use of the Mini Mental State Evaluation (MMSE; Folstein, Folstein, & McHugh, 1975) has become the predominant approach.

**MMSE**

The widespread diffusion of this testing tool, allowing an easy comparison between different clinical or research findings and the ease of administration have probably determined the MMSE’s success, despite some intrinsic weaknesses. The MMSE is composed of a low number of items (11) giving an overall score of 30 points and hence limiting its sensitivity with patients of differing severity; moreover, different items have a markedly different score range (sometimes the range is 0–1, sometimes 0–5), and points are unevenly distributed among different cognitive functions. The test covers five cognitive domains: (a) time-space orientation, (b) short-term memory and learning, (c) attention and calculation, (d) language, and (e) constructional abilities. However, the items are not strictly specific for different domains, which adds to the low score variability and makes a separate judgment of the single abilities quite unreliable. These problems are particularly noticeable with low scores, where there is a floor effect.

**SEVERE IMPAIRMENT BATTERY (SIB)**

Among the other tools available for assessing a severe cognitive impairment, the SIB (Saxton, McGonigle-Gibson, Swihart, Miller, & Boller, 1990; Saxton & Swihart, 1989) appears as a good alternative to the MMSE. The SIB consists of 40 one-step questions and commands, with a scale score of 100 points. The items are presented with gestural cues and can be repeated to facilitate comprehension. The SIB has the advantage that it includes, besides problem-solving tasks and questions, behavioral observations which make it more similar to an evaluation scale. As it elicits both effortful and automatic responses, with the SIB there is more opportunity to differentiate separate levels of performance. The whole battery administration takes about 30 minutes. It starts with some general questions related to daily life that avoid any distressing introduction. The battery has nine subscales (Social Interaction, Memory, Orientation, Language, Attention, Praxis, Visuospatial Ability, Construction, Orienting to Name), the Language subscale being further subdivided into Naming, Comprehension, Repetition, Reading and Writing. A preliminary standardization study investigated a sample of probable Alzheimer patients with MMSE scores of 13 or less. The interrater reliability ranged through the subscales from .87 to 1.00, with an overall test-retest correlation of .85, but with widely scattered correlations between the different subscales ranging from .22 (Construction) to .87 (Praxis). There was a significant SIB-MMSE correlation (.71). A second study, concerning 69 probable Alzheimer patients who were given French versions of the SIB and MMSE (Panisset, Roudier, Saxton, & Boller, 1994), concluded that the SIB was better able to discriminate between patients who had less than 11 points on the MMSE. In addition, fifteen patients who had a MMSE score lower than 6 had SIB scores ranging from 7 to 81 (the total scale score range in this version was 133). The correlation between the SIB and MMSE was significant ($r = .82, p < .001$), as was the interrater reliability studied on 36 patients ($r = .99, p < .001$), and the test-retest reliability performed
on 17 patients \((r = .87, \ p < .001)\). A longitudinal study on 26 of the patients performed over a period ranging from 10 to 52 weeks proved useful in monitoring the evolution across the nine different cognitive domains.

**BATTERIA NEUROPSICOLOGICA PRELIMINARE (BNP)**

Besides the MMSE and SIB, there is a third type of assessment tool for severe cognitive impairment which perhaps conforms to a more explicitly neuropsychological approach. The BNP (Cossa, Fabiani, Farinato, Laiacona, & Capitani, 1996) is a recently introduced tool originally devised for severely impaired patients emerging from coma (Cossa, Fabiani, Farinato, Laiacona, & Capitani, in press). At variance with SIB, which is in part an evaluation scale, BNP includes only test items consisting in verification tasks which do not need verbal answers: any code previously agreed between examiner and patient is suitable (opening or closing the eyes, left or right turning of the head, etc.). The battery is composed of 60 items, subdivided into 10 tasks of growing difficulty. The first five tasks are nonsymbolic: (a) dimension: the subject is requested to judge if two shapes are of different or equal dimension; (b) casual shapes: the subject must judge the identity of two nongeometric shapes; (c) numerosity: the subject is asked to judge whether two sets of nongeometric dots are presented in equal or different number; (d) color: the subject is asked to judge if two squares are of the same color (possible colors are blue, red black, yellow and green); and (e) quasi-literal shapes: the identity of two signs resembling letters has to be determined. The five symbolic tasks are as follows: (a) small and capital letters: the same letter is displayed twice either in the same or different character type; (b) word and picture: a verification of the match between a word and a picture of the referent are requested; (c) color-word and color: the name of a color and a color are consistently or inconsistently matched; (d) word and digit: a digit is written in arabic or literal characters and may be consistently or inconsistently matched; (e) addition of two digits: the proposed sum has to be checked. It must be stressed that all tasks are very easy, and nonidentities or disconcordances are gross and not subtle. This test was validated on a group of traumatic brain injured patients and has not yet been introduced in a psychogeriatric setting. The test is promising since it is easy and quick to administer, is a pure neuropsychological test, is modular and is of progressively growing difficulty.

As described above, these tests were devised and have proved useful with severely demented patients suspected of Alzheimer type dementia or head trauma patients, but they may also be appropriate for use with other pathologies. Our study was aimed at verifying the possible usefulness of the SIB and BNP as alternatives to the MMSE, in the cognitive assessment of a group of severely compromised elderly long-term resident psychogeriatric patients. We also investigated the possibility of formulating a neuropsychological profile with the SIB in these patients.

Thirty-seven patients were sampled from a psychogeriatric long-term resident population \((n = 201)\), living in the same institutional environment. Because the aim was to compare the properties of three psychometric tools in patients affected by severe cognitive impairment, we decided to include only patients who manifested overt clinical evidence of cognitive impairment in everyday life. For each study (reliability, regression analysis, item study), we included all the patients who were able to complete the set of tests at issue (see each part of the study for the precise number of patients, which ranged from a minimum of 27 to a maximum of 37). Where the aim of the study was to discriminate the metric properties of SIB and BNP against MMSE, the patients belonging to different diagnostic subgroups were collapsed for the purpose of analysis. However, patients were analyzed separately in the section of this paper devoted to assessing the
capacity of each test, taken singly, to identify any qualitative pattern specific to each different nosographic group.

**PART 1: RELIABILITY ANALYSIS**

*Patients and Methods*

Twenty-seven patients participated in this test-retest study, and were not separated for etiology. With respect to the original set of 37 patients, 10 of them could not complete the retest, due to behavioral problems, to refusal to cooperate, or to an interval longer than 2 weeks from the first test. Mean age was 75.4 years ($SD = 7.9$; range = 60–89). Eight were male, and 19 female. Education ranged from 0 to 13 years ($M = 5.5$, $SD = 3.6$). The two testing sessions were performed by the same examiner (C.A. or S.M.) on subsequent days, and in the other cases within 2 weeks, assuming that the cognitive status of the patients would not change during this period.

*Results*

The number of valid test-retest scores slightly varies for each test, because a patient who could not perform, for instance, the MMSE test-retest due to behavioral or severity problems, could perform the SIB test-retest, or vice-versa. Matched scores were 20 for the MMSE, 18 for the SIB, and 22 for the BNP.

Pearson's $r$ was .94 ($p < .001$) for the MMSE, .95 ($p < .001$) for the SIB, and .91 ($p < .001$) for the BNP, indicating a high and comparable reliability of all three tests.

**PART 2: REGRESSION AND CORRELATION ANALYSIS BETWEEN TESTS**

*Patients and Methods*

Thirty-five patients could be included in this study. Here too different etiologies were collapsed. Mean age was 75.3 years ($SD = 8.7$, range = 58–91). Education ranged from 2 to 13 years ($M = 5.7$, $SD = 2.9$). Eleven patients were male, and 24 were female. The three tests were administered to the same subject on the same day or, if this was not possible, within the shortest possible interval (maximum range was 5 days). A given patient was always examined by the same examiner.

We studied the regression of SIB and BNP on the MMSE, and of the BNP on the SIB, evaluating also the Pearson’s correlation between each couple of tests.

*Results*

All patients were able to perform the MMSE and SIB, but only 26 completed the BNP. Therefore, 35 subjects were considered for the analysis of MMSE versus SIB, but only 26 for MMSE versus BNP and SIB versus BNP.

The relationship between the SIB and MMSE (Figure 1a) was highly significant ($r = .88$, $p < .001$), and their dependence (SIB as a function of MMSE) is best explained by a logarithmic function. Even if the number of observations in the lowest score region was low, the SIB was more apt to discriminate different performances in this region; that is,

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*FIGURE 1. Regression analysis for each test pair (the white symbol in b represents two patients with identical scores).*
for the 5–10 score region of the MMSE, the corresponding range of the SIB was 30–70 points, so avoiding the floor effect. In the 5–10 score region of the MMSE we observed 8 subjects (i.e., 22.8% of the sample): for them the MMSE offers a scale span of just 4 points (i.e., 13.3% of the whole scale), whereas the SIB offers 39 points (i.e., 38% of the scale). The sensitivity of the SIB decreased in the highest score zone, but it is worth noting that even the MMSE was not very sensitive here, showing a clear ceiling effect. A similar logarithmic trend (Figure 1b) was evidenced in the regression of the BNP on MMSE, but the relationship was weaker ($r = .54$, $p = .008$).

The relation between the BNP and SIB was linear ($r = .75$, $p < .001$), and this points to a greater similarity of their metric properties (Figure 1c) with respect to the MMSE-SIB and MMSE-BNP.

**Comment**

The SIB seems the test best suited for describing the performances of elderly patients with a severe impairment, given the wide distribution of scoring observed. It is not so useful when used with less compromised subjects (cf. MMSE scores over 20) because it rapidly shows a ceiling effect in this region. This replicates the results of another study (Panisset et al., 1994) carried out on a population of demented patients: the authors observed a SIB score range of 7–81 points in the 0- to 5-point range of the MMSE. The scale properties of the BNP tend to be similar to those of the SIB, but we found the BNP more difficult to administer to severely impaired subjects, at least in the clinical setting of this study, and this limits its potential usefulness. Although apparently simple, these verification tasks probably require a certain degree of abstract thinking which was beyond the cognitive level of many patients of our sample.

**PART 3: ITEM ANALYSIS**

**Aim**

The aim of this section is to analyze whether the SIB and BNP are able to give a more precise picture of the distinct cognitive domains (SIB) or abilities (BNP) which they address. Can they be used to give a neuropsychological profile of the single patient or of the group studied, or indicate which cognitive domains deserve further analysis? Such a capacity would give them a considerable advantage over the MMSE.

**Patients and Methods**

Thirty-seven patients entered this part of the study. Mean age was 75.3 years ($SD = 8.5$; range = 58–92). Eleven were men, and 26 were women. Education ranged from 0 to 13 years ($M = 5.2$, $SD = 3.1$). Patients were further subdivided into three diagnostic categories: (a) Psychogeriatric patients, mostly having residual schizophrenic syndromes or showing moderately active syndromes; (b) Psychorganic patients, suffering various dementia syndromes (AD, MID, Pick’s disease, or Alcoholism); (c) Mentally Retarded patients, who suffered perinatal trauma or encephalitis, or have a congenital cerebral malformation. The Psychogeriatric patients numbered 18, Psychorganic patients 13, and Mentally Retarded 6. Their mean age and education (in parentheses) was respectively 74.6 (7.3), 79.0 (9.9), 69.6 (5.7).

Only 27 patients were able to produce a complete BNP score; those who did not show an understanding of the instructions in any section were discarded. To reduce the disper-
SIB and BNP vs. MMSE

Division of SIB scores, we grouped the cognitive domains according to the SIB subdivisions, as follows: (Domain A) Memory + Attention (10 items), (Domain B) Social Interaction + Orientation + Orienting to Name (7 items), (Domain C) Language (24 items), (Domain D) Praxis + Visuospatial Ability + Construction (10 items).

Results

The mean overall SIB score and scores for the different cognitive domains of the 37 subjects as a whole and per diagnostic subgroup are displayed in Table 1.

Figure 2 shows the same results after z standardization, in order to permit a direct confrontation between cognitive domains. There was a progressive decline in general performance from Psychogeriatric patients to Mentally Retarded. There were only

<table>
<thead>
<tr>
<th>Overall</th>
<th>M + ATT</th>
<th>SI + O + ON</th>
<th>L</th>
<th>PR + VS + C</th>
</tr>
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<tr>
<td>82.9</td>
<td>15.5</td>
<td>12.1</td>
<td>38.6</td>
<td>16.7</td>
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<td>74.7</td>
<td>14.5</td>
<td>10.3</td>
<td>34.9</td>
<td>15.0</td>
</tr>
<tr>
<td>58.5</td>
<td>9.5</td>
<td>10.3</td>
<td>27.2</td>
<td>11.5</td>
</tr>
<tr>
<td>76.1</td>
<td>14.2</td>
<td>11.2</td>
<td>35.5</td>
<td>15.3</td>
</tr>
</tbody>
</table>

Note. All patients, n = 37; psychogeriatric patients, n = 18; psychorganic, n = 13; mentally retarded, n = 6. m = memory; ATT = attention; SI = social interaction; O = orientation; ON = orientation to name; L = language; PR = praxis; VS = Visuospatial ability; C = construction.

Figure 2. Standardized SIB z scores of the 37 studied patients for the four cognitive domains (A, B, C, D) described in the text (M = memory; ATT = attention; SI = social interaction; O = orientation; ON = orienting to name; L = language; PR = praxis; VS = visuospatial ability; C = construction), compared with the overall SIB battery. Patients are subdivided into diagnostic categories (psychogeriatric patients, n = 18; psychorganic, n = 13; mentally retarded, n = 6).
slight, though qualitatively important, differences in performance levels over the four cognitive domains. Mentally Retarded subjects fared better than their overall performance in Domain B (Social Interaction + Orientation + Orienting to Name), and slightly worse in Domain A (Memory + Attention). Psychorganic patients showed a lower performance in Domain B, reflecting mainly their problems in social interaction.

These results suggest a distinct qualitative profile for each of the three groups. Considering the small number of subjects and the number of planned comparisons, we felt that our study could not allow a sound statistical evaluation of the inferential risk; therefore, the above results should be better viewed as descriptive remarks and interesting hypotheses in need of confirmation with larger studies based on controlled sampling.

The mean BNP score of the 27 patients who completed the test was 36.7 out of 60 (SD = 24.0). As with the SIB, there was a progressive decline from Psychogeriatric to Mentally Retarded patients (Table 2). However, in contrast to SIB, no differences were found collapsing and then comparing nonsymbolic with symbolic items across the three groups (Figure 3). Examining each performance individually, we found that 11 subjects had a better score in nonsymbolic than in symbolic items, 5 had no differences between the two scores, and 11 fared better in symbolic items. No significant differences in this pattern emerged within the three diagnostic groups.

**Comment**

The SIB was better able than the BNP to individuate different profiles and levels of performance for the three diagnostic groups studied. The profiles defined by the SIB were transparent with respect to the tested cognitive domains. It should be recalled however that in 27% of patients (the severest ones) a BNP score could not be obtained, due to failure in understanding of the task.

**GENERAL DISCUSSION**

The SIB and BNP both proved to be reliable tools for the cognitive assessment of the specific population of very elderly institutionalized patients. The SIB measurement properties in the lower score region are better suited for differentiating poor performances with respect to MMSE. The BNP's capacity in this respect, though similar, is less fully-fledged. Because for understanding and performing some SIB sections, the patients may rely on nonverbal comprehension and on the sparing of quasi-automatic ecological behavior, the SIB seems to be suitable also for those patients who fail to fully understand all BNP commands. The use of the BNP is probably of advantage in situations

### Table 2: BNP: Mean Overall Scores Obtained From the 27 Patients Studied

<table>
<thead>
<tr>
<th></th>
<th>All Nonsymbolic Items</th>
<th>All Symbolic Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychogeriatric</td>
<td>26.0</td>
<td>25.7</td>
</tr>
<tr>
<td>Psychorganic</td>
<td>25.6</td>
<td>24.3</td>
</tr>
<tr>
<td>Mentally retarded</td>
<td>22.7</td>
<td>21.7</td>
</tr>
</tbody>
</table>

*Note.* Psychogeriatric patients, *n* = 15; psychorganic, *n* = 9; mentally retarded, *n* = 3. Items are collapsed in nonsymbolic versus symbolic (maximum score for each subtest = 30). Refer to the Introduction for the meaning of *nonsymbolic* and *symbolic* items.
where the patient is less severe from the cognitive perspective but has a definite impairment in communication with the examiner due to motor and/or sensory limitation. The contribution coming from our study is that coping with a simple verification task proved more difficult than would have been expected even for such a cognitively compromised elderly population, as is witnessed by the fact that only part of the patients studied with the MMSE and SIB could be fully tested with the BNP. Besides its capacity to give a finer grained judgment of severe patients, a further advantage of the SIB over the MMSE is that it can draw a cognitive profile of the patient’s abilities.

Should we conclude that the SIB should systematically replace the MMSE in the assessment of severe neuropsychological samples? The answer depends on the type of survey that one has to perform, on the need or not to confront results with other Centers and on the attention and motivation of the patients (i.e., the type of population to test): Certainly, there are cases where the SIB’s longer administration time is justified in the face of the information gain obtained through its use. A possible strategy could be to use the SIB as a supplement in patients with MMSE scores of less than 10–12 points.

REFERENCES


